

# KIASU

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## SECONDARY 4

Express Exam Paper

### Pure Chemistry

1	CHIJ Katong Convent	SA1
2	Gan Eng Seng	SA1
3	Hua Yi Secondary	SA1
4	Mayflower Secondary	SA1
5	Temasek Secondary	SA1
6	Bendemeer Secondary	SA2
7	Bukit Batok Secondary	SA2
8	Geylang Methodist	SA2
9	Jurong West Secondary	SA2
10	Seng Kang Secondary	SA2





Name: \_\_\_\_\_ (      )

Class: \_\_\_\_\_



**CHIJ KATONG CONVENT**  
**MID-YEAR EXAMINATIONS 2018**  
**Secondary Four Express**

**CHEMISTRY**

**6092/01**

Duration: 1 hour

Classes: 406

Additional Materials: Optical Answer Sheet.

**READ THESE INSTRUCTIONS FIRST**

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid/ tape.

Write your name, class and index number in the spaces provided at the top of this page and on the Optical Answer Sheet.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers, **A, B, C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

**Read the instructions on the Answer Sheet very carefully.**

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done on the question paper.

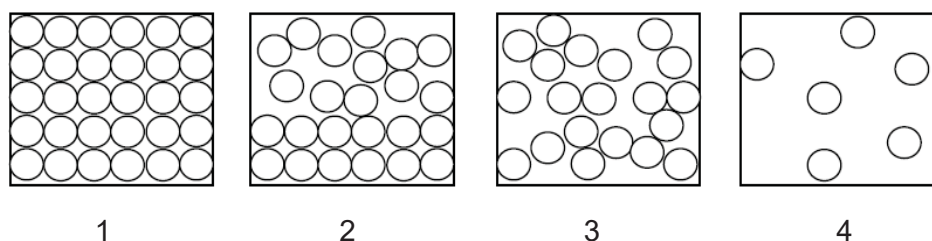
A copy of the Data Sheet is printed on page 14.

A copy of the Periodic Table is printed on page 15.

**At the end of the examination, hand in:**

1. Optical Answer Sheet; and
2. Question paper **separately**.

- 1 The diagram represents different arrangement of atoms.

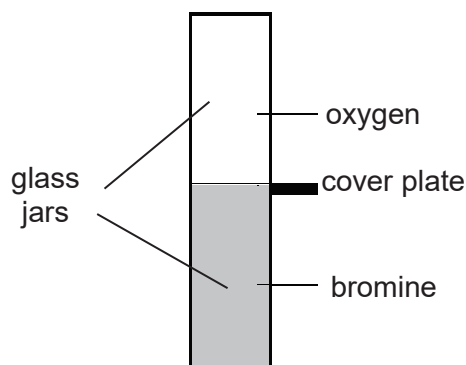


Bromine melts at  $-7^{\circ}\text{C}$  and boils at  $59^{\circ}\text{C}$ . A tank filled with bromine at  $30^{\circ}\text{C}$  (room temperature) is cooled to  $-7^{\circ}\text{C}$ .

Which row best represents the arrangement of bromine particles at  $-7^{\circ}\text{C}$  and at  $30^{\circ}\text{C}$ ?

	$-7^{\circ}\text{C}$	$30^{\circ}\text{C}$
<b>A</b>	1	4
<b>B</b>	2	3
<b>C</b>	1	2
<b>D</b>	2	4

- 2 The diagram shows the cover plate removed from the gas jars containing oxygen and bromine respectively. After several days, the colour of the gas is the same in both jars.



Which statement explains this change?

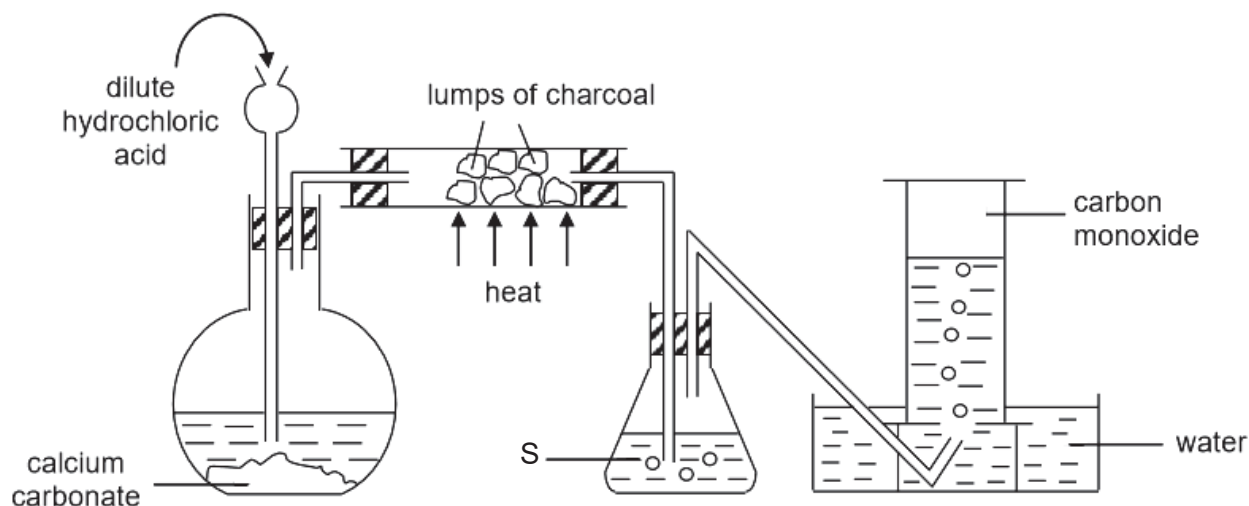
- A** Equal volumes of oxygen and bromine contain equal numbers of molecules.  
**B** Oxygen and bromine gases have equal densities.  
**C** Oxygen and bromine molecules are in random motion.  
**D** Oxygen and bromine molecules diffuse at the same rate.
- 3 The properties of two substances are shown in the table.

substance	melting point/ $^{\circ}\text{C}$	boiling point/ $^{\circ}\text{C}$	solubility in water
1	8	67	insoluble
2	- 95	210	soluble

Which is the best method to separate these two substances at room temperature and pressure?

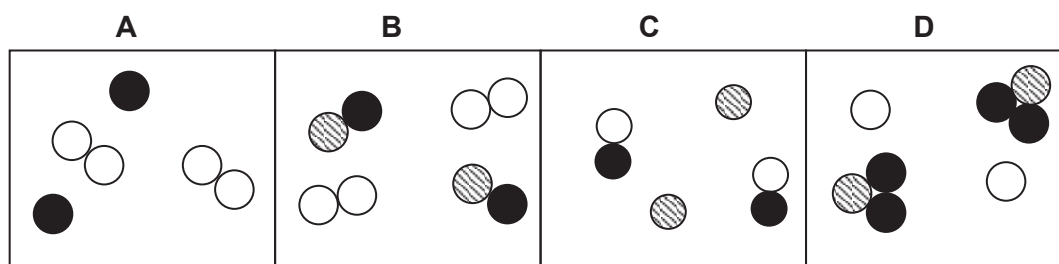
- A** filtration  
**B** paper chromatography  
**C** separating funnel  
**D** simple distillation

- 4 The diagram shows a set-up used to obtain carbon monoxide gas.



What is the purpose of solution S?

- A to remove the presence of carbon dioxide gas
  - B to remove the presence of hydrogen chloride gas
  - C to remove the presence of water vapour
  - D to prevent water from being drawn into the hot charcoal
- 5 Which diagram best represents a mixture of neon and hydrogen bromide?



- 6 Potassium has 2 major isotopes. They are  $^{39}\text{K}$  and  $^{41}\text{K}$ .

If the relative atomic mass of naturally occurring potassium is 39.14, what are the relative abundance of  $^{39}\text{K}$  and  $^{41}\text{K}$ ?

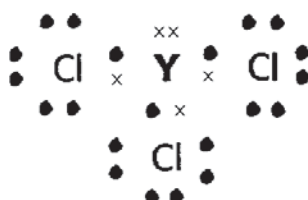
	$^{39}\text{K}$	$^{41}\text{K}$
A	7%	93%
B	25%	75%
C	75%	25%
D	93%	7%

- 7 The table shows the number of neutrons and electrons in the following four particles.

particle	number of neutrons	number of electrons
P	18	8
Q <sup>+</sup>	12	10
R <sup>2-</sup>	16	10
S	13	11

Which particle is an isotope of P?

- A Q<sup>+</sup>  
 B R<sup>2-</sup>  
 C S  
 D none of the above
- 8 The electronic structure of a compound formed between an element Y and chlorine is shown in the diagram. Only valence electrons are shown.



What is the chemical formula when sodium combines with element Y?

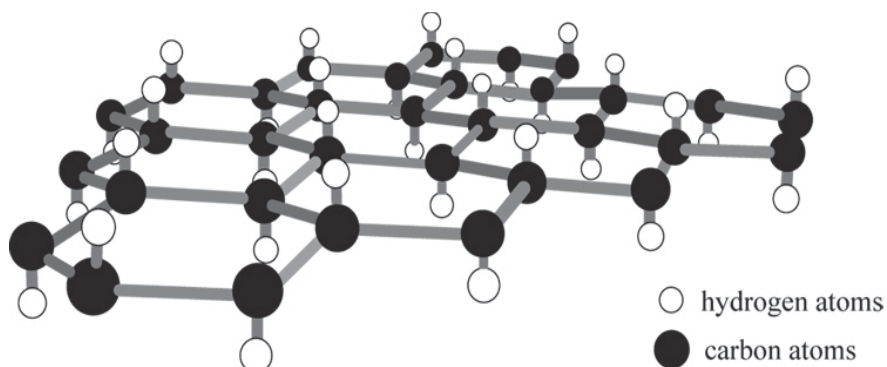
- A Na<sub>2</sub>Y  
 B NaY<sub>2</sub>  
 C Na<sub>3</sub>Y  
 D Na<sub>5</sub>Y
- 9 The following table shows four elements P, Q, R and S with their proton numbers.

elements	P	Q	R	S
proton number	6	8	17	19

Which are the likely formulae of the ionic compound and covalent compound formed from the four elements?

	ionic compound	covalent compound
A	PR <sub>4</sub>	SR
B	S <sub>2</sub> Q	PQ <sub>2</sub>
C	SP	PR <sub>4</sub>
D	SR	RQ

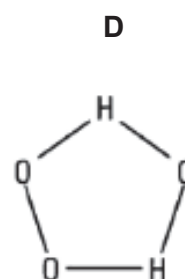
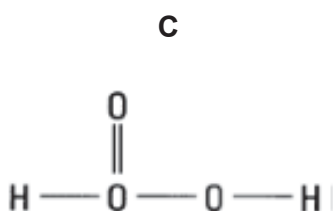
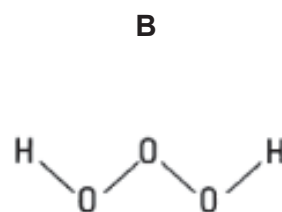
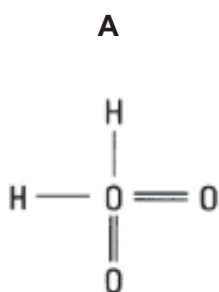
- 10 Graphane, an allotrope of carbon, has a structure similar to graphite. Graphane, however, has one hydrogen atom attached to each carbon as shown in the diagram.



Which set of properties will graphane have?

- 1 It is soluble in water.
- 2 It has a high melting point.
- 3 It has a giant molecular structure.
- 4 It conducts electricity in the solid state.

- A** 1 and 2 only  
**B** 2 and 3 only  
**C** 1, 2 and 3 only  
**D** 1, 2, 3 and 4
- 11 Trioxidane has the formula  $\text{H}_2\text{O}_3$ .  
Which is the most likely structure of trioxidane?



- 12 An element Q has x neutrons and y protons.

Which symbol can be used to represent the ion of Q if it belongs to Group VI?

- A  ${}^{x+y}_{y}\text{Q}^{2+}$   
B  ${}^x_{y}\text{Q}^{2+}$   
C  ${}^{x+y}_{y}\text{Q}^{2-}$   
D  ${}^x_{y}\text{Q}^{2-}$

- 13 The elements in a group of the Periodic Table show the following trends.

- 1 The element with the lowest proton number has the lowest reactivity.
- 2 All the elements in the group form basic oxides.
- 3 The density of the elements increases down the group.
- 4 The melting point of the elements decreases down the group.

In which group are the elements found?

- A I  
B IV  
C VI  
D VII

- 14 Elements X and Y are in the same period.

Which statement is correct?

- A Atoms of X and Y have the same electronic structure.  
B Atoms of X and Y have the same number of electrons.  
C If X is a metal, Y must be a non-metal.  
D The number of shells containing electrons is the same in atoms X and Y.

- 15 Two unlabelled bottles contain colourless solutions. One of which was sodium carbonate solution and the other was sodium chloride solution.

Which solution when added to a sample from each bottle would most readily identify the bottles?

- A ammonia  
B hydrochloric acid  
C lead(II) nitrate  
D sodium hydroxide

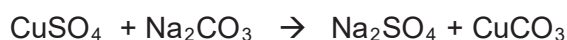
16 Four statements about hydroxide,  $\text{OH}^-$  ions are made.

- It reacts with hydrogen ions to form water.
- It reacts with aqueous iron(III) sulfate to form a green precipitate.
- It migrates to the cathode in electrolysis of an aqueous solution.
- Its solution gives an alkaline gas when warmed with aqueous ammonium chloride.

How many statement(s) is/ are correct?

- A 1 only
- B 2 only
- C 3 only
- D 4 only

17 In an experiment,  $10.0 \text{ cm}^3$  of  $0.01 \text{ mol/dm}^3$  copper(II) sulfate solution was mixed with  $5.0 \text{ cm}^3$  of  $0.01 \text{ mol/dm}^3$  sodium carbonate solution in a flask according to the equation:



What was observed in the flask at the end of the reaction?

- A a colourless solution only
- B a green precipitate and a blue solution
- C a green precipitate and a colourless solution
- D a white precipitate and a colourless solution

18 A student would like to prepare a high yield of lead(II) sulfate salt.

Which is the best method?

- A Adding excess dilute sulfuric acid to lead(II) hydroxide.
- B Adding excess lead(II) carbonate to dilute sulfuric acid.
- C Adding excess lead metal to dilute sulfuric acid, filter and collect the residue.
- D Adding excess lead metal to dilute nitric acid, filter, and followed by adding dilute sulfuric acid to filtrate.

19 The statements give some information about metals R, S, T and U.

- Carbonate of U does not decompose on heating.
- Only oxides of R and T can be reduced by heating with carbon.
- R and S react with dilute hydrochloric acid but not with cold water.
- T reacts with neither dilute hydrochloric acid nor water.

Which is the correct order of increasing reactivity of the four metals?

- A  $T < R < S < U$
- B  $T < S < R < U$
- C  $U < S < R < T$
- D  $U < T < R < S$

- 20** Chrysotile is a type of asbestos which is used in buildings for its flame-retarding and insulating properties. It has the formula  $\text{Mg}_3\text{Si}_2\text{O}_5(\text{OH})_4$ .

What is the oxidation state of silicon in this compound?

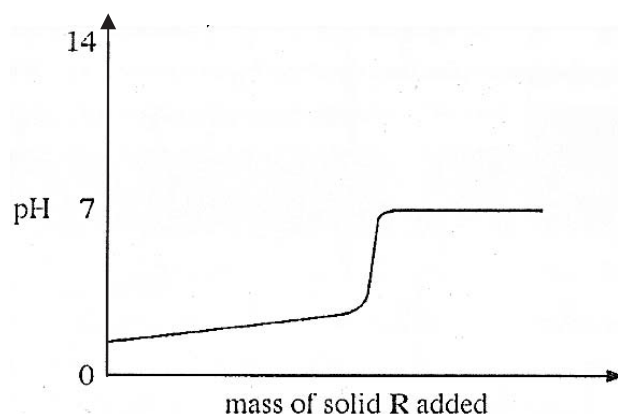
- A** +2  
**B** -2  
**C** +4  
**D** -4

- 21** A sample of flue gas from the power station is bubbled into different solutions and the results are shown in the table.

solution	observation
acidified potassium manganate (VII)	purple solution turns colourless
acidified potassium iodide	colourless solution turns brown
red litmus solution	turns blue
blue litmus solution	turns red

Which are the possible gases present in the sample?

- A** sulfur dioxide gas and chlorine gas  
**B** chlorine gas, hydrogen gas and carbon monoxide gas  
**C** ammonia gas, sulfur dioxide and oxygen gas  
**D** ammonia gas, nitrogen monoxide gas and oxygen gas
- 22** Solid R is gradually added to aqueous solution S. The changes in pH are shown in the graph below.



What are R and S?

	R	S
<b>A</b>	insoluble metal oxide	hydrochloric acid
<b>B</b>	insoluble non-metal oxide	sodium hydroxide
<b>C</b>	soluble metal oxide	hydrochloric acid
<b>D</b>	soluble non-metal oxide	sodium hydroxide



- 23 Which volume of  $1.0 \text{ mol/dm}^3$  hydrochloric acid is required to react completely with 1.25 g of zinc carbonate?

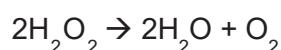
A  $10 \text{ cm}^3$   
B  $20 \text{ cm}^3$   
C  $100 \text{ cm}^3$   
D  $200 \text{ cm}^3$

- 24 An 8 g sample of oxygen atoms contains the same number of atoms as 16 g of element X.

What is X?

A helium  
B sodium  
C sulfur  
D xenon

- 25 When hydrogen peroxide is used as a bleaching agent, it decomposes to form water and oxygen.



When 68 g of hydrogen peroxide decomposes, the volume of oxygen gas collected under room temperature and pressure is  $1200 \text{ cm}^3$ .

What is the percentage purity of hydrogen peroxide?

A 2.5 %  
B 5.0 %  
C 10.0 %  
D 15.0 %

- 26 The compound  $\text{S}_2\text{O}_7$  reacts with water to produce sulfuric acid and oxygen only.

What volume of oxygen, measured at room temperature and pressure, is produced when 0.704 g of  $\text{S}_2\text{O}_7$  is reacted?

A  $48 \text{ cm}^3$   
B  $96 \text{ cm}^3$   
C  $192 \text{ cm}^3$   
D  $384 \text{ cm}^3$

- 27 Which equation does not represent a redox reaction?

A  $3\text{Cl}_2(\text{g}) + 2\text{Fe}(\text{s}) \rightarrow 2\text{FeCl}_3(\text{s})$   
B  $\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{BaSO}_4(\text{s})$   
C  $\text{Fe}^{2+}(\text{aq}) + \text{Mg}(\text{s}) \rightarrow \text{Fe}(\text{s}) + \text{Mg}^{2+}(\text{aq})$   
D  $\text{Zn}(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{ZnCl}_2(\text{aq}) + \text{H}_2(\text{g})$

28 The table shows some bond energies.

bond	kJ/ mol
C – C	346
C – H	413
Si – Si	176
Si – H	318

Which statement is correct?

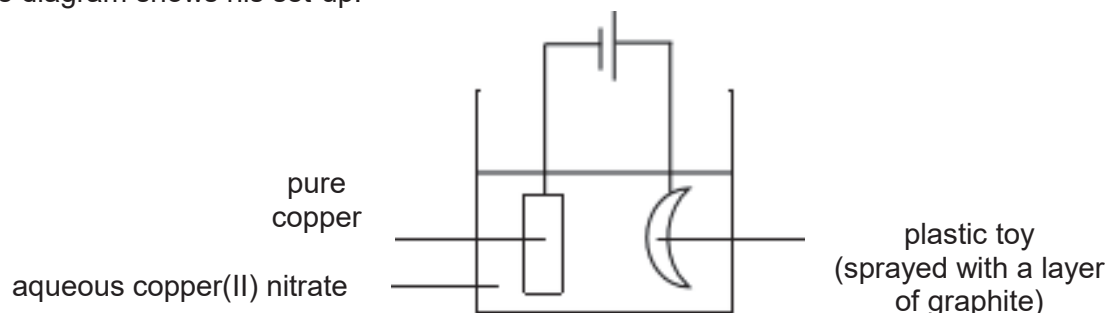
- A** Si – Si chains are more stable than C – C chains.  
**B** Si – Si bonds are the least readily broken of those listed.  
**C** Methane, CH<sub>4</sub>, is chemically more stable than silane, SiH<sub>4</sub>.  
**D** 346 kJ is the energy evolved when 1 mole of graphite sublimes.
- 29 Which is an endothermic process?
- A** C(s) + O<sub>2</sub>(g) → CO<sub>2</sub>(g)  
**B** HCl(aq) + NaOH (aq) → NaCl(aq) + H<sub>2</sub>O(l)  
**C** 6CO<sub>2</sub>(g) + 6H<sub>2</sub>O(g) → C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>(aq) + 6O<sub>2</sub>(g)  
**D** H<sub>2</sub>O(g) → H<sub>2</sub>O(l)
- 30 Which requires the largest number of electrons for complete discharge during electrolysis?
- A** 4 mol of aluminium ions  
**B** 5 mol of hydroxide ions  
**C** 6 mol of copper(II) ions  
**D** 7 mol of oxide ions
- 31 The combustion of methane is an exothermic process.
- $$\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g}) \quad \Delta H = - 890 \text{ kJ/ mol}$$
- How much methane should be used to produce 2670 kJ of heat?
- A** 48 g  
**B** 64 g  
**C** 96 g  
**D** 120 g
- 32 Which statement correctly describes how the ammonia that is produced in the Haber Process is separated from the reaction mixture?
- A** By cooling the mixture.  
**B** By dissolving the other two gases.  
**C** By filtering out the other two gases by passing through cotton wool.  
**D** By passing the gaseous mixture through fused calcium chloride.
- 33 Which statement about the three processes – respiration, combustion and rusting, is correct?
- A** Nitrogen must be present for the processes to occur.  
**B** The mass of reactants is greater than that of the products.  
**C** The processes cause a decrease in the oxygen content of the atmosphere.  
**D** The processes cause an increase in the carbon dioxide content of the atmosphere.

**34** Ammonia is manufactured by the Haber Process.

Which statement is correct?

- A** At the optimum conditions, the yield of ammonia is 100 %.
- B** Hydrogen is the reducing agent.
- C** Increasing the temperature lowers the activation energy.
- D** Nitrogen is oxidised by hydrogen.

**35** A student decides to coat his plastic toy with a layer of copper metal using electrolysis. The diagram shows his set-up.

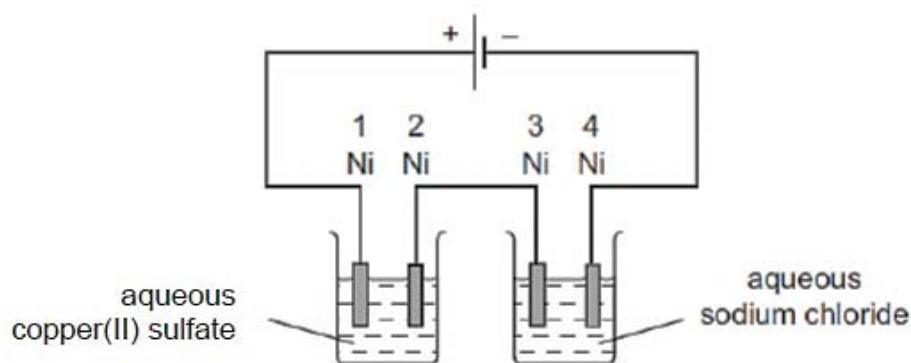


The experiment failed and no copper was deposited on the plastic toy.

Which statement best explains why the experiment failed?

- A** The electrolyte used should be aqueous silver nitrate.
- B** The plastic toy should not be submerged in the electrolyte.
- C** The plastic toy should not be sprayed with a layer of graphite.
- D** The pure copper strip should be attached to the positive electrode.

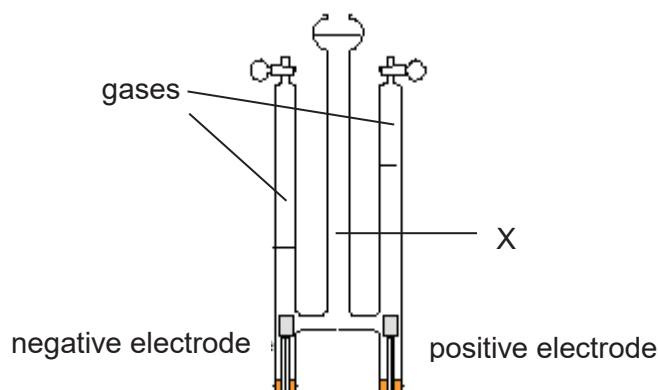
**36** The diagram shows an electrolysis experiment to electroplate nickel with a different metal.



Which nickel electrode(s) is/ are plated with a metal?

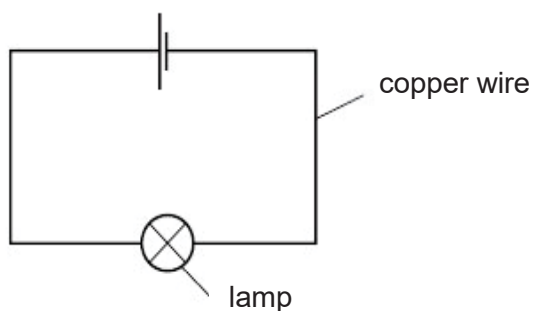
- A** 1 only
- B** 1 and 3 only
- C** 2 only
- D** 2 and 4 only

- 37 The diagram shows the electrolysis of a substance X after a few hours.



What substance could X be?

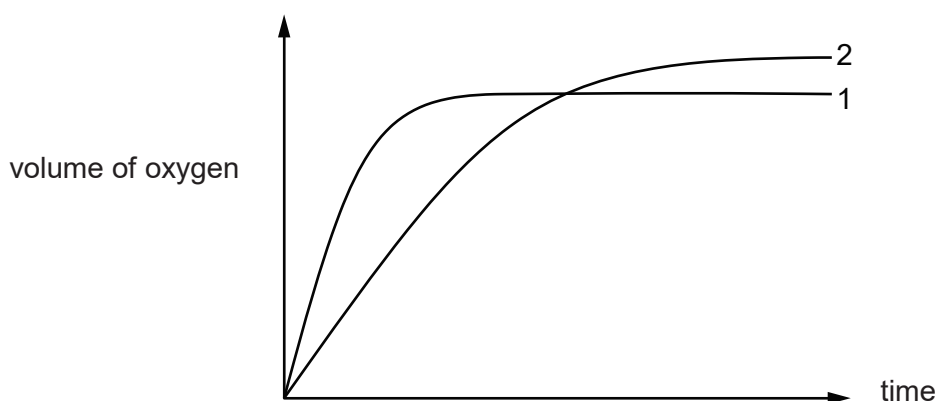
- A copper(II) sulfate solution
  - B concentrated hydrochloric acid
  - C silver nitrate solution
  - D sodium chloride solution
- 38 Copper wire is used to complete an electrical circuit.



Which statement correctly describes what happens in the copper wire?

- A Electrons move along the wire to the negative terminal and positive ions stay in position.
- B Electrons move along the wire to the positive terminal and positive ions move to the negative terminal.
- C Electrons move along the wire to the positive terminal and positive ions stay in position.
- D Negative ions move along the wire to the positive terminal while positive ions move to the negative terminal.

- 39** In the graph, curve 1 was obtained by observing the decomposition of 100 cm<sup>3</sup> of 1.0 mol/dm<sup>3</sup> hydrogen peroxide solution, catalysed by manganese(IV) oxide.



Which alteration to the original experimental conditions would produce curve 2?

- A** adding some 0.1 mol/dm<sup>3</sup> hydrogen peroxide solution
  - B** lowering the temperature
  - C** using a different catalyst
  - D** using less manganese(IV) oxide
- 40** In which reaction is the pressure least likely to affect the speed of reaction?
- A**  $\text{C(s)} + \text{CO}_2\text{(g)} \rightarrow 2\text{CO(g)}$
  - B**  $\text{N}_2\text{(g)} + 3\text{H}_2\text{(g)} \rightarrow 2\text{NH}_3\text{(g)}$
  - C**  $2\text{SO}_2\text{(g)} + \text{O}_2\text{(g)} \rightarrow 2\text{SO}_3\text{(g)}$
  - D**  $\text{NaOH(aq)} + \text{HCl(aq)} \rightarrow \text{NaCl(aq)} + \text{H}_2\text{O(l)}$

### Colours of Some Common Metal Hydroxides

aluminium hydroxide	white
calcium hydroxide	white
copper(II) hydroxide	light blue
iron(II) hydroxide	green
iron(III) hydroxide	red-brown
lead(II) hydroxide	white
zinc hydroxide	white

# The Periodic Table of Elements

Group																											
I	II	1 H hydrogen 1										III	IV	V	VI	VII	0										
<div>Key</div> <div>proton (atomic) number atomic symbol name relative atomic mass</div>																											
3 Li lithium 7	4 Be beryllium 9												5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20									
11 Na sodium 23	12 Mg magnesium 24												13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40									
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84										
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131										
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium -	85 At astatine -	86 Rn radon -										
87 Fr francium -	88 Ra radium -	89 – 103 actinoids	104 Rf Rutherfordium	105 Db dubnium	106 Sg seaborgium	107 Bh bohrium	108 Hs hassium	109 Mt meitnerium	110 Ds darmstadtium	111 Rg roentgenium	112 Cn copernicium		114 Fl flerovium		116 Lv livermorium												
lanthanoids													57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium -	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids													89 Ac actinium -	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium -	94 Pu plutonium -	95 Am americium -	96 Cm curium -	97 Bk berkelium -	98 Cf californium -	99 Es einsteinium -	100 Fm fermium -	101 Md mendelevium -	102 No nobelium -	103 Lr lawrencium -

The volume of one mole of any gas is  $24\text{ dm}^3$  at room temperature and pressure (r.t.p.).

Name: \_\_\_\_\_ (      )

Class: \_\_\_\_\_



# CHIJ KATONG CONVENT

## MID-YEAR EXAMINATIONS 2018

### Secondary Four Express

## CHEMISTRY

**6092/02**

Duration: 1 hour 45 minutes

Class: 406

Candidates answer on the Question Paper.

### READ THESE INSTRUCTIONS FIRST

Write your name, registration number and class on all the work you hand in.  
You may use a soft pencil for any diagrams, graphs, tables or rough working.  
Do not use staples, paper clips, highlighters, glue or correction fluid/ tape.  
The use of an approved scientific calculator is expected, where appropriate.

#### Section A

Answer **all** questions.

Write your answers in the spaces provided on the Question Paper.

#### Section B

Answer **all** three questions, the last question is in the format of either/ or.

Write your answers in the spaces provided on the Question Paper.

You are advised to spend no longer than one hour on Section A and no longer than 45 minutes on Section B.

At the end of the examination fasten all your work securely together.

The number of marks is given in brackets [ ] at the end of each question or part question.

A copy of the Data Sheet is printed on page 21.

A copy of the Periodic Table is printed on page 22.

FOR EXAMINER'S USE	
Paper 1	/ 40
Section A	/ 50
Section B	/ 30
TOTAL	/ 120

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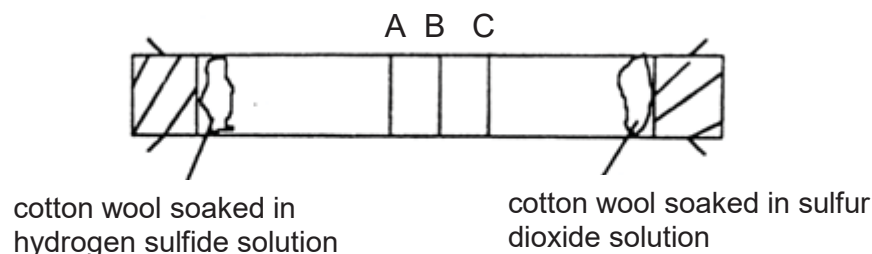
This question paper consists of **22** printed pages.



**Section A [50 marks]**

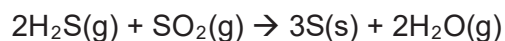
Answer **all** the questions in this section.  
Write your answers in the spaces provided.

- 1 Fig 1.1 shows the set-up of an experiment. After some time, a ring of yellow powder is seen in the tube. A, B or C are possible positions at which this ring may be formed.



**Fig 1.1**

It is known that hydrogen sulfide gas reacts with sulfur dioxide gas as follows:



- (a) Name the yellow powder formed in the tube.

..... [1]

- (b) (i) At which position, A, B or C is the ring of yellow powder most likely to be formed?

..... [1]

- (ii) Explain your answer to (b)(i).

.....  
.....  
..... [2]

[Total: 4]

2 Fig. 2.1 shows the structures of various compounds, **A**, **B**, **C**, **D**, **E** and **F**.

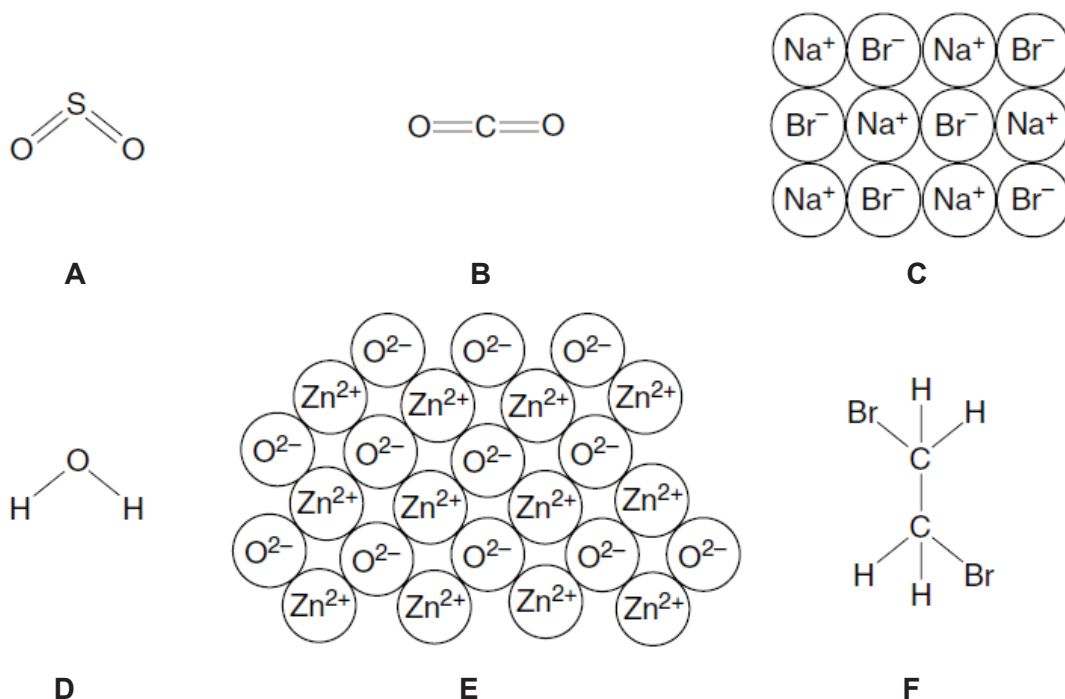


Fig. 2.1

(a) Use the letters **A** to **F** to answer the following.

Each compound may be used once, more than once or not at all.

(i) Which compound is most likely to contribute to acid rain?

..... [1]

(ii) Which compound is an amphoteric oxide?

..... [1]

(iii) Which two of these compounds have giant structures?

..... [1]

(iv) Which compound when molten, releases a reddish brown gas at the anode during electrolysis?

..... [1]

(b) State the empirical formula of compound **F**.

..... [1]

[Total: 5]

- 3 Two experiments were carried out to find out the positions of the metals cobalt (Co), gallium (Ga) and bismuth (Bi) in the reactivity series.

In experiment I, hydrogen gas was passed separately over the heated oxides of the three metals in the combustion tube. The results are given in Table 3.1.

**Table 3.1**

metal oxide	formula	appearance before heating	appearance after heating
cobalt oxide	CoO	green powder	grey powder and a colourless liquid on the side of the glass tube
gallium oxide	Ga <sub>2</sub> O <sub>3</sub>	white powder	white powder; no liquid on glass tube
bismuth oxide	Bi <sub>2</sub> O <sub>3</sub>	yellow powder	grey powder and a colourless liquid on the side of the glass tube

In experiment II, pieces of Bi, Ga and Co were added separately to a solution of Pb(NO<sub>3</sub>)<sub>2</sub>. The results are given in Table 3.2.

**Table 3.2**

cobalt	gallium	bismuth
Grey solid formed on cobalt. The solution slowly turned pink.	Grey solid formed on gallium. The solution remained colourless.	No change in bismuth metal or in solution.

- (a) From the results of both experiments, place Bi, Ga, Co and Pb in the correct order in the reactivity series.

most reactive .....

.....

.....

least reactive .....

[2]

- (b) Name the colourless liquid observed when Bi<sub>2</sub>O<sub>3</sub> and CoO are heated in hydrogen.

..... [1]

- (c) State the property hydrogen shows when it reacts with bismuth oxide.

..... [1]

- (d) Write an ionic equation for the reaction between Ga and Pb(NO<sub>3</sub>)<sub>2</sub> solution.

..... [2]

- 3 (e) Describe what you would observe if a piece of cobalt is placed in aqueous bismuth nitrate.

.....  
 ..... [2]

[Total: 8]

- 4 Fig. 4.1 shows some reactions of copper(II) nitrate,  $\text{Cu}(\text{NO}_3)_2$ .

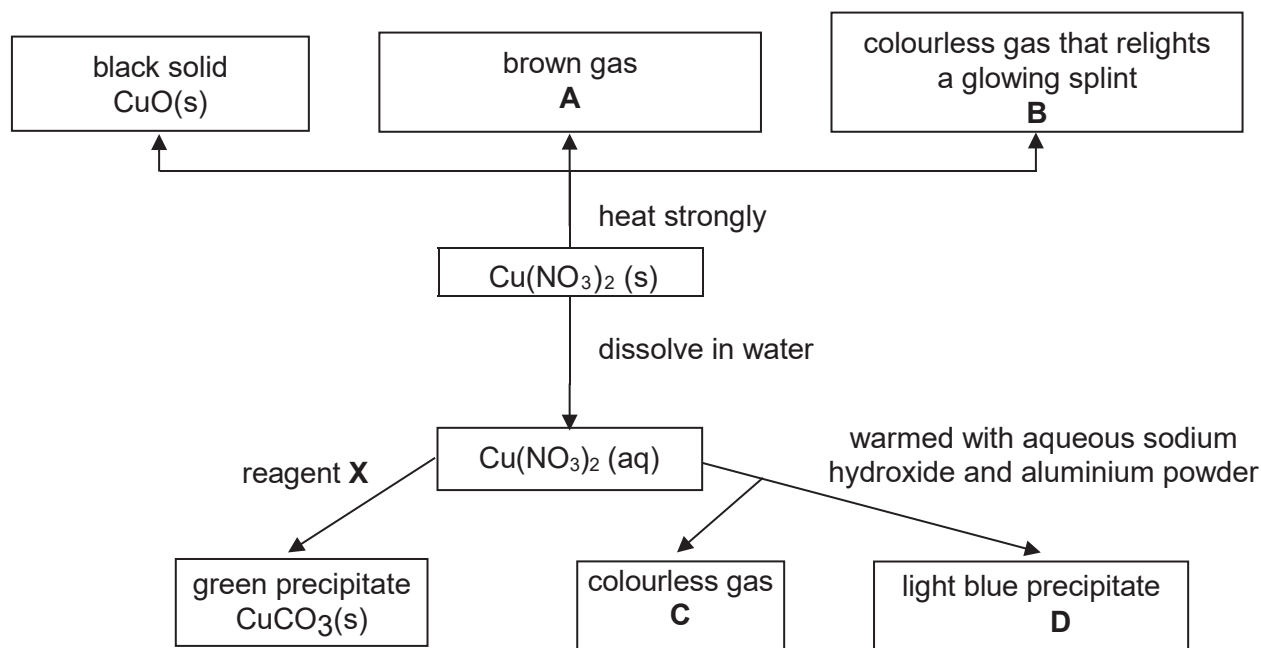


Fig. 4.1

- (a) When two moles of  $\text{Cu}(\text{NO}_3)_2$  is heated strongly, two moles of  $\text{CuO}$ , four moles of **A** and one mole of **B** are made.

- (i) Identify **B**.

..... [1]

- (ii) Write the balanced chemical equation for the reaction when  $\text{Cu}(\text{NO}_3)_2$  is heated.

..... [2]

- (b) Identify

**C** ..... [1]

**D** ..... [1]

**X** ..... [1]

- (c) Write the ionic equation for the formation of the light blue precipitate **D**.

..... [1]

[Total: 7]

- 5 5 g of hydrogen reacts with 142 g of chlorine to form hydrogen chloride. The reaction is exothermic and can be represented by the equation shown.



- (a) Explain with supporting calculations which reactant is in excess.

.....  
.....  
.....  
..... [3]

- (b) Calculate the energy released when 4 g of hydrogen reacts completely with 71 g of chlorine.

You may assume that no other side reaction occurs.

..... [1]

- (c) Explain why the reaction is exothermic, in terms of the energy changes that take place during bond breaking and bond making.

.....  
.....  
.....  
..... [3]

[Total: 7]

- 6** In an experiment,  $20.0 \text{ cm}^3$  of  $0.550 \text{ mol/dm}^3$  of barium nitrate was added to excess aqueous sodium sulfate to produce barium sulfate and sodium nitrate.

**(a)** Calculate the maximum mass of barium sulfate produced.

mass = ..... g

[2]

**(b)** A mass of 1.92 g of dry barium sulfate was obtained.

Calculate the percentage yield of barium sulfate.

percentage yield = ..... %

[2]

[Total: 4]

- 7 Fig. 7.1 shows part of the electrolytic cell for an electroplating process.

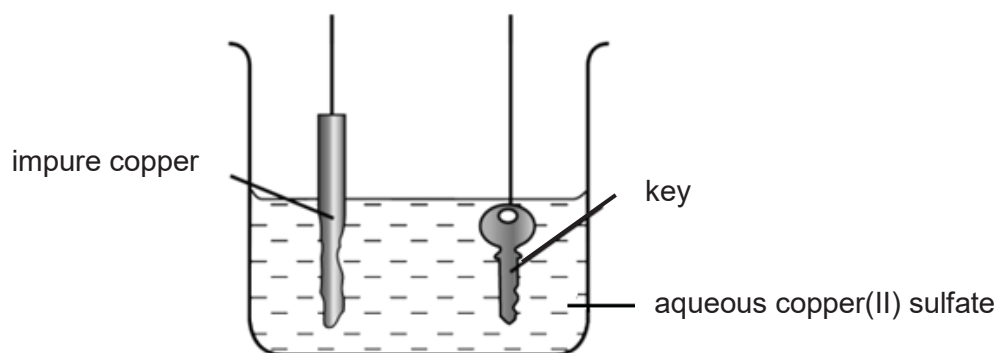


Fig. 7.1

- (a) A student wants to electroplate her key with copper.

Complete Fig. 7.1 by drawing in a battery and connecting wires.

[1]

- (b) Write the half equations for the reactions occurring at the electrodes.

anode : .....

cathode : .....

[2]

- (c) State one use of electroplating.

.....

[1]

- (d) Table 7.1 shows information about the electroplating process.

Table 7.1

	before electroplating	after electroplating
mass of impure copper electrode/ g	150	136.5
mass of key/ g	62	74.6

Calculate the percentage of impurities in the impure copper electrode

percentage yield = ..... %

[2]

[Total: 6]

- 8 (a) Fig. 8.1 shows the set-up of a simple cell which can be used to determine the relative positions of metals in the reactivity series. The voltage of the cell is measured by a voltmeter.

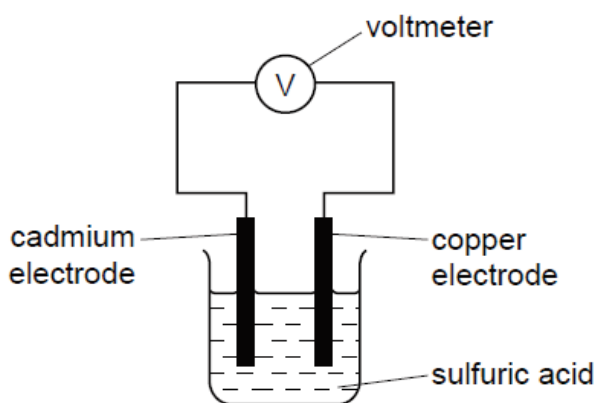


Fig. 8.1

Results from cells using the metals cadmium, tin, zinc and copper are given in Table 8.1.

Table 8.1

cell	electrode 1 (–)	electrode 2 (+)	voltage / volts
1	cadmium	copper	0.74
2	tin	copper	0.48
3	zinc	copper	1.10

- (i) Explain what is meant by a *simple cell*?

.....  
 ..... [2]

- (a) (ii) Place the four metals in order of increasing reactivity and explain how you used the data in Table 8.1 to arrive at this order.

least reactive .....

.....

.....

most reactive .....

.....

.....

.....

..... [3]



- 8 (b) Cadmium is in the same group of the Periodic Table as zinc. Cadmium carbonate is insoluble in water and reacts in the same way as zinc carbonate with dilute acids. Cadmium sulfate is soluble in water.

Describe how you would prepare a pure, dry sample of cadmium carbonate, starting from cadmium sulfate.

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 9]

**Section B [30 marks]**Answer **three** questions.

Question **11** is in the form of an **Either/ Or** question. Only one part should be answered.  
Write your answers in the spaces provided.

**9** Aspirin is a medicine that is used as a painkiller. It is made from salicylic acid.

**(a)** A student makes a sample of aspirin. She thinks it contains some impurities.

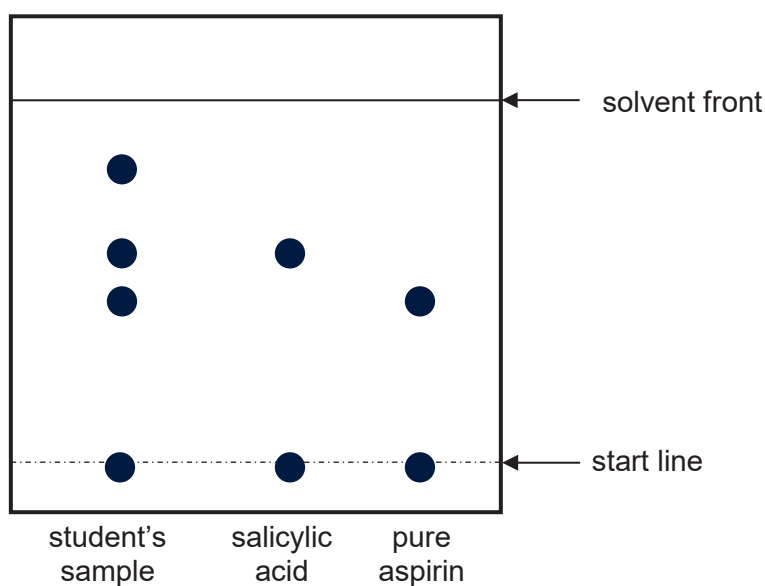
**(i)** The student tests the melting point of the sample of aspirin.

Explain how she can use the result of the test to find out whether the sample contains impurities.

.....  
.....  
..... [2]

**(ii)** The student uses chromatography to compare the sample of aspirin in **(a)** with pure samples of aspirin and salicylic acid.

Fig. 9.1 shows the results of the chromatogram.



**Fig. 9.1**

Is the student's sample of aspirin pure? Explain your answer.

.....  
..... [2]

- 9 (a) (iii) In another chromatography using pure samples of aspirin and salicylic acid, the solvent was allowed to travel 9 cm from the start line.

Table 9.1 shows the  $R_f$  values of pure aspirin and salicylic acid.

**Table 9.1**

substance	aspirin	salicylic acid
$R_f$ values	0.56	0.654

Using the information provided in Table 9.1, calculate the distance travelled by aspirin.

distance = ..... cm  
[1]

- (b) The student buys a few packets of aspirin tablets from a store and performs a titration using a crushed tablet and aqueous sodium hydroxide.

The formula for aspirin can be represented as  $\text{C}_6\text{H}_4(\text{COOH})\text{COOCH}_3$ .

The equation for the reaction between aspirin and aqueous sodium hydroxide is shown below.



Table 9.2 shows the results of the student's titration.

**Table 9.2**

concentration of aqueous NaOH used	0.10 mol/dm <sup>3</sup>
volume of aqueous NaOH needed for neutralisation	15.90 cm <sup>3</sup>
relative molecular mass of aspirin	180

- (i) Calculate the mass of aspirin, in mg, in one tablet. Leave your answer in 3 significant figures. (1 g = 1000 mg)

mass = ..... g  
[3]

- 9 (b) (ii) It is known that some aspirin tablets also contain citric acid. The student repeats the titration using one of these tablets.

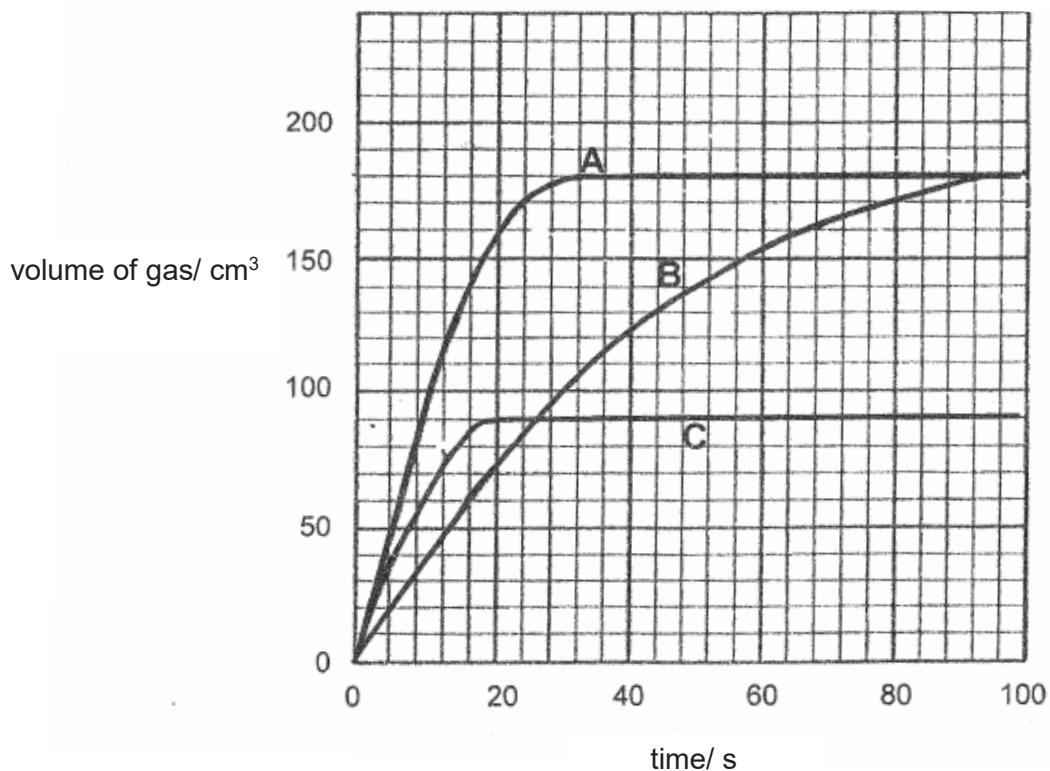
Explain why the mass of aspirin calculated in the second titration is different from that in (b)(i).

.....  
.....  
..... [2]

[Total: 10]

- 10** An experiment was carried out involving two separate reactions between 0.18 g of magnesium and two acids, hydrochloric acid and sulfuric acid. The volume and concentration of both acids used were  $20.0 \text{ cm}^3$  and  $2.00 \text{ mol/dm}^3$ . The results of reactions A and B are shown on Fig. 10.1.

A third reaction C was carried out using  $20.0 \text{ cm}^3$  and  $2.00 \text{ mol/dm}^3$  of an acid and a unknown amount of magnesium ribbon.



- (a) With relevant equations and calculations, explain why the same volume of gas was produced for reactions A and B.

.....

.....

.....

.....

.....

..... [3]

- 10 (b)** Determine which reaction, A or B, used sulfuric acid.

Explain your choice.

.....

.....

.....

.....

.....

..... [3]

- (c)** In reaction C, identify the acid and calculate the mass of magnesium ribbon that was used.

.....

.....

.....

..... [2]

- (d)** When calcium was used in place of magnesium to react with the  $2.00 \text{ mol/dm}^3$  sulfuric acid, the reaction stopped very quickly and also produced less gas.

Give reasons for this observation.

.....

.....

.....

..... [2]

[Total: 10]

## 11 Either

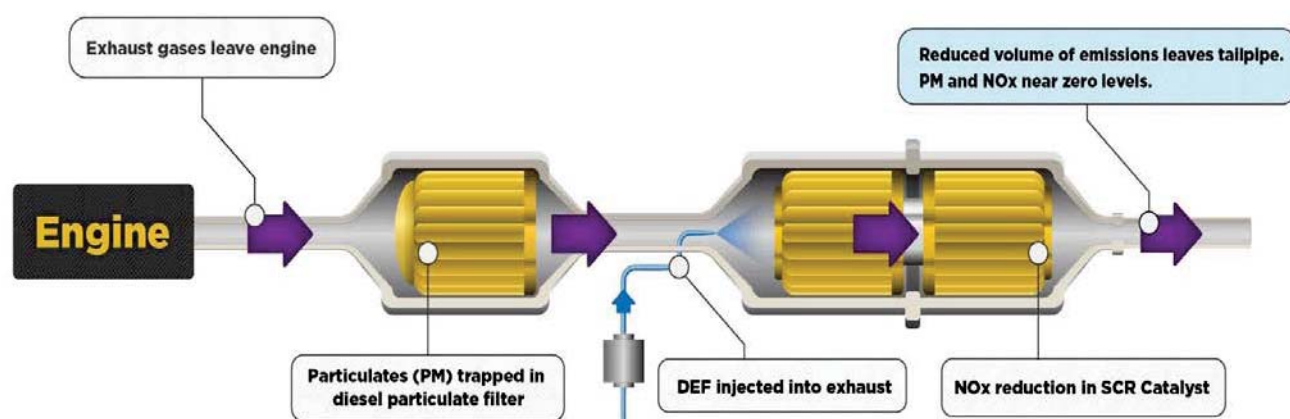
Diesel engines can be run with a lean burn air-to-fuel ratio which is larger than that in petrol engine. This is to ensure the full combustion of soot and to prevent them from giving out unburnt fuel. This then leads to generation of oxides of nitrogen ( $\text{NO}_x$ ), which are harmful pollutants, from the nitrogen and oxygen in the air.

### Introduction to Diesel Exhaust Fluid (DEF)

Diesel exhaust fluid (DEF) is an aqueous urea solution made with 32.5% by mass of urea,  $(\text{NH}_2)_2\text{CO}$ , and 67.5% by mass of deionised water. It is called AUS 32 (aqueous urea solution).

DEF is used in selective catalytic reduction (SCR) in order to lower the concentration of  $\text{NO}_x$  in the diesel exhaust emissions from diesel engines. Within the the SCR catalyst, the  $\text{NO}_x$  are catalytically reduced by ammonia into water and nitrogen, which are both harmless. These are then released through the exhaust.

### Diesel Emissions Control System



Source: <http://www.dieselforum.org/about-clean-diesel/what-is-scr>

### Selective Catalytic Reduction (SCR) systems

SCR catalysts are made from various ceramic materials used as a carrier, such as titanium oxide, and active catalytic components are usually oxides of base metals such as vanadium, molybdenum and tungsten.

The two most common designs of SCR catalyst geometry used today are honeycomb and plate. Each design has different advantages and disadvantages.

	plate-type	honeycomb-type
pressure drop	lower	larger
plugging and fouling	less susceptible	more susceptible
size	large and bulky	smaller
price	expensive	relatively cheaper

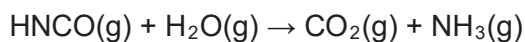
*\*\*Plugging and fouling' causes the catalyst to be coated with a layer of unwanted material.*

**Reduction of oxides of nitrogen (NO<sub>x</sub>)**

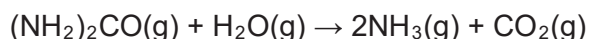
DEF from a separate tank is injected into the exhaust pipeline. When it is injected into the hot exhaust gas stream, the water evaporates and the urea thermally decomposes to form ammonia and isocyanic acid:



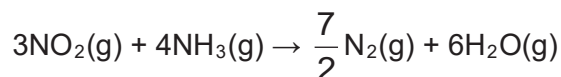
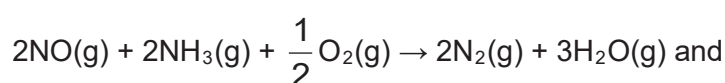
The isocyanic acid hydrolyses to carbon dioxide and ammonia:



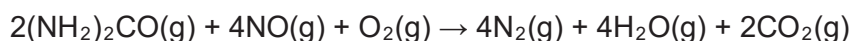
Overall reaction:



From this point, ammonia, in the presence of oxygen and a catalyst, will reduce oxides of nitrogen:



The overall reduction of nitrogen monoxide by urea is:



DEF is injected into the exhaust gas at 2–6% of diesel consumption volume.

**Storage**

It is recommended that DEF be stored in a cool, dry, and well-ventilated area that is out of direct sunlight.

*Adapted from: [https://en.wikipedia.org/wiki/Diesel\\_exhaust\\_fluid](https://en.wikipedia.org/wiki/Diesel_exhaust_fluid)  
[https://en.wikipedia.org/wiki/Selective\\_catalytic\\_reduction](https://en.wikipedia.org/wiki/Selective_catalytic_reduction)*

- (a) Suggest why the running of diesel engines with a lean burn air-to-fuel ratio leads to the production of more oxides of nitrogen.

.....  
..... [1]

- (b) Suggest why, unlike diesel engines, petrol engines do not require the use of DEF.

.....  
..... [1]

- (c) Which type of SCR design, honeycomb or plate, is more suitable to be fitted in cars?

Give a reason for your answer.

.....  
..... [1]



- 11 (d)** State the overall equation for the reduction of nitrogen dioxide ( $\text{NO}_2$ ) by urea.  
..... [1]
- (e) (i)** What is the maximum volume of DEF vapour that needs to be added to  $100 \text{ dm}^3$  of diesel vapour?  
..... [1]
- (ii)** What is the maximum volume of nitrogen gas that can be formed from the combustion of  $100 \text{ dm}^3$  of diesel vapour if the DEF injected only contains urea?  
..... [1]
- (f)** State why active catalytic components are usually oxides of metals such as vanadium, molybdenum and tungsten instead of Group I metals.  
.....  
..... [1]
- (g)** Suggest why DEF should be stored in a cool area that is out of direct sunlight.  
.....  
..... [1]
- (h)** Explain why the use of DEF is not completely environmentally friendly.  
.....  
.....  
..... [2]

[Total: 10]

**11 OR**

The reaction between nitrogen and hydrogen to form ammonia is a reversible reaction. This means that when nitrogen and hydrogen react to form ammonia, some ammonia is decomposed back to its reactants at the same time. The two reactions are shown below:



The forward reaction is exothermic.

During the development of Haber process, Fritz Haber conducted a series of experiments to determine the most cost-effective way to produce ammonia. Table 11.1 shows some of the results. In each case, the experiment began with the molar ratio of nitrogen to hydrogen 1:3.

**Table 1.1**

temperature (°C)	pressure (atm)		
	300	400	500
400	48% $\text{NH}_3$	55% $\text{NH}_3$	61% $\text{NH}_3$
500	26% $\text{NH}_3$	32% $\text{NH}_3$	38% $\text{NH}_3$
600	13% $\text{NH}_3$	17% $\text{NH}_3$	21% $\text{NH}_3$

He applied **Le Chatelier's principle** to the reaction. This principle, in simple terms, states that when a change is applied to a reaction system, the system will tend to move in a direction that reduces the change.

For example, when a change such as increased pressure is applied to a mixture of nitrogen and hydrogen, more ammonia will be formed as there will be fewer number of moles of ammonia than nitrogen and hydrogen. As a result, the change is reduced. Hence, in this reaction, an increase in pressure tends to favour the forward reaction as it reduces the pressure on the system. Consequently, more ammonia is produced.

- (a) By referring to the data in Table 11.1, state the physical conditions required to produce the highest amount of ammonia.

.....  
 ..... [1]

- (b) With reference to the kinetic particle theory and relevant number of moles of gases, explain why the forward reaction of Haber Process reduces pressure.

.....  
 .....  
 .....  
 ..... [2]

- 11 (c)** Ideally, as ammonia is being formed, it should be removed as quickly as possible. With reference to Le Chatelier's principle and/ or other suitable explanation, suggest why this is done.
- .....
- .....
- .....
- ..... [2]
- (d)** With reference to Le Chatelier's principle and enthalpy change, explain the effect of raising the temperature on the amount of ammonia produced in the Haber process.
- .....
- .....
- .....
- ..... [2]
- (e)** One way to increase the rate of reaction between nitrogen and hydrogen to produce ammonia is to raise the temperature. Unfortunately, this method increases the rate of decomposition of ammonia as well.
- Suggest another way to increase the rate of reaction between nitrogen and hydrogen in the Haber process without altering the temperature.
- ..... [1]
- (f)** Draw and label the energy profile diagram of the forward reaction of the Haber process.

[2]

[Total: 10]

### Colours of Some Common Metal Hydroxides

aluminium hydroxide	white
calcium hydroxide	white
copper(II) hydroxide	light blue
iron(II) hydroxide	green
iron(III) hydroxide	red-brown
lead(II) hydroxide	white
zinc hydroxide	white

# The Periodic Table of Elements

Group																	
I	II	Key										VII	0				
		proton (atomic) number atomic symbol name relative atomic mass															
		1 H hydrogen 1															
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium -	85 At astatine -	86 Rn radon -
87 Fr francium -	88 Ra radium -	89 – 103 actinoids	104 Rf Rutherfordium	105 Db dubnium	106 Sg seaborgium	107 Bh bohrium	108 Hs hassium	109 Mt meitnerium	110 Ds darmstadtium	111 Rg roentgenium	112 Cn copernicium		114 Fl flerovium		116 Lv livermorium		
lanthanoids																	
57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium	60 Nd neodymium 144	61 Pm promethium -	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175			
actinoids																	
89 Ac actinium -	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium -	94 Pu plutonium -	95 Am americium -	96 Cm curium -	97 Bk berkelium -	98 Cf californium -	99 Es einsteinium -	100 Fm fermium -	101 Md mendelevium -	102 No nobelium -	103 Lr lawrencium -			

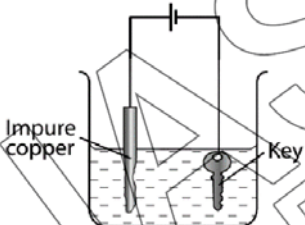
The volume of one mole of any gas is  $24\text{ dm}^3$  at room temperature and pressure (r.t.p.).



# 4E Chemistry MYE 2018 answer scheme

1	B	2	C	3	C	4	A	5	C
6	D	7	B	8	C	9	B	10	B
11	B	12	C	13	A	14	D	15	B
16	B	17	B	18	C	19	A	20	C
21	C	22	A	23	B	24	C	25	B
26	A	27	B	28	C	29	C	30	B
31	A	32	A	33	C	34	B	35	D
36	C	37	D	38	C	39	A	40	D

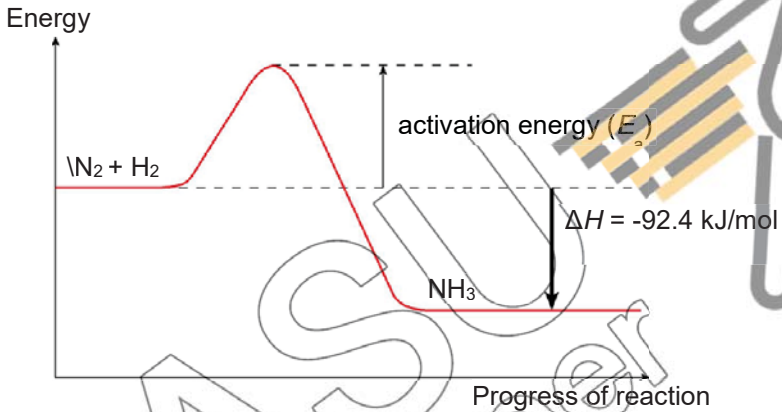
Section A (50 marks)		
Qn no	Answer	Marks/ Remarks
1(a)	sulfur	[1]
1(b)(i)	Position C	[1]
1(b)(ii)	Hydrogen sulfide (Mr = 34) has a smaller molecular mass compared to sulfur dioxide (Mr = 64). Hence, hydrogen sulfide diffuses faster than sulfur dioxide and travel further to react with sulfur dioxide at point C.	[1] [1]
2(a)(i)	A	[1]
2(a)(ii)	E	[1]
2(a)(iii)	C and E	[1]
2(a)(iv)	C	[1]
2(b)	CH <sub>2</sub> Br	[1]
3(a)	Gallium/ Ga Cobalt/ Co Lead/ Pb Bismuth/ Bi	All correct – [2], 2-3 correct – [1]
3(b)	water	[1]
3(c)	Hydrogen is a reducing agent. (Accept Hydrogen is more reactive than Bismuth)	[1]
3(d)	$2\text{Ga (s)} + 3\text{Pb}^{2+} \text{ (aq)} \rightarrow 2\text{Ga}^{3+} \text{ (aq)} + 3\text{Pb (s)}$  ½ mark – correct formula ½ mark – correct state symbols 1 mark – correct balancing	[2]
3(e)	Grey solid formed on cobalt. The solution turned pink.	[1] [1]
4(a)(i)	B is O <sub>2</sub>	[1]
4(a)(ii)	$2\text{Cu(NO}_3)_2 \rightarrow 2\text{CuO} + 4\text{NO}_2 + \text{O}_2$  Identification of NO <sub>2</sub> as a product (1) Balanced equation	[2]
4(b)	C is ammonia D is copper(II) hydroxide X is Any soluble carbonate e.g. sodium carbonate/potassium carbonate/ammonium carbonate	[1] [1] [1]
4(c)	$\text{Cu}^{2+} \text{ (aq)} + 2\text{OH}^- \text{ (aq)} \rightarrow \text{Cu(OH)}_2 \text{ (s)}$	[1]

5(a)	Hydrogen; Number of moles of $H_2 = 5/2 = 2.5 \text{ mol}$ Number of moles of $Cl_2 = 142/71 = 2 \text{ mol}$ ; Mole ratio is 1: 1, hence hydrogen is in excess	[1] [1] [1]
5(b)	Energy released = $184 \times 2 = 368 \text{ kJ}$ ;	[1]
5(c)	Energy taken in to break bonds in hydrogen and chlorine; is less than; energy given out to form bonds in hydrogen chloride;	[1] [1] [1]
6(a)	Number of moles = $0.020 \times 0.550 = 0.011 \text{ mol}$ Mass = $0.011 \times (137 + 32 + 16 \times 4) = 2.563 \text{ g}$	[1] [1]
6(b)	Percentage yield = $(1.92 \div 2.563) \times 100 \% = 74.9\%$ ECF for (a)	[1]
7(a)	 <p>Must show correct polarity of cell</p>	[1]
7(b)	Anode: $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$ Cathode: $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ <i>1 mark for each correctly balanced equation with state symbols.</i>	[1] [1]
7(c)	To prevent corrosion/ to improve the appearance of an object	[1]
7(d)	<p>Mass of copper + impurities lost from electrode = <math>150 - 136.5</math> = <math>13.5 \text{ g}</math></p> <p>Mass of copper deposited on key = <math>74.6 - 62</math> = <math>12.6 \text{ g}</math></p> <p>Mass of impurity = <math>13.5 - 12.6</math> = <math>0.9 \text{ g}</math></p> <p>Percentage of impurities in copper electrode = <math>\frac{0.9}{13.5} \times 100\% = 6.67\%</math></p> <p><i>Award 1 mark if students found percentage purity instead of percentage impurity.</i></p>	0.5  0.5  0.5  0.5
8(a)(i)	device which changes chemical energy [1] into electrical energy; [1] OR produces a voltage / potential difference / electricity [1] due to difference in reactivity of two metals; [1] OR produces a voltage / potential difference / electricity [1] by redox reactions [1]	

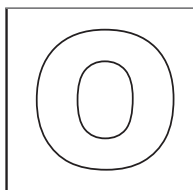


8(a)(ii)	<p>Cu Sn Cd Zn (i.e. all 4 in correct order)</p> <p>The further apart the metals in the reactivity series, the greater the voltage produced. Tin-copper pair has the smallest voltage hence tin is just slightly more reactive than copper. Zinc-copper pair has the largest voltage hence zinc is the most reactive amongst the 4 metals.</p>	<p>[1]</p> <p>[1]</p> <p>[1]</p>
8(b)	<p>1. Add aqueous cadmium sulfate to <u>aqueous sodium carbonate (or any soluble carbonate)</u>. 2. <u>Filter</u> the mixture to obtain the precipitate (cadmium carbonate). 3. <u>Wash</u> the <u>residue</u>. 4. <u>Dry</u> the residue (using sheets of filter paper).</p>	<p>[1]</p> <p>[1]</p> <p>[1]</p> <p>[1]</p>
<b>Section B (30 marks)</b>		
Qn no	Answer	Marks/ Remarks
9(a)(i)	<p>If his sample is pure, the melting point should be a fixed temperature. If his sample is not pure, the aspirin should melt over a range of temperatures.</p>	<p>[1]</p> <p>[1]</p>
9(a)(ii)	<p>Sample is not pure. Sample contains <b>two</b> impurities. The impurities are salicylic acid and an unidentified/unknown substance.</p>	<p>[1]</p> <p>[1]</p>
9(a)(iii)	$0.56 \times 9 = 5.04 \text{ cm}$	[1]
9(b)(i)	<p>mole ratio of aspirin : NaOH = 1:1 (from equation)</p> <p>Mass of aspirin = <math>\left(\frac{15.90}{1000} \times 0.10\right) \times \frac{1}{1} \times 180 = 0.286 \text{ g} = \mathbf{286 \text{ mg}}</math> Award 1m for calculating number of moles of aspirin using '<math>M = C \times V</math>'. Award 1m for calculating mass of aspirin using '<math>\text{mass} = \text{molar mass} \times \text{moles}</math>'. Award 1m for giving final answer in mg and 3 s.f.</p>	[3]
9(b)(ii)	<p>Citric acid (in the tablets) will also <b>react with / be neutralised</b> by sodium hydroxide during the titration. Hence <b>more</b> sodium hydroxide would be used / the calculated mass of aspirin will be <b>greater</b> than actual.</p>	<p>[1]</p> <p>[1]</p>
10(a)	<p>No. of moles of Mg = <math>0.18 / 24 = \mathbf{0.0075}</math> No. of moles of hydrochloric acid = No. of moles of sulfuric acid = <math>0.02 \times 2.00 = \mathbf{0.04}</math> <b><math>\text{Mg} + 2 \text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2</math></b> 1 mole of Mg reacts with 2 moles of HCl, hence, magnesium is the limiting reactant and hydrochloric acid is in excess. <b><math>\text{Mg} + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2</math></b> 1 mole of Mg reacts with 1 mole of <math>\text{H}_2\text{SO}_4</math> hence, magnesium is the limiting reactant and sulfuric acid is in excess. Since magnesium is the <b>limiting reactant for both reactions</b>, the same volume of hydrogen is produced.</p>	<p>[1]</p> <p>[1]</p> <p>[1]</p>
10(b)	<p>Curve A. This is because curve A has a <b>steeper gradient</b> showing that its reaction is faster. Reaction between magnesium and sulfuric acid is faster than its reaction with hydrochloric acid because there are <b>more hydrogen ions per unit volume / higher concentration of hydrogen ions in sulfuric acid</b>.</p>	<p>[1]</p> <p>[1]</p> <p>[1]</p>

10(c)	<p>The acid used is <b>sulfuric acid</b> because it has the same initial rate of reaction.</p> <p>Volume of hydrogen = <math>90 \text{ cm}^3</math>.</p> <p>No. of moles of hydrogen = <math>0.09 / 24 = 0.003750</math></p> <p>No. of moles of magnesium = <math>0.003750</math></p> <p>Therefore, mass of magnesium = <math>0.003750 \times 24</math>  <b>= 0.09 g</b></p> <p>OR</p> <p>Volume of hydrogen is half that of curve A and magnesium is the limiting reactant. Hence mass of magnesium = <math>0.18 / 2 = \mathbf{0.09 \text{ g}}</math></p>	<p>[1]</p> <p>[1]</p>
10(d)	<p>The reaction stopped very quickly because when calcium reacts with sulfuric acid, <b>a layer of insoluble calcium sulfate coats over the calcium.</b></p> <p>Hence, <b>some calcium remains unreacted</b>, resulting in less hydrogen produced.</p>	<p>[1]</p> <p>[1]</p>
<b>11</b>		
<b>Either</b>		
11(a)	Lean burn engines uses more air so more nitrogen gas can burn in oxygen;	[1]
11(b)	Petrol engines produce less soot; petrol is easier to burn completely; petrol engines produce less oxides of nitrogen;	[1]
11(c)	Honeycomb type as it is smaller;	[1]
11(d)	$2(\text{NH}_2)_2\text{CO} + 3\text{NO}_2 \rightarrow \frac{7}{2}\text{N}_2 + 4\text{H}_2\text{O} + 2\text{CO}_2$ ;	[1]
11(e)(i)	$6 \text{ dm}^3$	[1]
11(e)(ii)	$12 \text{ dm}^3$	[1]
11(f)	They are transition metals;	[1]
11(g)	To prevent the decomposition of DEF;	[1]
11(h)	It produces carbon dioxide which is a greenhouse gas;	[1]
	excessive amount leads to global warming which results in melting of polar ice caps;	[1]
<b>11 OR</b>		
11(a)	$400^\circ\text{C}$ , $500 \text{ atm}$	[1]
11(b)	When more ammonia is formed, the total number of moles of gases reduces since 4 moles of reactants (nitrogen) produce 2 moles of products (ammonia). Since there are fewer particles per unit volume, pressure is reduced.	[1]
11(c)	<p>The change is 'ammonia removal'. To reduce this change, there is a tendency to produce more ammonia.</p> <p>Hence, removing ammonia will cause more ammonia to be formed.</p> <p>Or</p> <p>The reaction between nitrogen and ammonia is a reversible process.</p> <p>Thus some of the ammonia produced will be converted back into nitrogen and hydrogen.</p>	<p>[1]</p> <p>[1]</p> <p>[1]</p> <p>[1]</p>
11(d)	<p>The reaction is exothermic so heat is produced.</p> <p>When heat is applied to the system, to reduce this change, the reverse reaction which is endothermic (cold) will tend to occur to reduce the amount of heat that is applied.</p>	<p>[1]</p> <p>[1]</p>
11(e)	use a catalyst (of iron)	[1]

11(f)		[1] shape [1] label
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**GAN ENG SENG SCHOOL**  
**Mid-Year Examination 2018**



**CANDIDATE  
NAME**

**CLASS**

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**INDEX  
NUMBER**

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**CHEMISTRY**

**Secondary 4 Express**

**Paper 1 Multiple Choice**

**6092/01**

**7 May 2018**

**1 hour**

Additional Materials: OTAS

Calculators are allowed in the examination

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**READ THESE INSTRUCTIONS FIRST**

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, class and index number on the OTAS.

There are **forty** questions in this paper. Answer **all** questions. For each question there are four possible answers **A, B, C, and D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate OTAS.

**Read the instructions on the OTAS very carefully.**

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

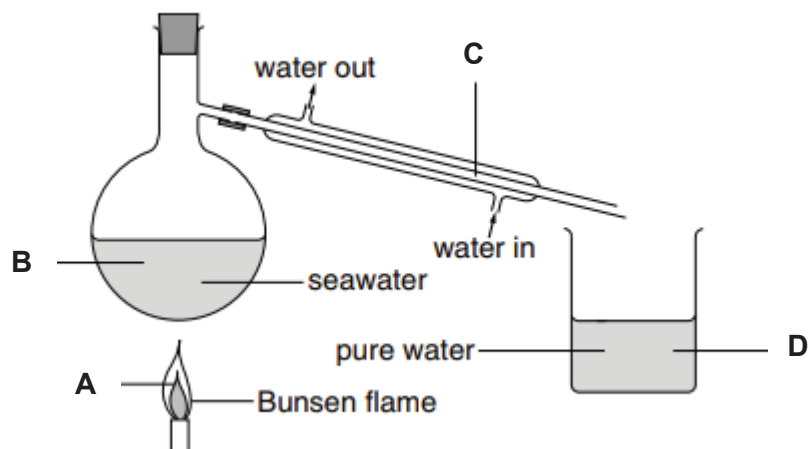
A copy of the Periodic Table is on page 14.

The use of an approved scientific calculator is expected, where appropriate.

Total Marks
40

- 1 The diagram shows how to obtain pure water from seawater.

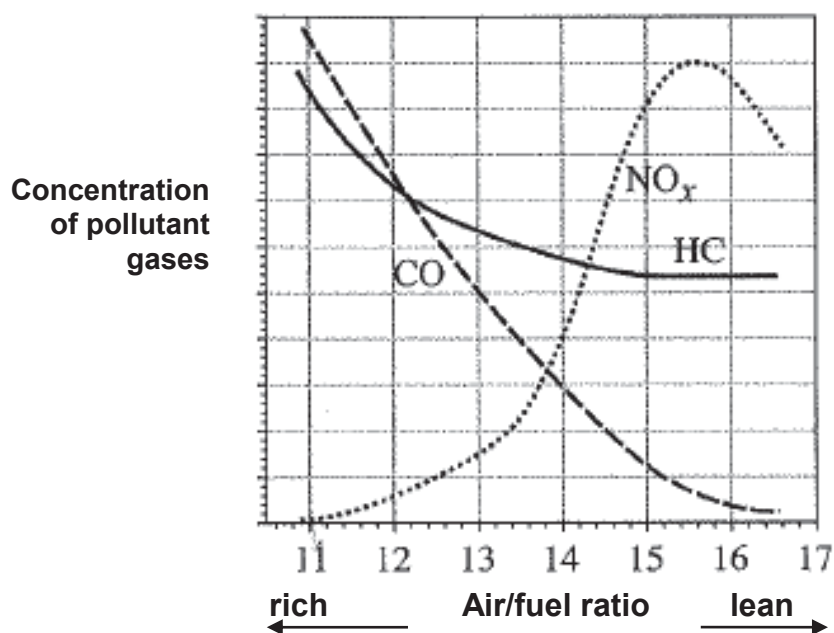
Where do water molecules lose energy?



Refer to the following to answer questions 2 and 3.

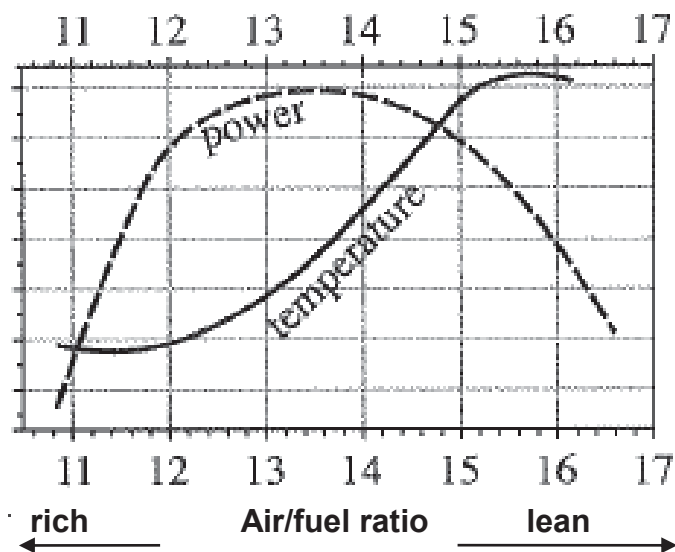
- 2 In a car engine, petrol vapour is mixed with air and undergoes combustion. When different amounts of petrol are mixed with air, different amounts of pollutant gases will be formed.

Graph I shows how the production of carbon monoxide (CO), nitrogen oxides (NO<sub>x</sub>) and hydrocarbons (HC) is dependent on the ratio of air to petrol.



Graph I

Graph II shows how the engine power and temperature vary with the different ratios of air to fuel of the fuel mixture.



Graph II

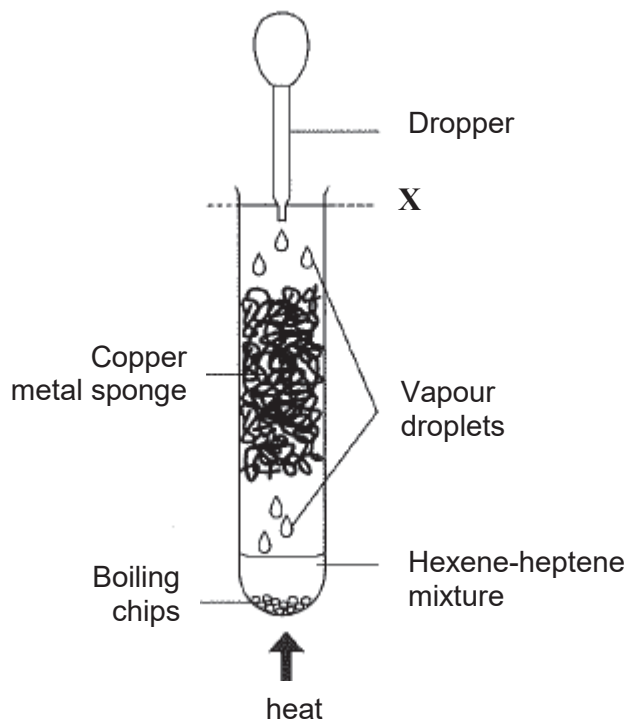
Which of the following is not true?

- A The amount of carbon monoxide decreases as the air to fuel ratio increases.
  - B The emission of nitrogen oxides increases as temperature of engine increases.
  - C Increasing the proportion of air in the mixture will increase the amount of hydrocarbons emitted.
  - D Increasing the proportion of air in the mixture will increase the level of nitrogen oxides produced.
- 3 Which of the following conclusions **cannot** be drawn based on the information from the graphs?
- A A fuel-rich mixture and low combustion temperature will reduce nitrogen oxide formation.
  - B The overall levels of the three pollutants are best reduced by increasing the air-to-fuel ratio.
  - C A fuel-lean mixture reduces the carbon monoxide and hydrocarbons but reduces the engine output.
  - D A fuel-rich mixture reduces the level of nitrogen oxides emitted but reduces the engine power output.

Refer to the following to answer questions 4 and 5.

1-hexene and 1-heptene are two members of the alkene class of hydrocarbons.

A small amount of mixture of 1-hexene and 1-heptene was placed in a boiling tube and gently heated to boiling in a sand bath using the following setup:



Droplets were formed and could be seen condensing on the sides of the tube. When the vapour condensation line reached the level marked **X**, the hot vapours were very slowly withdrawn and condensed by using a small dropper.

- 4** What is the purpose of the copper metal sponge?
- |  |   |
|--|---|
| <b>A</b> Minimises contact of the mixture with air.                        | <b>B</b> Prevents the two compounds from escaping.                                  |
| <b>C</b> Acts as a catalyst to speed up the reaction of the two compounds. | <b>D</b> Provides a large surface area for repeated vapourisation and condensation. |
- 5** What process is demonstrated in this experiment?
- |                            |                                  |
|----------------------------|----------------------------------|
| <b>A</b> Cracking          | <b>B</b> Combustion              |
| <b>C</b> Addition reaction | <b>D</b> Fractional distillation |
- 6** Which of the following does not affect the rate at which a gas spreads throughout a room?
- |                                |                             |
|--------------------------------|-----------------------------|
| <b>A</b> Boiling point of gas  | <b>B</b> Temperature of gas |
| <b>C</b> Molecular mass of gas | <b>D</b> Density            |



- 7 Three elements, **X**, **Y** and **Z** have consecutive increasing atomic numbers.

If element **Y** is a noble gas, what will be the symbol for the ions formed by elements **X** and **Z** in their compounds?

- |          |                 |          |                       |
|----------|-----------------|----------|-----------------------|
| <b>A</b> | $X^-$ and $Z^+$ | <b>B</b> | $X^{2-}$ and $Z^{2+}$ |
| <b>C</b> | $X^+$ and $Z^-$ | <b>D</b> | $X^{2+}$ and $Z^{2-}$ |

- 8 Potassium ferrate,  $K_2FeO_4$ , has been described as a 'green oxidising agent' because the by-products generated are environmentally-friendly.

What are the ions in this compound?

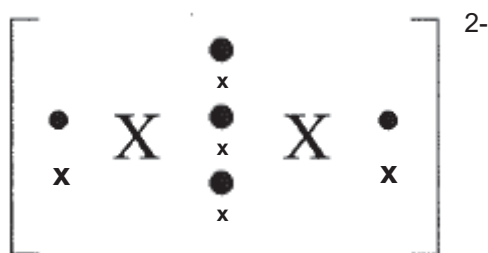
- |          |                                |
|----------|--------------------------------|
| <b>A</b> | $K^+$ , $FeO_4^{2-}$           |
| <b>B</b> | $K_2^+$ , $FeO_4^-$            |
| <b>C</b> | $K^+$ , $Fe^{6+}$ , $O^{2-}$   |
| <b>D</b> | $K_2^+$ , $Fe^{2+}$ , $O^{2-}$ |

- 9 Peeling onions often causes tearing of the eyes due to the release of a sulfide compound. Peeling them under running water reduces the problem. Which of the following statements are true of the sulfide compound?

- I. It is soluble in water
- II. It has low boiling point.
- III. It has small and light ions with weak bonding.
- IV. It is a covalent compound with weak covalent bonds.

- |          |                    |          |                   |
|----------|--------------------|----------|-------------------|
| <b>A</b> | I and II only      | <b>B</b> | I and IV only     |
| <b>C</b> | I, II and III only | <b>D</b> | I, II and IV only |

- 10 Element **X** forms the ion  $X_2^{2-}$  with the following structure:



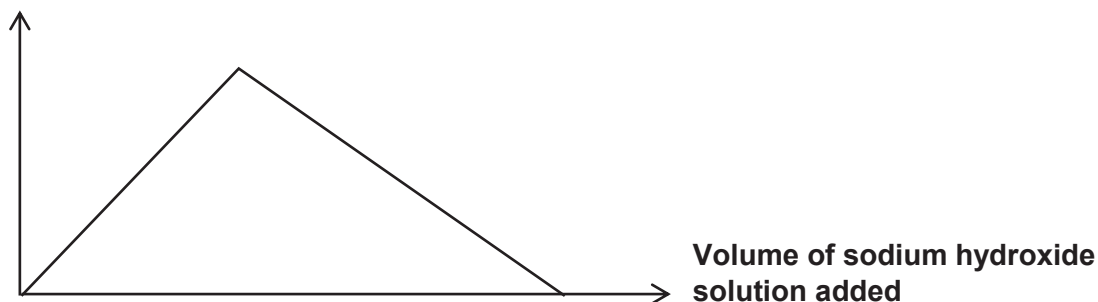
What is the formula of the covalent compound **X** forms with chlorine?

- |          |          |          |          |
|----------|----------|----------|----------|
| <b>A</b> | $XC/$    | <b>B</b> | $XC l_2$ |
| <b>C</b> | $XC l_3$ | <b>D</b> | $XC l_4$ |

- 11 What is the maximum concentration of  $\text{H}^+$  ions in  $0.250 \text{ mol/dm}^3$  of phosphoric(V) acid,  $\text{H}_3\text{PO}_4$ ?
- A  $0.125 \text{ mol/dm}^3$   
B  $0.250 \text{ mol/dm}^3$   
C  $0.500 \text{ mol/dm}^3$   
D  $0.750 \text{ mol/dm}^3$
- 12 Heating iron in dry chlorine gas results in the formation of an iron(II) chloride. Experimental determination gives a reading of 34.5% by mass of iron in the Iron(II) chloride formed. What is the charge of the iron in the chloride?
- A 2-  
B 2+  
C 3-  
D 3+
- 13 Which of the following results is obtained when  $100 \text{ cm}^3$  of  $0.500 \text{ mol/dm}^3$  dilute sulfuric acid is added to 60.0 g of granular solid lead(II) carbonate?
- A No visible reaction.  
B Colourless solution with effervescence is produced.  
C Colourless solution with white precipitate  
D A colourless solution with white precipitate, effervescence and granular remains.
- 14 Which of the following pairs of aqueous reagents is **not** suitable for preparing insoluble salts?
- A Sulfuric acid and calcium chloride  
B Aluminium chloride and silver nitrate  
C Barium hydroxide and copper(II) sulfate  
D Lithium carbonate and iron(II) sulfate
- 15 A salt has the formula  $\text{NH}_4\text{Fe}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$ . Excess aqueous sodium hydroxide was added to an aqueous solution of the salt in a test tube and the mixture was then warmed gently. Which of the following would **not** be observed?
- A A pungent gas was detected.  
B A green precipitate was formed.  
C A reddish brown precipitate was obtained.  
D A piece of moist litmus paper placed at the mouth of the test tube turned blue.
- 16 A compound **Q** formed white precipitate when acidified aqueous silver nitrate is added. Aqueous ammonia was used to identify the presence of the other ion and there is no visible change. Identify compound **Q**.
- A Calcium chloride  
B Ammonium nitrate  
C Calcium nitrate  
D Zinc chloride

- 17 An aqueous solution of a salt **X** is placed in a test tube and sodium hydroxide solution is gradually added. The height of the precipitate in a test tube is plotted against the volume of sodium hydroxide solution added.

Height of precipitate



What could be **X**?

- A** Aluminium sulfate
  - B** Calcium nitrate
  - C** Iron(II) sulfate
  - D** Ammonium nitrate
- 18 The formula for hydrated copper(II) nitrate is  $\text{Cu}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$ . It contains 36.5% water of crystallisation by mass.
- What is the value of  $x$ ?
- A** 4
  - B** 5
  - C** 6
  - D** 7
- 19 Element **X** is found in Group IV of the Periodic table. Which of the following could not be a formula for a compound of **X**?
- A**  $\text{XO}$
  - B**  $\text{XO}_2$
  - C**  $\text{XO}_3^{2-}$
  - D**  $\text{XO}_4$
- 20 Which of the following statements best explains why 99.99% copper is used in manufacturing high quality electrical wires for audio equipment?
- A** Copper is a good conductor of electricity.
  - B** Copper is a very reactive metal.
  - C** 99.99% copper is less ductile and cannot be stretched easily.
  - D** Copper is of high purity and is able to conduct electric current.

21 Which of the following statements about Group VII is **false**?

- |          |   |          |   |
|----------|---|----------|---|
| <b>A</b> | Colours of elements become darker down the Group.   | <b>B</b> | Densities of elements increase down the Group.                    |
| <b>C</b> | Melting points of elements increase down the Group. | <b>D</b> | Number of valence electrons of elements increases down the Group. |

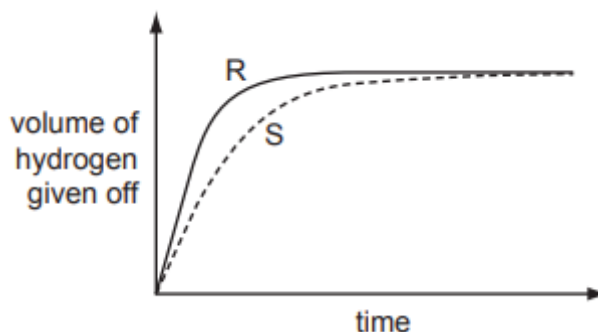
22 Methane gas reacts extremely slowly with air at room temperature. If a piece of warm platinum is held in a methane-air mixture, methane ignites. Which of the following statements correctly describes the reaction with platinum?

- I** The activation energy is low.
- II** The energy change is greater.
- III** The energy of the reactants is lower than expected.
- IV** The rate of reaction is faster.

- A** I and II
- B** I and IV
- C** I, II and IV
- D** I, II, III and IV

23 A student investigates the rate of reaction between magnesium and excess sulfuric acid. The volume of hydrogen given off in the reaction is measured over time.

The graph shows the results of two experiments, **R** and **S**.



Which change in conditions would cause the difference between **R** and **S**?

- A** Catalyst is added into **S**.
- B** The acid is more concentrated in **R** than in **S**.
- C** The magnesium is less finely powdered in **R** than in **S**.
- D** The temperature in **R** is lower than in **S**.

**24** Which statement is correct for the element of proton number 19?

- A** It is a gas that dissolves in water.
- B** It is a hard metal that is not very reactive with water.
- C** It is a non-metal that burns quickly in air.
- D** It is a soft metal that is highly reactive with water.

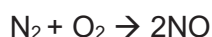
**25** Statement 1: Alloying iron with other materials to form stainless steel prevents iron from rusting by excluding oxygen.

Statement 2: Painting, oiling and electroplating are all methods of preventing iron from rusting.

Which is correct?

- A** Both statements are correct and statement 2 explains statement 1.
- B** Both statements are correct but statement 2 does not explain statement 1.
- C** Statement 1 is correct but statement 2 is incorrect.
- D** Statement 2 is correct but statement 1 is incorrect.

**26** The reactions shown may occur in the air during a thunder-storm.



Which row shows what happens to the reactant molecules in each of these reactions?

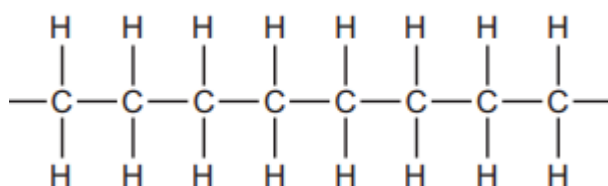
	<b>N<sub>2</sub></b>	<b>NO</b>	<b>O<sub>3</sub></b>
<b>A</b>	oxidised	oxidised	oxidised
<b>B</b>	oxidised	oxidised	reduced
<b>C</b>	reduced	reduced	oxidised
<b>D</b>	reduced	reduced	reduced

**27** Iron is extracted from hematite in a blast furnace.

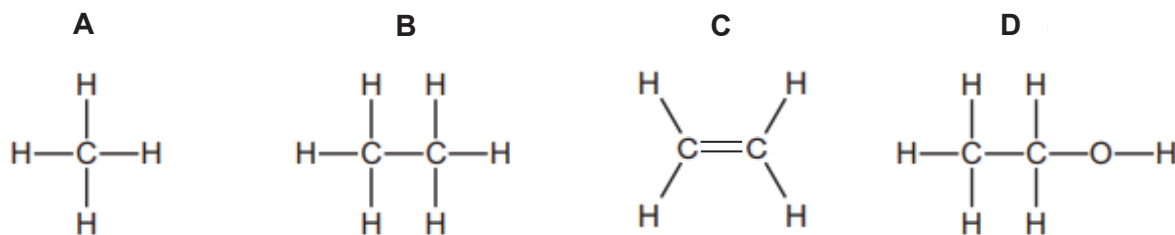
Which reaction contributes most of the heat in the blast furnace as it increases the temperature to over 1500°C?

- A** calcium carbonate → calcium oxide + carbon dioxide
- B** calcium oxide + silicon dioxide → calcium silicate
- C** carbon + oxygen → carbon dioxide
- D** carbon dioxide + carbon → carbon monoxide

- 28 The diagram shows part of the molecule of a polymer.

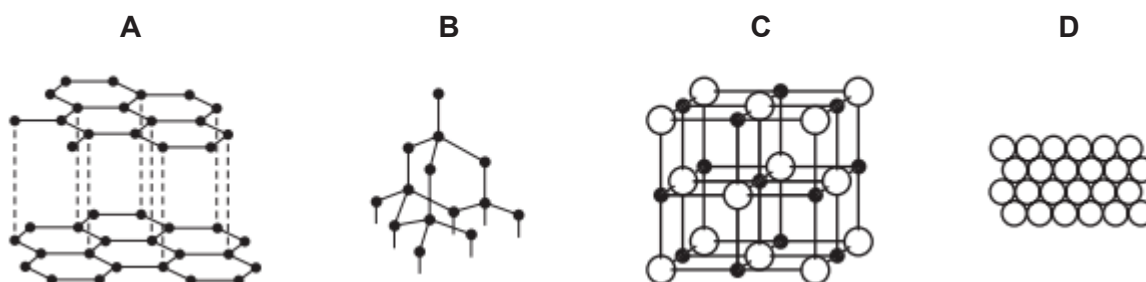


Which diagram shows the monomer from which this polymer could be manufactured?



- 29 Slate has a layered structure and is slippery.

Which diagram shows a structure that closely resembles slate?



- 30 In separate experiments conducted, a gaseous halogen was bubbled into an aqueous solution of a halide salt.

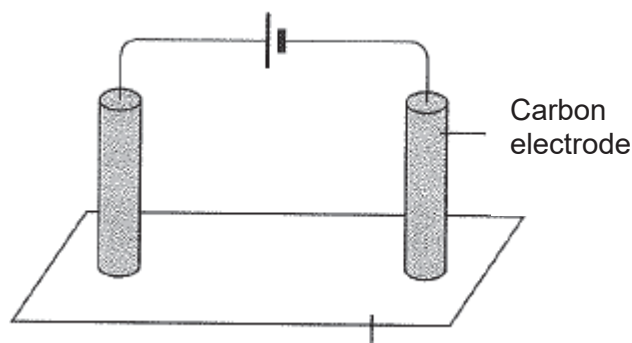
The following results were observed.

Halogen	Halides	
	$\text{Y}^-$	$\text{Z}^-$
$\text{X}_2$	No observable reaction	Displaced as $\text{Z}_2$
$\text{Y}_2$	No observable reaction	Displaced as $\text{Z}_2$
$\text{Z}_2$	No observable reaction	No observable reaction

What is the arrangement of halogens **X**, **Y** and **Z** in Group VII in order of decreasing reactivity?

- A** X, Y, Z  
**B** Y, X, Z  
**C** Z, X, Y  
**D** Y, Z, X

- 31 Two carbon electrodes are placed on a piece of red litmus paper soaked in concentrated sodium chloride solution as shown:

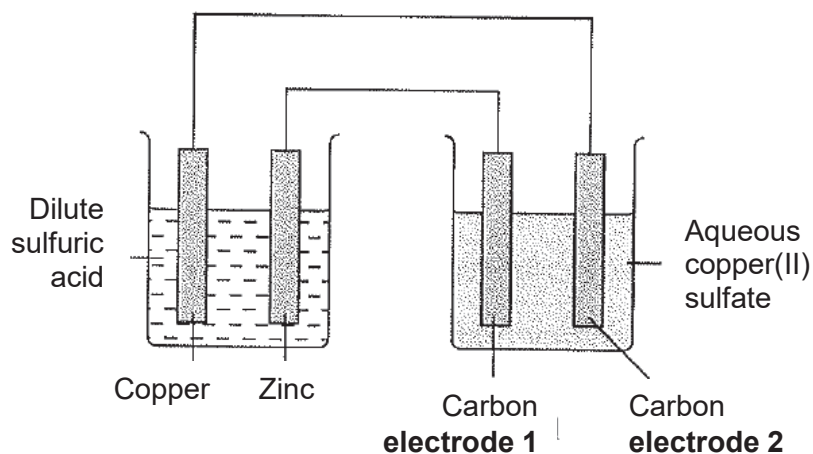


Litmus paper soaked in concentrated sodium chloride solution

What are the observations of the litmus paper at the respective electrodes?

	<b>Cathode</b>	<b>Anode</b>
<b>A</b>	Litmus paper is bleached.	Litmus paper turns blue.
<b>B</b>	Litmus paper turns blue.	Litmus paper is bleached.
<b>C</b>	Litmus paper turns blue.	Litmus paper remains red.
<b>D</b>	Litmus paper remains red.	Litmus paper remains red.

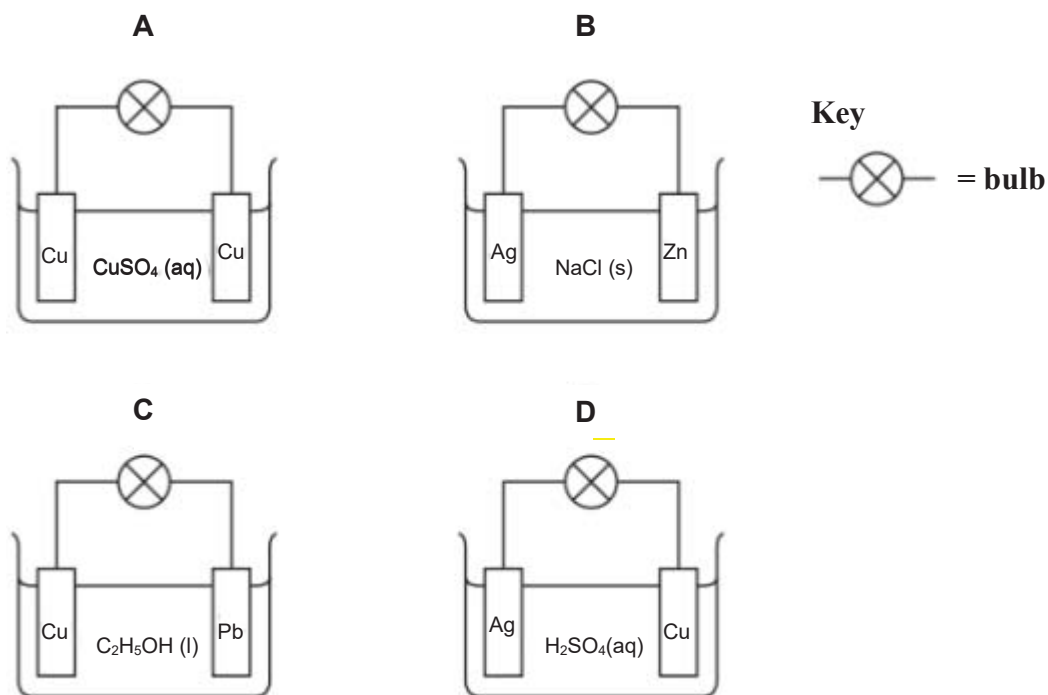
- 32 Two simple cells were set up as shown:



Two substances were discharged at the carbon electrodes. What were these two substances?

	<b>Electrode 1</b>	<b>Electrode 2</b>
<b>A</b>	Copper metal	Hydrogen gas
<b>B</b>	Hydrogen gas	Copper metal
<b>C</b>	Copper metal	Oxygen gas
<b>D</b>	Oxygen gas	Copper metal

33 In which circuit does the bulb light?



34 What are the main gases that escape from the top of the blast furnace in the manufacture of iron by the blast furnace?

- A** Nitrogen, steam and oxygen  
**B** Oxygen, carbon dioxide and steam  
**C** Nitrogen, carbon monoxide and carbon dioxide  
**D** Carbon monoxide, carbon dioxide and nitrogen monoxide

35 A molten compound is electrolysed. Two atoms of X are deposited at the negative electrode at the same time as three atoms of Y are deposited at the positive electrode.

These results show that:

X is a ...**1**...;

Y is a ...**2**...;

the formula of the compound is ...**3**... .

How are gaps **1**, **2** and **3** correctly completed?

	<b>1</b>	<b>2</b>	<b>3</b>
<b>A</b>	Metal	Non-metal	$X_3Y_2$
<b>B</b>	Metal	Non-metal	$X_2Y_3$
<b>C</b>	Non-metal	Metal	$X_3Y_2$
<b>D</b>	Non-metal	metal	$X_2Y_3$



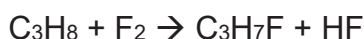
- 36 Zinc reacts with acids to form salts. Which of the following solutions would give the slowest rate of reaction when reacted with zinc?

**A** 0.0500 mol sulfuric acid in 500 cm<sup>3</sup> of water.  
**B** 0.0250 mol sulfuric acid in 100 cm<sup>3</sup> of water.  
**C** 0.0500 mol hydrochloric acid in 200 cm<sup>3</sup> of water.  
**D** 0.0250 mol hydrochloric acid in 75 cm<sup>3</sup> of water.

- 37 Which compound will react with steam, in the presence of catalyst, to produce the alcohol CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>OH?

**A** CH<sub>3</sub>CHCH<sub>2</sub> **B** CH<sub>3</sub>CHCHCH<sub>3</sub>  
**C** CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>CH<sub>3</sub> **D** CH<sub>3</sub>CH<sub>2</sub>COOH

- 38 Which type of reaction does this equation show?



**A** Hydration  
**B** Neutralisation  
**C** Addition  
**D** Substitution

- 39 An unsaturated hydrocarbon with six carbon atoms contains only three C=C double bonds. This hydrocarbon is reacted with excess bromine at a room temperature.

What is the formula of the resulting hydrocarbon?

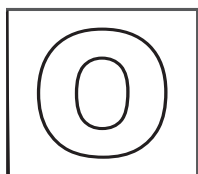
**A** C<sub>6</sub>H<sub>8</sub>Br<sub>3</sub> **B** C<sub>6</sub>H<sub>10</sub>Br<sub>3</sub>  
**C** C<sub>6</sub>H<sub>8</sub>Br<sub>6</sub> **D** C<sub>6</sub>H<sub>14</sub>

- 40 A hydrocarbon is found to contain about 80% of carbon by mass. What is the hydrocarbon?

**A** Methane **B** Ethene  
**C** Propane **D** Hexene

**END OF PAPER**

The volume of one mole of any gas is  $24 \text{ dm}^3$  at room temperature and pressure (r.t.p.).



**GAN ENG SENG SCHOOL**  
**Mid-Year Examination 2018**



**CANDIDATE  
NAME**

**CLASS**

**INDEX  
NUMBER**

**CHEMISTRY**

**Paper 2**

**Secondary 4 Express**

**6092/02**

**3 May 2018**

**1 hour 45 minutes**

Candidates answer on the Question Paper.  
Calculators are allowed in the examination

**READ THESE INSTRUCTIONS FIRST**

Write your class, index number and name on all the work you hand in.  
Write in dark blue or black pen.  
You may use a soft pencil for any diagrams or graphs.  
Do not use staples, paper clips, glue or correction fluid / tape.

**Section A**

Answer **all** questions in the spaces provided.

**Section B**

Answer all **three** questions, the last question is in the form either/or.  
Answer **all** questions in the spaces provided.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [ ]  
at the end of each question or part question.

A copy of the Periodic Table is on page 20.

The use of an approved scientific calculator is  
expected, where appropriate.

	For Examiner's Use
<b>Section A</b>	.....
<b>Section B</b>	
B7	.....
B8	.....
B9 *Either / OR	.....
*Circle where appropriate	
<b>Total</b>	<b>80</b>

This paper consists of **20** printed pages including the cover page.

**[ Turn over**

## Section A (50 marks)

Answer **all** the questions in the spaces provided.

- A1** The table below shows some information about elements **A-F**. The letters are **not** the chemical symbols of the elements.

Element	Colour	Melting point / °C	Boiling point / °C	Conducts electricity	Density / g/cm <sup>3</sup>
<b>A</b>	Dull grey	1415	2898	Yes	2.0300
<b>B</b>	Pale yellow	-219	-188	No	0.0017
<b>C</b>	Orange brown	-7	59	No	3.1000
<b>D</b>	Shiny brown	1074	2927	Yes	8.9200
<b>E</b>	Shiny grey	1540	2861	Yes	7.8700
<b>F</b>	Colourless	-157	-153	No	0.0033

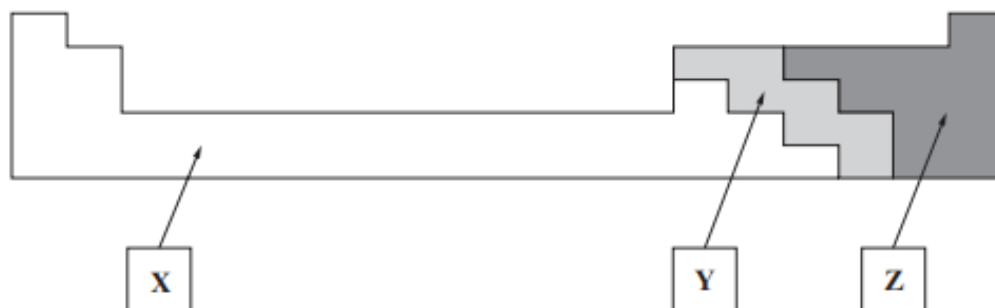
- (a) (i) State which of the elements **A-F** are gases at room temperature. [1]

.....

- (ii) Give the letter of the element **A-F** that has the biggest difference between melting point and boiling point. [1]

.....

- (iii) The diagram shows an outline of the Periodic Table.



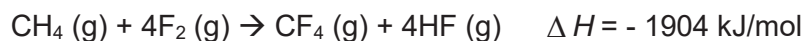
- Element **A** is found in area **Y** of the Periodic Table shown above. Explain how the information in the table above supports this statement. [2]

.....

.....

.....

- (b) Methane reacts violently with fluorine according to the following equation.



Mean bond energies are given in the table shown below.

Bond	C-H	C-F	H-F
Mean bond energy / kJ/mol	412	484	562

A student suggested that one reason for the high reactivity of fluorine is a weak F-F bond.

Is the student correct? Justify your answer with calculations using the above data.

[4]

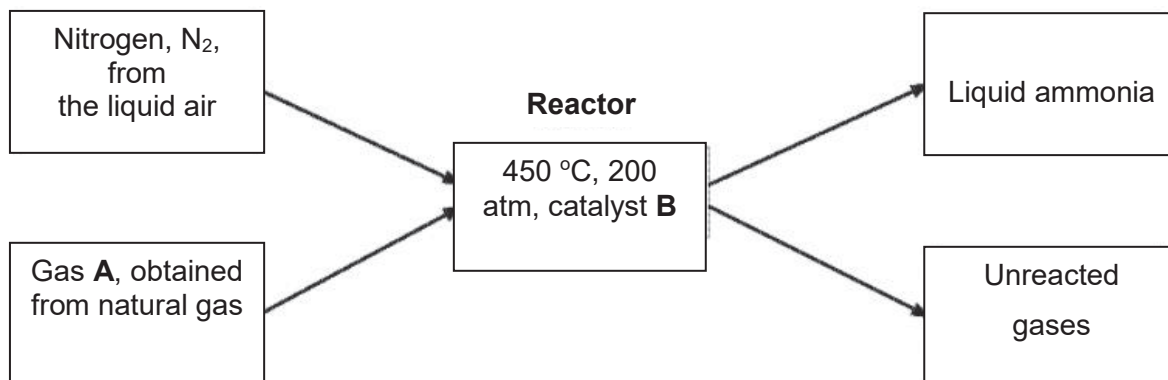
- (c) Write an ionic equation for the reaction between potassium and cold water.

[1]

.....

[Total: 9]

- A2** Ammonia is produced during the Haber process. The reaction is summarised in the diagram below.



(a) Give the name of gas **A**. ..... [1]

(b) Name the catalyst **B** and explain why it is used. [2]

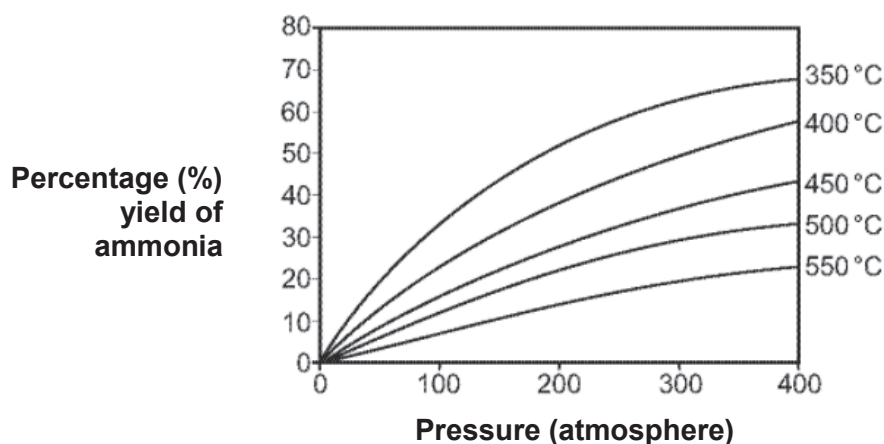
.....  
 .....

(c) The yield of ammonia is only 28% therefore 72% of the gases remain unreacted. [2]

Describe what happens to these unreacted gases and explain why this is important.

.....  
 .....  
 .....

(d) The following graph below shows the effect of temperature and pressure on the yield of ammonia during the Haber process.



Describe how the yield of ammonia varies with temperature and pressure. [2]

.....  
 .....

- (e) (i) Construct an equation for the production of ammonia in a Haber process. State [1]  
symbols are required.

.....

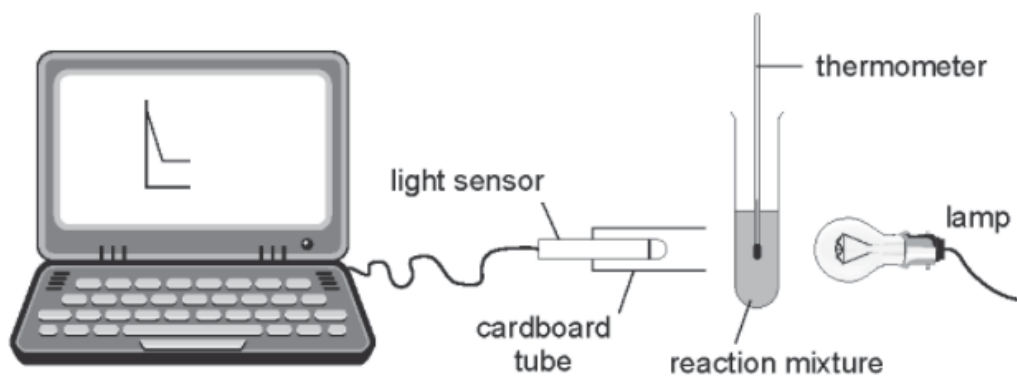
- (ii) Explain if the above process is a redox reaction. Use oxidation number in your [2]  
explanation.

.....

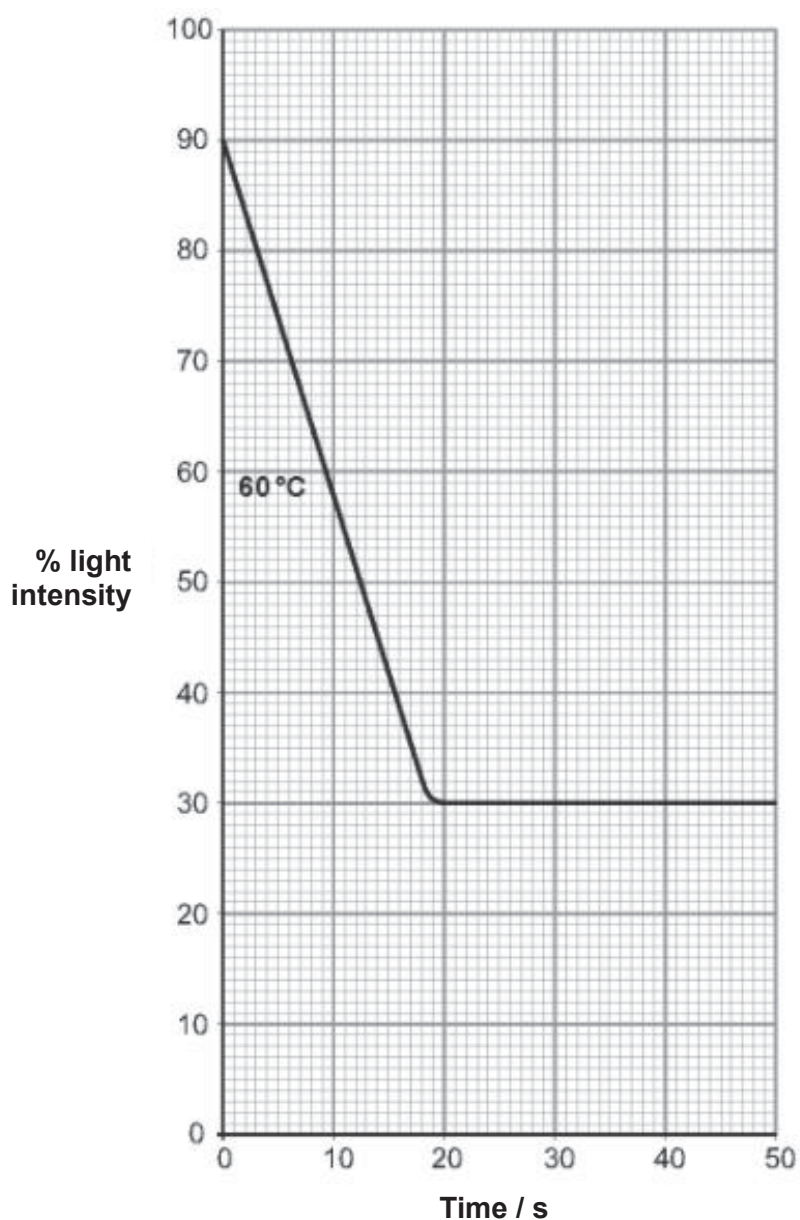
.....

[Total: 10]

- A3** Sodium thiosulfate solution reacts with dilute hydrochloric acid forming a yellow precipitate. This reaction was investigated using the equipment below.



5 cm<sup>3</sup> of dilute hydrochloric acid was added to 10 cm<sup>3</sup> of sodium thiosulfate solution at 60 °C and the light intensity was measured over time. The results are shown on the grid below.





- (a) Explain why the light intensity decreases as the reaction takes place. [2]

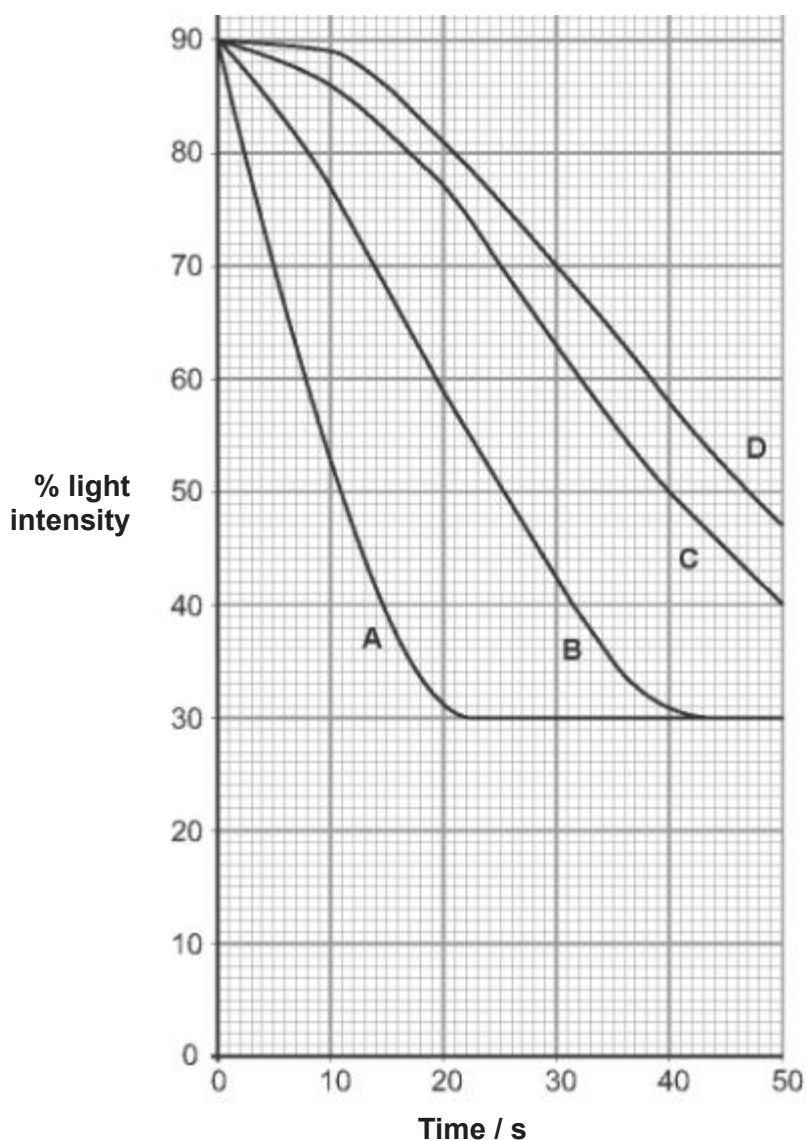
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- (b) Suggest one possible reason why the light intensity does not fall to 0%. [1]

.....

- (c) In a separate experiment, 5 cm<sup>3</sup> of dilute hydrochloric acid was added separately to 10 cm<sup>3</sup> of sodium thiosulfate solution at four different temperatures. All other factors were kept the same. The results are shown on the grid below.



- (i) Provide the letter **A**, **B**, **C** or **D** from the graph shown that represents the reaction carried out at the highest temperature. Explain your choice. [1]

.....

.....

- (ii) The rate of reaction can be calculated using the formula: [1]

$$\text{Rate} = 1 / \text{time}$$

The reaction is considered to be complete when the percentage light intensity reaches 30%. Calculate the mean rate for experiment **B**.

- (iii) Using collision theory, provide a conclusion you can draw from the above investigation. [3]

.....

.....

.....

- (d) A chemist carried out an experiment to find out the reactivity of the metals. Below shows the time taken for limewater to form white precipitate for each metal carbonate.

Metal carbonate	Time taken to form white precipitate / s
Copper carbonate	10
Magnesium carbonate	40
Zinc carbonate	24

- Explain these results in terms of reactivity of the metals. [2]

.....

.....

.....

[Total: 10]

**A4** An alcohol **G** was known to be one of the following.



A sample of 1.20 g of alcohol **G** was burned in excess oxygen. 1.79 g of carbon dioxide was formed.

(a) Calculate the mass of carbon present in the sample of alcohol **G**. [1]

(b) The mass of hydrogen in the sample is 0.0812 g. Assuming that the rest of the sample is oxygen, calculate the mass of oxygen in the sample. [1]

(c) Use your answers above to find the empirical formula of alcohol **G**. [2]

(d) State the identity of alcohol **G**. Explain clearly how you reached this conclusion. [1]

.....

.....

.....

.....

- (e) Describe a chemical test to distinguish between alcohol **1** and alcohol **2**. Include [1]  
expected results in your answer.

.....

.....

.....

.....

- (f) Propene can be converted into an alcohol.

Show the **structural equation** for the above reaction.

[2]

[Total: 8]

- A5 (a)** Aspirin tablets have important medical uses.

Aspirin ( $C_9H_8O_4$ ) is made when salicylic acid ( $C_7H_6O_3$ ) reacts with ethanoic anhydride.

The equation for this reaction is



Calculate the **maximum** mass of aspirin that could be made from 100 g of salicylic [2]  
acid.

- (b) (i) In an experiment, a chemist calculated the maximum yield of aspirin is 400 g. The chemist did the experiment but only made 250 g of aspirin. Calculate the percentage yield of aspirin for this experiment.

Show clearly how you work out your answer and suggest one possible reason [2]  
why the chemist did not have a percentage yield of 100%.

.....  
.....

- (ii) Suggest how the use of catalyst might reduce costs in the industrial production [1]  
of aspirin.

.....  
.....

- (c) Instant cold packs are used to treat sports injuries.



One type of cold pack has a plastic bag containing water. Inside the bag is a smaller bag containing solid ammonium nitrate. The outer bag is squeezed so that the inner bag bursts.

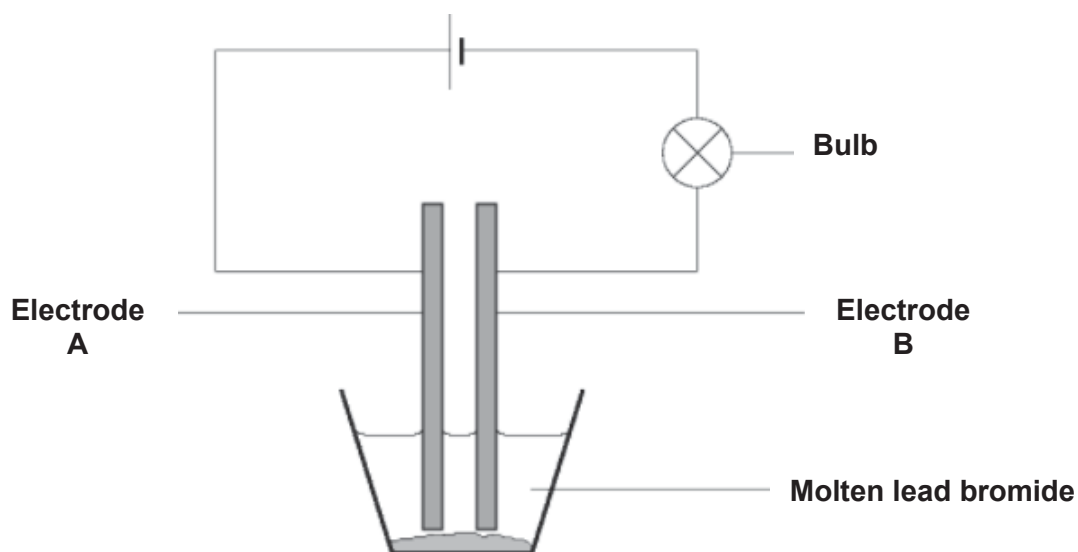
Explain why the bag becomes cold.

[2]

.....  
.....

[Total: 7]

- A6** The diagram below shows the apparatus used during electrolysis of molten lead (II) bromide.



- (a) Suggest a reason why lead (II) bromide must be molten in order for electricity to flow. [1]

.....  
 .....

- (b) Write the half equation for the reaction taking place at the electrode **A**. [1]

.....

- (c) (i) State, in terms of electrons, what happens to the ions at the electrode **B**. [1]

.....  
 .....

- (ii) Describe an observation you would expect at the electrode **B**. [2]

.....  
 .....

- (iii) Electrolysis is allowed to continue for some time before the apparatus is cooled to room temperature. The bulb remains lit. [1]

Explain this observation.

.....  
 .....  
 .....

[Total: 6]

**Section B (30 marks)**

Answer all **three** questions. The last question is in the form **either/or**.  
Write your answers in the spaces provided.

**B7 The investigation of hydrocarbons****Information 1**

From its modest beginning in 1980, the U.S. ethanol industry has grown tremendously in response to surging domestic use and worldwide demand.

The table below shows two different identified processes to produce ethanol.

Process 1	Process 2
Fermentation of a sugar solution by yeast in a reaction vessel.	Reaction of ethene (from crude oil) with steam in a reactor.
The reaction vessel has to be emptied, cleaned and refilled every few days.	The reaction is only stopped if there is a fault in the reactor.
The process produces a 15% ethanol solution in water daily.	The process produces 100% pure ethanol.

**Information 2**

An advertisement for crisps claimed that they are healthier because they are cooked in certain oils. A student found the following information about four oils that are used to make crisps.

	Rapeseed oil	Sunflower oil	Olive oil	Corn oil
<b>Saturated fat / %</b>	6.6	12.0	14.2	14.4
<b>Poly-unsaturated fat / %</b>	29.3	63.3	8.1	51.3
<b>Melting point / °C</b>	+5	-18	-12	-15

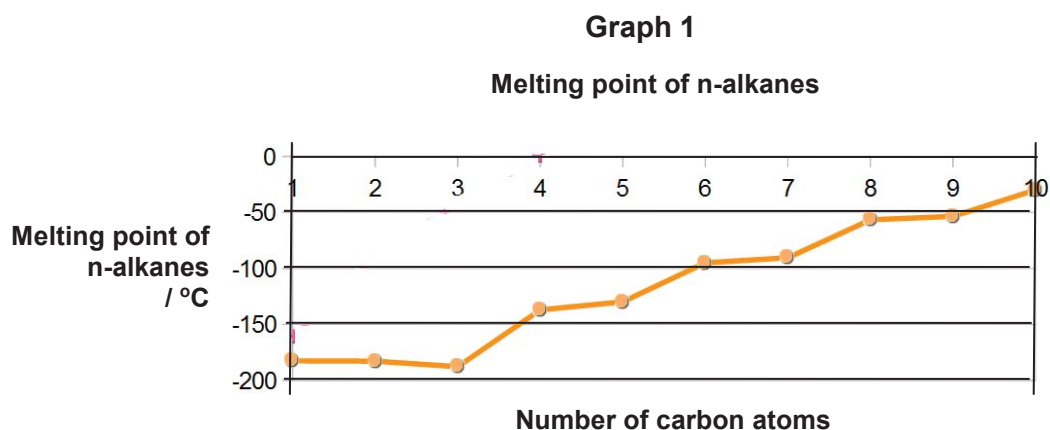
One hypothesis is that oils are thought to be healthier if they are:

- Low in saturated fat.
- High in poly-unsaturated fat.

For certain oils and fats such as olive oil, soybean oil, or nut oils, when compared with others, such as margarine, butter, chicken fat and beef fat (the white stuff found in and around slabs of meat), the most prominent difference that was discovered was that different oils and fats have different states of matter at room temperature.

Some oils and fats are liquid at room temperature, and even when kept in the fridge, like olive oil and soybean oil. By contrast, other fats have higher melting temperatures.

The melting point of fats is the temperature at which they become liquid. **Graph 1** shows the change in melting point for saturated hydrocarbon.



The melting temperature is the same as freezing temperature; it is the temperature where the fat changes from a liquid to a solid.

In addition, the effect of the percentage of saturated fats within certain oils on the energy released from combustion was investigated. It was found out that as the saturation of the carbon chain increases, the energy released from combustion decreases.

**Table 1: Experimental results on the four different oil used**

		Rapeseed oil	Sunflower oil	Olive oil	Corn oil
<b>Energy released from combustion (kJ/g)</b>	Trial 1	5.05	3.48	6.55	3.95
	Trial 2	4.98	3.20	5.98	2.01
	Trial 3	4.46	2.98	6.24	3.88

**Table 2: Hydrocarbon table**

Name	Chemical formula	Heat of combustion (kJ/g)
Methane	CH <sub>4</sub>	55.6
Ethane	C <sub>2</sub> H <sub>6</sub>	52.0
Propane	C <sub>3</sub> H <sub>8</sub>	50.0
Butane	C <sub>4</sub> H <sub>10</sub>	49.2

*Note: Heat of combustion is also known as enthalpy change. It refers to the heat energy released when a compound undergoes complete combustion with oxygen under a given condition.*



**(a) Using Information 1,**

- (i) Give one advantage that Process 1 has over Process 2. [1]

.....  
 .....

- (ii) State one advantage Process 2 has over Process 1 as a manufacturer of ethanol. [2]

.....  
 .....  
 .....

**(b) Using Information 2,**

- (i) Determine which oil should be healthier. [2]

Explain your answer.

.....  
 .....  
 .....

- (ii) These unsaturated oils can be hardened by an addition reaction with hydrogen at 200 °C with nickel catalyst. [2]

A student said that this hardening process would make sunflower oil healthier.

Is this student's hypothesis correct? Explain your answer.

.....  
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- (iii) Using **Table 2**, describe and explain the data patterns for series of heat of combustion on the different alkanes. [2]

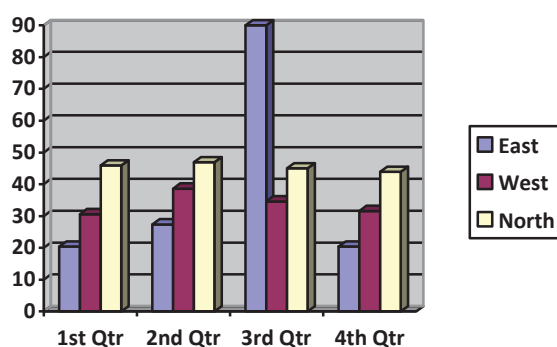
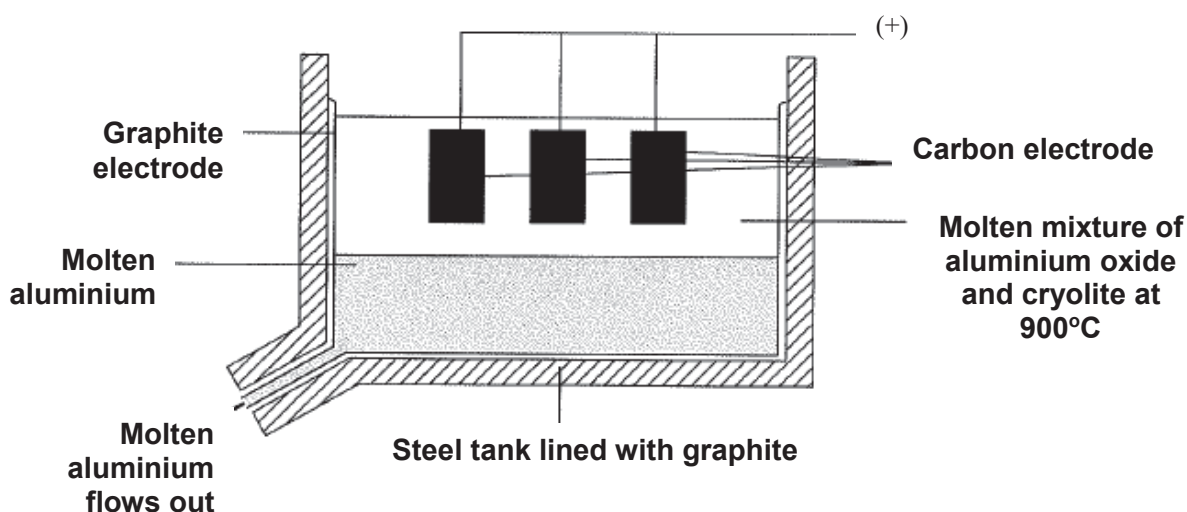
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- (iv) Based on the information given, describe the trend of the melting point of alkanes. [1]

.....

[Total: 10]

- B8** The diagram shows an electrolysis tank used to extract aluminium from aluminium oxide. Pure aluminium oxide melts at 2055 °C.



- (a) Cryolite is mixed, as an impurity, with aluminium oxide. State the effect it has on the melting point of the mixture and explain why mixing cryolite is necessary. [2]
- .....
- .....
- (b) Write half equations for the reactions that take place at the anode and cathode. [2]
- Anode: .....
- Cathode: .....
- (c) Draw **two** arrows on the diagram to indicate the flow of electrons. Clearly label on the two electrodes. [1]
- (d) What is the volume of oxygen produced, under room temperature and pressure when 540 g of aluminium is produced? [2]

- (e) The carbon electrodes are replaced at regular intervals. Explain the need for this. [1]
- .....
- .....
- (f) Draw a clearly labelled diagram to show how a metal object could be electroplated with copper. [2]

[Total: 10]

**EITHER**

- B9** Zinc is extracted from an ore called zinc blende, which consists mainly of zinc sulfide,  $\text{ZnS}$ . The zinc blende is first crushed to powder and then treated by froth flotation (*mineral processing, where it is used in the extraction of several metals*).

Zinc blende reacts with oxygen in the air to produce zinc oxide and a gas which escapes as waste gas.

- (a) (i)** Explain why zinc blende is crushed to powder before treatment? [1]

.....  
 .....

- (ii)** Write a chemical equation for the reaction in **(a)(i)**. [1]

.....

- (b)** Zinc oxide is converted into zinc. Zinc oxide and coke are fed into a furnace. Hot air is blown into the bottom of the furnace. Zinc has a melting point of  $420\text{ }^{\circ}\text{C}$  and a boiling point of  $907\text{ }^{\circ}\text{C}$ . The temperature inside the furnace is over  $1000\text{ }^{\circ}\text{C}$ .

- (i)** Explain how zinc oxide is converted into zinc. Your answer should include details of how the heat is produced and equations for all the reactions you describe. [3]

.....  
 .....  
 .....

- (ii)** Give **two** reasons why the zinc produced inside the furnace is in gaseous state. [2]

.....  
 .....

- (iii)** State the name of the physical change for conversion of gaseous zinc into molten zinc. [1]

.....

- (c)** Rusting of steel can be prevented by coating the steel with a layer of zinc. [2]

Explain, in terms of electron transfer, why steel does not rust even if the layer of zinc is scratched and the steel is exposed to air and water.

.....  
 .....  
 .....

[Total: 10]

OR

B9 Petroleum is a source of many important chemicals.

- (a) Name **two** industrial processes which must take place to produce alkenes from petroleum. [2]
- .....

- (b) Ethene and propene can both be converted into polymers.

- (i) State the type of polymerisation that takes place when ethene forms a polymer. [1]
- .....

- (ii) Identify the empirical formula of the polymer formed from ethene. [1]
- .....

- (iii) Draw **two** repeat units of the polymer made from propene. [2]

- (c) Most of the hydrocarbons obtained from petroleum are alkanes. The alkanes are homologous series of saturated hydrocarbons with the general formula  $C_nH_{2n+2}$ . [2]

Give two characteristics, other than having the same general formula, of members in the same homologous series.

.....

.....

- (d) When one mole of chlorine,  $Cl_2$ , reacts with one mole of propane, a mixture of **two** structural isomers is formed in the **first step** of substitution. [2]

Draw **all** the structural formulas of the isomers formed when one mole of chlorine reacts with one mole of propane.

[Total: 10]

END OF PAPER

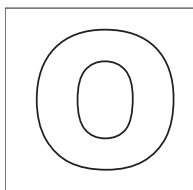
## The Periodic Table of Elements

Group																	
I	II	<div>1 H hydrogen 1</div>										III	IV	V	VI	VII	0
<div>Key</div> <div>proton (atomic) number atomic symbol name relative atomic mass</div>																	
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium -	85 At astatine -	86 Rn radon -
87 Fr francium -	88 Ra radium -	89 – 103 actinoids	104 Rf rutherfordium -	105 Db dubnium -	106 Sg seaborgium -	107 Bh bohrium -	108 Hs hassium -	109 Mt meitnerium -	110 Ds darmstadtium -	111 Rg roentgenium -	112 Cn copernicium -	114 Fl flerovium -	116 Lv livermorium -				

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium -	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium -	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium -	94 Pu plutonium -	95 Am americium -	96 Cm curium -	97 Bk berkelium -	98 Cf californium -	99 Es einsteinium -	100 Fm fermium -	101 Md mendelevium -	102 No nobelium -	103 Lr lawrencium -

The volume of one mole of any gas is 24 dm<sup>3</sup> at room temperature and pressure (r.t.p.).





**GAN ENG SENG SCHOOL**  
**Mid-Year Examination 2018**



**CANDIDATE  
NAME**

**CLASS**

**INDEX  
NUMBER**

**CHEMISTRY**

**Secondary 4 Express**

**Paper 1 Multiple Choice**

Additional Materials: OTAS

Calculators are allowed in the examination

**6092/01**

**7 May 2018**

**1 hour**

**READ THESE INSTRUCTIONS FIRST**

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, class and index number on the OTAS.

There are **forty** questions in this paper. Answer **all** questions. For each question there are four possible answers **A, B, C, and D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate OTAS.

**Read the instructions on the OTAS very carefully.**

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

A copy of the Periodic Table is on page 14.

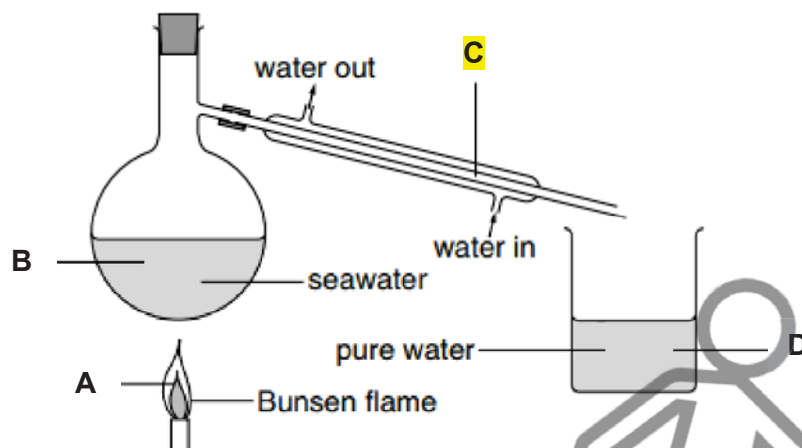
The use of an approved scientific calculator is expected, where appropriate.

Total Marks	
40	



- 1 The diagram shows how to obtain pure water from seawater.

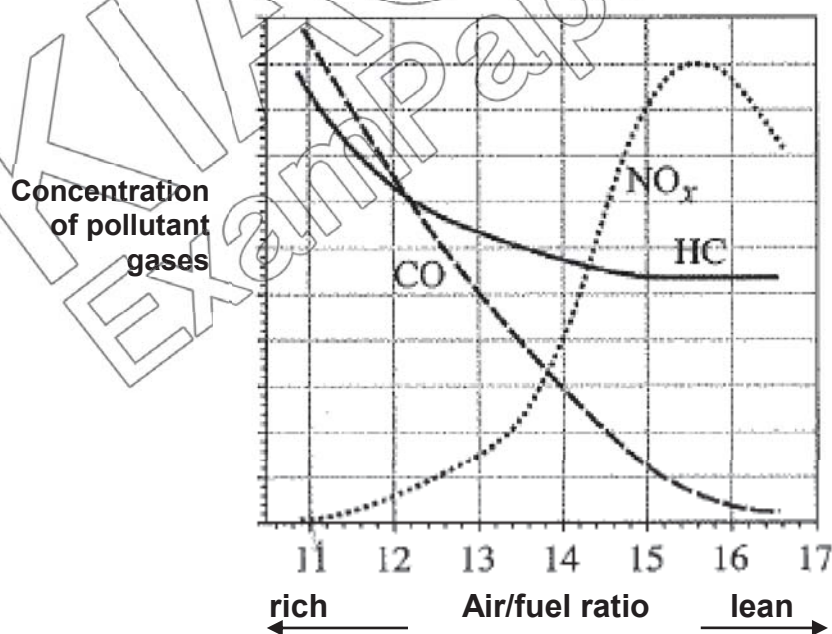
Where do water molecules lose energy?



Refer to the following to answer questions 2 and 3.

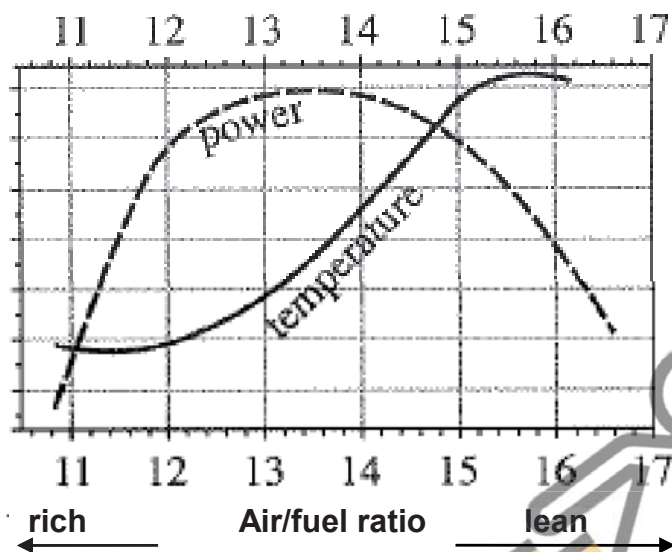
- 2 In a car engine, petrol vapour is mixed with air and undergoes combustion. When different amounts of petrol are mixed with air, different amounts of pollutant gases will be formed.

Graph I shows how the production of carbon monoxide (CO), nitrogen oxides (NO<sub>x</sub>) and hydrocarbons (HC) is dependent on the ratio of air to petrol.



Graph I

Graph II shows how the engine power and temperature vary with the different ratios of air to fuel of the fuel mixture.



Graph II

Which of the following is not true?

- A** The amount of carbon monoxide decreases as the air/ratio fuel ratio increases.
- B** The emission of nitrogen oxides increases as temperature of engine increases.
- C** Increasing the proportion of air in the mixture will increase the amount of hydrocarbons emitted.
- D** Increasing the proportion of air in the mixture will increase the level of nitrogen oxides produced.

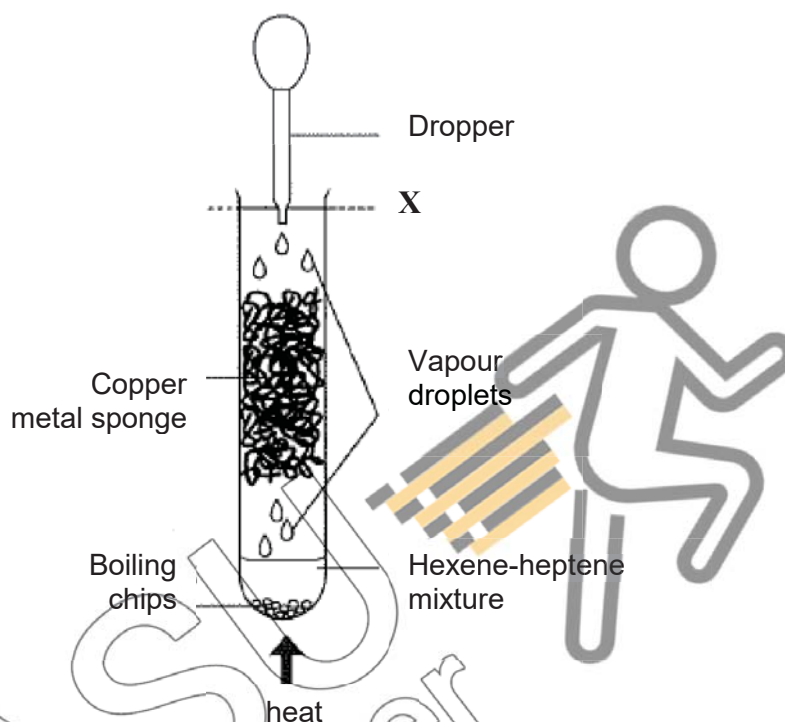
**3** Which of the following conclusions **cannot** be drawn based on the information from the graphs?

- A** A fuel-rich mixture and low combustion temperature will reduce nitrogen oxide formation.
- B** The overall levels of the three pollutants are best reduced by increasing the air-to-fuel ratio.
- C** A fuel-lean mixture reduces the carbon monoxide and hydrocarbons but reduces the engine output.
- D** A fuel-rich mixture reduces the level of nitrogen oxides emitted but reduces the engine power output.

Refer to the following to answer questions 4 and 5.

1-hexene and 1-heptene are two members of the alkene class of hydrocarbons.

A small amount of mixture of 1-hexene and 1-heptene was placed in a boiling tube and gently heated to boiling in a sand bath using the following setup:



Droplets were formed and could be seen condensing on the sides of the tube. When the vapour condensation line reached the level marked **X**, the hot vapours were very slowly withdrawn and condensed by using a small dropper.

- 4** What is the purpose of the copper metal sponge?
- |  |   |
|--|---|
| <b>A</b> Minimises contact of the mixture with air.                        | <b>B</b> Prevents the two compounds from escaping.                                  |
| <b>C</b> Acts as a catalyst to speed up the reaction of the two compounds. | <b>D</b> Provides a large surface area for repeated vapourisation and condensation. |
- 5** What process is demonstrated in this experiment?
- |                            |                                  |
|----------------------------|----------------------------------|
| <b>A</b> Cracking          | <b>B</b> Combustion              |
| <b>C</b> Addition reaction | <b>D</b> Fractional distillation |
- 6** Which of the following does not affect the rate at which a gas spreads throughout a room?
- |                                |                             |
|--------------------------------|-----------------------------|
| <b>A</b> Boiling point of gas  | <b>B</b> Temperature of gas |
| <b>C</b> Molecular mass of gas | <b>D</b> Density            |

- 7 Three elements, **X**, **Y** and **Z** have consecutive increasing atomic numbers.

If element **Y** is a noble gas, what will be the symbol for the ions formed by elements **X** and **Z** in their compounds?

- A**  $X^-$  and  $Z^+$  **B**  $X^{2-}$  and  $Z^{2+}$   
**C**  $X^+$  and  $Z^-$  **D**  $X^{2+}$  and  $Z^{2-}$

- 8 Potassium ferrate,  $K_2FeO_4$ , has been described as a 'green oxidising agent' because the by-products generated are environmentally-friendly.

What are the ions in this compound?

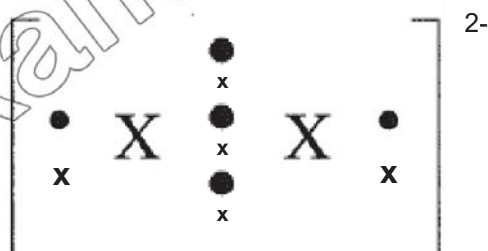
- A**  $K^+$ ,  $FeO_4^{2-}$   
**B**  $K_2^+$ ,  $FeO_4^-$   
**C**  $K^+$ ,  $Fe^{6+}$ ,  $O^{2-}$   
**D**  $K_2^+$ ,  $Fe^{2+}$ ,  $O^{2-}$

- 9 Peeling onions often causes tearing of the eyes due to the release of a sulfide compound. Peeling them under running water reduces the problem. Which of the following statements are true of the sulfide compound?

- I. It is soluble in water  
 II. It has low boiling point.  
 III. It has small and light ions with weak bonding.  
 IV. It is a covalent compound with weak covalent bonds.

- A** I and II only **B** I and IV only  
**C** I, II and III only **D** I, II and IV only

- 10 Element **X** forms the ion  $X_2^{2-}$  with the following structure:



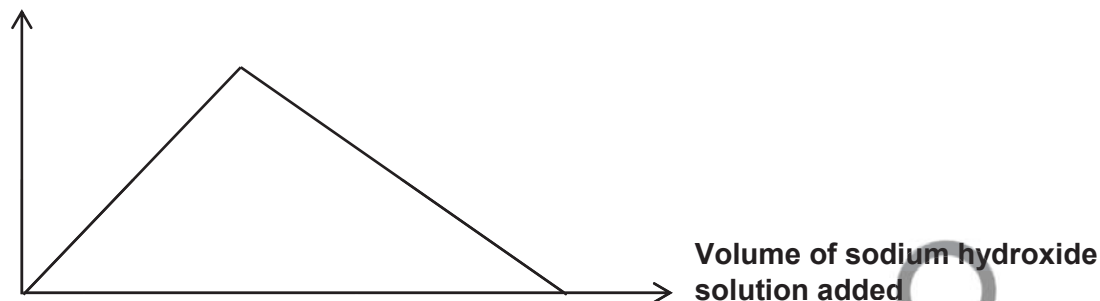
What is the formula of the covalent compound **X** forms with chlorine?

- A**  $XC/$  **B**  $XC/2$   
**C**  $XC/3$  **D**  $XC/4$

- 11** What is the maximum concentration of  $\text{H}^+$  ions in  $0.25 \text{ mol/dm}^3$  of phosphoric(V) acid,  $\text{H}_3\text{PO}_4$ ?  $0.25 \times 3 = 0.750$
- A  $0.125 \text{ mol/dm}^3$                       B  $0.250 \text{ mol/dm}^3$   
 C  $0.500 \text{ mol/dm}^3$                       D  $0.750 \text{ mol/dm}^3$
- 12** Heating iron in dry chlorine gas results in the formation of an iron(II) chloride. Experimental determination gives a reading of 34.5% by mass of iron in the Iron(II) chloride formed. What is the charge of the iron ion in the chloride?  $34.5\% = 56 / (56 + 106.5)$
- A -2    B +2  
 C -3    D +3
- 13** Which of the following results is obtained when  $100 \text{ cm}^3$  of  $0.500 \text{ mol/dm}^3$  dilute sulfuric acid is added to 60 g of granular solid lead(II) carbonate?
- A No visible reaction.                      B Colourless solution with effervescence is produced.  
 C Colourless solution with white precipitate                      D A colourless solution with white precipitate, effervescence and granular remains.
- 14** Which of the following pairs of aqueous reagents is not suitable for preparing insoluble salts? Salts containing group I metals are soluble
- A Sulfuric acid and calcium chloride  
 B Aluminium chloride and silver nitrate  
 C Barium hydroxide and copper(II) sulfate → barium sulfate and copper(II) hydroxide  
 D Lithium carbonate and iron(II) sulfate → Lithium sulfate and iron(II) carbonate
- 15** A salt has the formula  $\text{NH}_4\text{Fe}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$ . Excess aqueous sodium hydroxide was added to an aqueous solution of the salt in a test tube and the mixture was then warmed gently. Which of the following would **not** be observed?  $\text{Fe} = +3$  (reddish brown iron ion)
- A A pungent gas was detected.  
 B A green precipitate was formed.  
 C A reddish brown precipitate was obtained.  
 D A piece of moist litmus paper placed at the mouth of the test tube turned blue.
- 16** A compound Q formed white precipitate when acidified aqueous silver nitrate is added. Aqueous ammonia was used to identify the presence of the other ion and there is no visible change. Identify compound Q.
- A Calcium chloride  
 B Ammonium nitrate  
 C Calcium nitrate  
 D Zinc chloride

- 17 An aqueous solution of a salt **X** is placed in a test tube and sodium hydroxide solution is gradually added. The height of the precipitate in a test tube is plotted against the volume of sodium hydroxide solution added.

Height of precipitate



What could be **X**?

- A** Aluminium sulfate (soluble salt, Al is soluble in excess sodium hydroxide)  
**B** Calcium nitrate  
**C** Iron(II) sulfate  
**D** Ammonium nitrate
- 18 The formula for hydrated copper(II) nitrate is  $\text{Cu}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$ . It contains 36.5% water of crystallisation by mass.
- What is the value of  $x$ ?
- A** 4  
**C** 6  
**B** 5  
**D** 7
- 19 Element **X** is found in Group IV of the Periodic table. Which of the following could not be a formula for a compound of **X**?
- A**  $\text{XO}$   
**B**  $\text{XO}_2$   
**C**  $\text{XO}_3^{2-}$   
**D**  $\text{XO}_4$
- 20 Which of the following statements best explains why 99.99% copper is used in manufacturing high quality electrical wires for audio equipment?
- A** Copper is a good conductor of electricity.  
**B** Copper is a very reactive metal.  
**C** 99.99% copper is less ductile and cannot be stretched easily.  
**D** Copper is of high purity and is able to conduct electric current.



21 Which of the following statements about Group VII is **false**?

- |          |   |          |   |
|----------|---|----------|---|
| <b>A</b> | Colours of elements become darker down the Group.   | <b>B</b> | Densities of elements increase down the Group.                    |
| <b>C</b> | Melting points of elements increase down the Group. | <b>D</b> | Number of valence electrons of elements increases down the Group. |

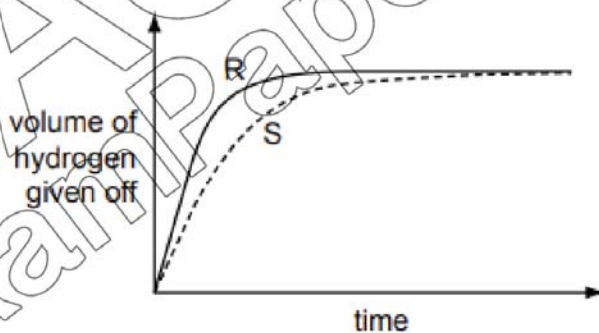
22 Methane gas reacts **extremely slowly** with air at room temperature. If a piece of warm platinum is held in a methane-air mixture, methane ignites. Which of the following statements correctly describes the reaction with platinum?

- I The activation energy is low.  
 II The energy change is greater.  
 III The energy of the reactants is lower than expected.  
 IV The rate of reaction is faster.

- A** I and II  
**B** I and IV  
**C** I, II and IV  
**D** I, II, III and IV

23 A student investigates the rate of reaction between magnesium and excess sulfuric acid. The volume of hydrogen given off in the reaction is measured over time.

The graph shows the results of two experiments, **R** and **S**.



Which change in conditions would cause the difference between **R** and **S**?

- A** Catalyst is added into **S**.  
**B** The acid is more concentrated in **R** than in **S**.  
**C** The magnesium is less finely powdered in **R** than in **S**.  
**D** The temperature in **R** is lower than in **S**.

24 Which statement is correct for the element of proton number 19?

- A It is a gas that dissolves in water.
- B It is a hard metal that is not very reactive with water.
- C It is a non-metal that burns quickly in air.
- D It is a soft metal that is highly reactive with water.

25 Statement 1: Alloying iron with other materials to form stainless steel prevents iron from rusting by excluding oxygen.

Statement 2: Painting, oiling and electroplating are all methods of preventing iron from rusting.

Which is correct?

- A Both statements are correct and statement 2 explains statement 1.
- B Both statements are correct but statement 2 does not explain statement 1.
- C Statement 1 is correct but statement 2 is incorrect.
- D Statement 2 is correct but statement 1 is incorrect.

26 The reactions shown may occur in the air during a thunder-storm.



Which row shows what happens to the reactant molecules in each of these reactions?

	$\text{N}_2$	$\text{NO}$	$\text{O}_3$
A	oxidised	oxidised	oxidised
B	oxidised	oxidised	reduced
C	reduced	reduced	oxidised
D	reduced	reduced	reduced

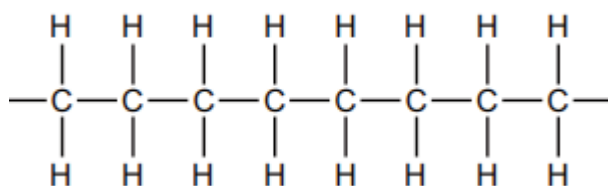
27 Iron is extracted from hematite in a blast furnace.

Which reaction contributes most of the heat in the blast furnace as it increases the temperature to over 1500°C?

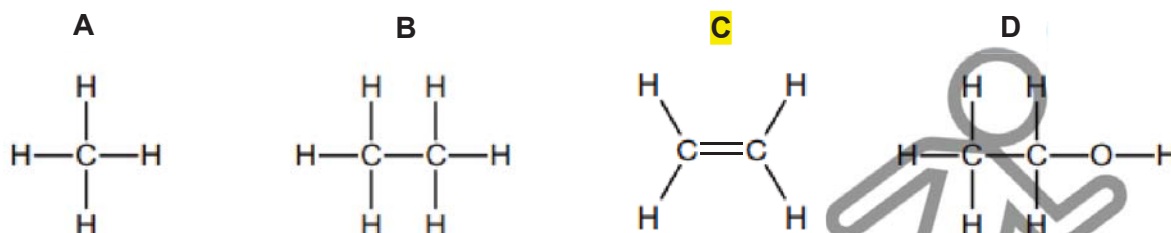
- A calcium carbonate  $\rightarrow$  calcium oxide + carbon dioxide
- B calcium oxide + silicon dioxide  $\rightarrow$  calcium silicate
- C carbon + oxygen  $\rightarrow$  carbon dioxide
- D carbon dioxide + carbon  $\rightarrow$  carbon monoxide



- 28 The diagram shows part of the molecule of a polymer.

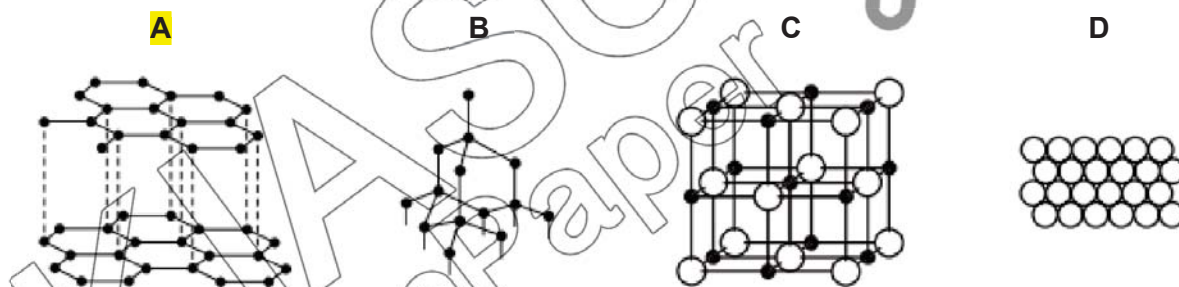


Which diagram shows the monomer from which this polymer could be manufactured?



- 29 Slate has a layered structure and is slippery.

Which diagram shows a structure that closely resembles slate?



- 30 In separate experiments conducted, a gaseous halogen was bubbled into an aqueous solution of a halide salt.

The following results were observed.

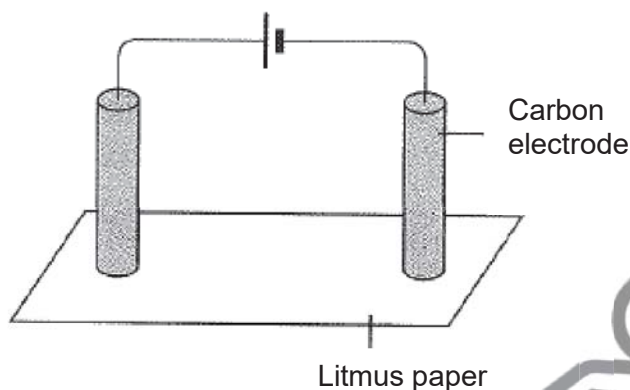
Halogen	Halides	
	$\text{Y}^-$	$\text{Z}^-$
$\text{X}_2$	No observable reaction	Displaced as $\text{Z}_2$
$\text{Y}_2$	No observable reaction	Displaced as $\text{Z}_2$
$\text{Z}_2$	No observable reaction	No observable reaction

What is the arrangement of halogens **X**, **Y** and **Z** in Group VII in order of decreasing reactivity?

- A** X, Y, Z
- B** Y, X, Z
- C** Z, X, Y

D Y, Z, X

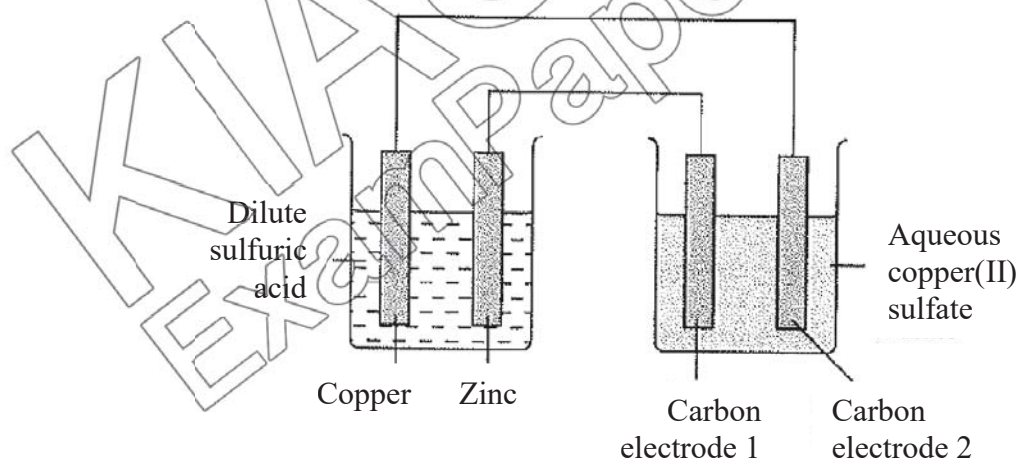
- 31 Two carbon electrodes are placed on a piece of red litmus paper soaked in concentrated sodium chloride solution as shown:



What are the observations of the litmus paper at the respective electrodes?

	<b>Cathode</b>	<b>Anode</b>
A	Litmus paper is bleached.	Litmus paper turns blue.
B	Litmus paper turns blue.	Litmus paper is bleached.
C	Litmus paper turns blue.	Litmus paper remains red.
D	Litmus paper remains red.	Litmus paper remains red.

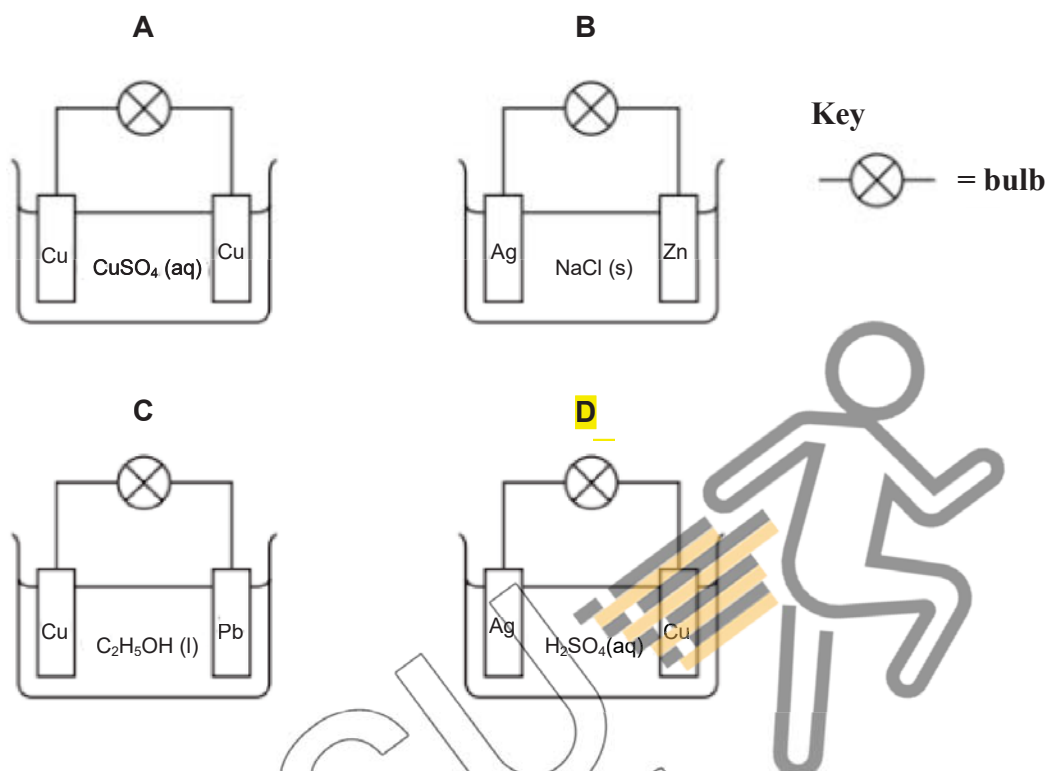
- 32 Two simple cells were set up as shown:



Two substances were discharged at the carbon electrodes. What were these two substances?

	<b>Electrode 1</b>	<b>Electrode 2</b>
A	Copper metal	Hydrogen gas
B	Hydrogen gas	Copper metal
C	Copper metal	Oxygen gas
D	Oxygen gas	Copper metal

**33** In which circuit does the bulb light?



**34** What are the main gases that escape from the top of the blast furnace in the manufacture of iron by the blast furnace?

- A** Nitrogen, steam and oxygen  
**B** Oxygen, carbon dioxide and steam  
**C** Nitrogen, carbon monoxide and carbon dioxide  
**D** Carbon monoxide, carbon dioxide and nitrogen monoxide

**35** A molten compound is electrolysed. Two atoms of X are deposited at the negative electrode at the same time as three atoms of Y are deposited at the positive electrode.

These results show that:

X is a ...**1**....;

Y is a ...**2**....;

the formula of the compound is ...**3**....

How are gaps **1**, **2** and **3** correctly completed?

	<b>1</b>	<b>2</b>	<b>3</b>
<b>A</b>	Metal	Non-metal	$X_3Y_2$
<b>B</b>	Metal	Non-metal	$X_2Y_3$
<b>C</b>	Non-metal	Metal	$X_3Y_2$
<b>D</b>	Non-metal	metal	$X_2Y_3$

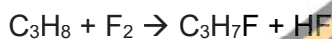
- 36 Zinc reacts with acids to form salts. Which of the following solutions would give the slowest rate of reaction when reacted with zinc?

**A** 0.0500 mol sulfuric acid in 500 cm<sup>3</sup> of water.  
**B** 0.0250 mol sulfuric acid in 100 cm<sup>3</sup> of water.  
**C** 0.0500 mol hydrochloric acid in 200 cm<sup>3</sup> of water.  
**D** 0.0250 mol hydrochloric acid in 75 cm<sup>3</sup> of water.

- 37 Which compound will react with steam, in the presence of catalyst, to produce the alcohol CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>OH?

**A** CH<sub>3</sub>CHCH<sub>2</sub>  
**B** CH<sub>3</sub>CHCHCH<sub>3</sub>  
**C** CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>CH<sub>3</sub>  
**D** CH<sub>3</sub>CH<sub>2</sub>COOH

- 38 Which type of reaction does this equation show?



**A** Hydration  
**B** Neutralisation  
**C** Addition  
**D** Substitution

- 39 An unsaturated hydrocarbon with six carbon atoms contains only three C=C double bonds. This hydrocarbon is reacted with excess bromine at a room temperature.

What is the formula of the resulting hydrocarbon?

**A** C<sub>6</sub>H<sub>8</sub>Br<sub>3</sub>  
**C** C<sub>6</sub>H<sub>8</sub>Br<sub>6</sub>  
**B** C<sub>6</sub>H<sub>10</sub>Br<sub>3</sub>  
**D** C<sub>6</sub>H<sub>14</sub>

- 40 A hydrocarbon is found to contain about 80% of carbon by mass. What is the hydrocarbon?

**A** Methane  
**C** Propane  
**B** Ethene  
**D** Hexene

END OF PAPER

Group																	
I	II											III	IV	V	VI	VII	0
<div>Key</div> <div>proton (atomic) number atomic symbol name relative atomic mass</div>																	
<div>1 H hydrogen 1</div>																	
3 Li lithium 7	4 Be beryllium 9																
11 Na sodium 23	12 Mg magnesium 24																
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium -	85 At astatine -	86 Rn radon -
87 Fr francium -	88 Ra radium -	89 – 103 actinoids	104 Rf rutherfordium -	105 Db dubnium -	106 Sg seaborgium -	107 Bh bohrium -	108 Hs hassium -	109 Mt meitnerium -	110 Ds darmstadtium -	111 Rg roentgenium -	112 Cn copernicium -		114 Fl flerovium -		116 Lv livermorium -		
lanthanoids																	
actinoids																	

The volume of one mole of any gas is  $24 \text{ dm}^3$  at room temperature and pressure (r.t.p.).



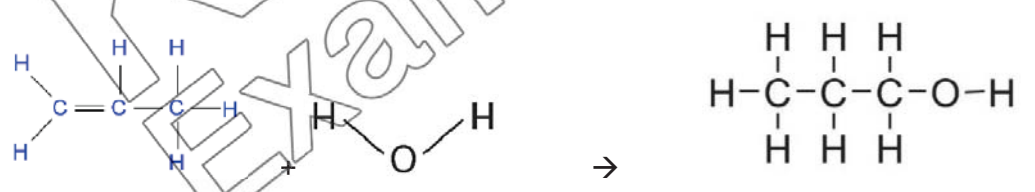
## Marking Scheme for Paper 2

Qn	Possible answers	Mark
A1 (a)	<p>(i) B and F [1]</p> <p>(ii) D [1]</p> <p>(iii) It is a metalloid/shows properties of both metal and non metal. [1]                      (Provide one property of a metal and one of a non metal e.g. conducts electricity but low density, dull colour accepted ) – [1]</p>	[4]
A1 (b)	<p><b>Bonds broken</b></p> <p><math>4(\text{C-H}) + 4(\text{F-F}) = 4 \times 412 + 4 \times \text{F-F}</math> - [1]</p> <p><b>Bonds formed</b></p> <p><math>4(\text{C-F}) + 4(\text{H-F}) = 4 \times 484 + 4 \times 562</math> - [1]</p> <p>[ Enthalpy change = bond break – bond make]</p> <p><math>-1904 = [4 \times 412 + 4(\text{F-F})] - [4 \times 484 + 4 \times 562]</math> [1]</p> <p><math>4(\text{F-F}) = -1904 - 4 \times 412 + [4 \times 484 + 4 \times 562] = 632</math></p> <p><math>\text{F-F} = 632 / 4 = 158 \text{ kJ/mol}</math>, The student is correct. [1]</p> <p>because the F–F bond energy is much less than the C–H or other covalent bonds, therefore the F–F bond is weak / easily broken.</p>	[4]

<b>A1 (c)</b>	<b>Chemical eqn</b> $2K(s) + 2H_2O(l) \rightarrow 2KOH(aq) + H_2(g)$ <b>Ionic eqn</b> $2K(s) + 2H_2O(l) \rightarrow 2K^+(aq) + 2OH^-(aq) + H_2(g)$ [1]	[1]
<b>A2 (a)</b>	Hydrogen	[1]
<b>(b)</b>	<u>Finely divided Iron.</u> [1] It <u>speeds up the reaction</u> / <u>increase the rate</u> of reaction. [1]	[2]
<b>(c)</b>	It will be fed back into the reactor / recycled / returned to the reaction. [1] It helps to <u>reduce the cost</u> of the process / <u>less waste of raw materials</u> used. [1]	[2]
<b>(d)</b>	A <u>higher temperature will give a lower yield</u> [1] A <u>higher pressure will give a higher yield</u> [1]	[2]
<b>(e)</b>	<b>(i)</b> $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ Reversible arrow and state symbols are required.	[1]
	<b>(ii)</b> It is a redox reaction. The <u>oxidation number of N decreases from 0 in <math>N_2</math> to -3 in <math>NH_3</math>. Hence nitrogen gas has been reduced.</u> [1] The <u>oxidation number of H increases from 0 in <math>H_2</math> to +1 in <math>NH_3</math>. Hence hydrogen gas has been oxidised.</u> [1]	[2]
<b>A3 (a)</b>	<u>Insoluble</u> substance / precipitate formed [1] Hence, light cannot travel through / stops light / block light [1]	[2]
<b>(b)</b>	Precipitate formed is not dense enough / thick enough / does not block all light / settled to the bottom of the tube.	[1]

(c) (i)	A. It is the <u>steepest graph</u> , indicating fastest rate of reaction / finishes in the <u>shortest time</u>	[1]
(c) (ii)	Time = 42s Rate = $1/42$ = <u><math>0.024 \text{ s}^{-1}</math> [1, with units]</u>  <b>NO FRACTIONS ALLOWED IN CALCULATION !</b>	[1]
(c) (iii)	As temperature increases, particles <u>gain heat with more kinetic energy</u> and will move faster at a higher temperature and <u>collide more frequently</u> . [1] More particles <u>possess energy greater or equal than the activation energy</u> . [1] Therefore, there is a <u>higher frequency of effective collision</u> , <u>increasing the rate of reaction</u> [1]	[3]
(d)	A <u>more reactive metal</u> will form a <u>more stable metal carbonate</u> [1] which takes a longer time to <u>decompose to produce carbon dioxide gas</u> [1] where white precipitate is formed in the limewater.  <b>Note: Metal carbonate <math>\rightarrow</math> Metal oxide + carbon dioxide gas</b>	[2]
A4 (a)	Mole of $\text{CO}_2 = 1.79 / (12+16+16)$ = $0.04068 \text{ mol}$ (leave to at least 4 sf in working) Mass of C = $0.04068 \text{ mol} \times 12$ = <b>0.488 g (3sf)</b>	[1]
(b)	$1.20 - 0.488 - 0.0812 = 0.631 \text{ g}$ <b>[Ecf allow from part (a)]</b>	[1]



(c)	<p>                         C : H : O  <math>0.488/12 : 0.0812/1 : 0.631/16</math> - [1]  <math>0.0407 : 0.0812 : 0.0394</math>  <math>1 : 2 : 1</math>                          Empirical formula is: <b>CH<sub>2</sub>O</b> - [1]  <b>[Ecf allowed from part (b) and part (a)]</b> </p>	[2]
(d)	<p>                         Since Empirical formula is: <b>CH<sub>2</sub>O</b>  <b>[Ecf allowed]</b>                          Mr of empirical formula is 30.                          For alcohol 1,  <math>120 / 30 = 4</math>                          Hence, molecular formula will be C<sub>4</sub>H<sub>8</sub>O<sub>4</sub> [1]  <b><u>Therefore, alcohol G is alcohol 1. – above proven.</u></b>                          For alcohol 2, not possible.                          OR                          Alcohol 1 has the simplest ratio that is the same as the empirical formula. [1]                     </p>	[1]
(e)	<p>                         Add <u>aqueous bromine to alcohol 1, it decolourises</u> OR <u>turned from reddish brown to colourless.</u>                          From <u>alcohol 2, aq bromine remains reddish brown.</u> </p>	[1]
(f)		[2]

$0.7246 \text{ mol} \times 180 = 130.4 \text{ g}$

$= 130 \text{ g (3sf) [1]}$

62.5 % [1]

reaction / Some products are lost through other reactions / n

[1]

an alternative pathway of lesser energy, hence less energy / tem

c reaction [1]

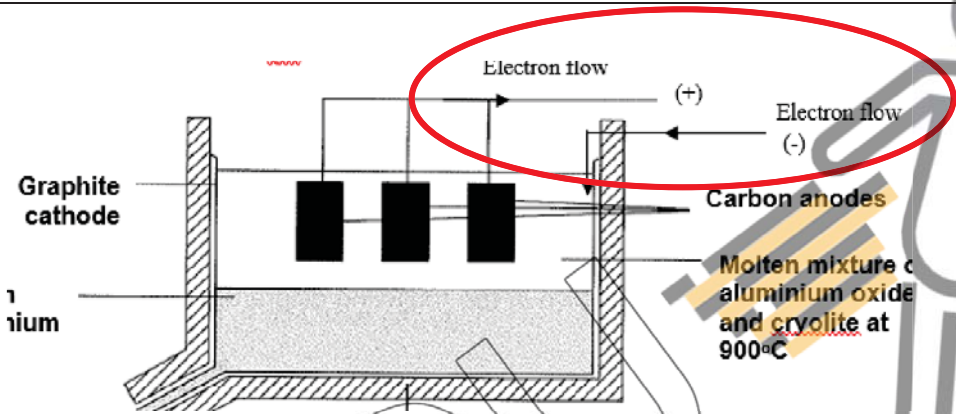
energy from the surroundings / temperature mixture as the ammon

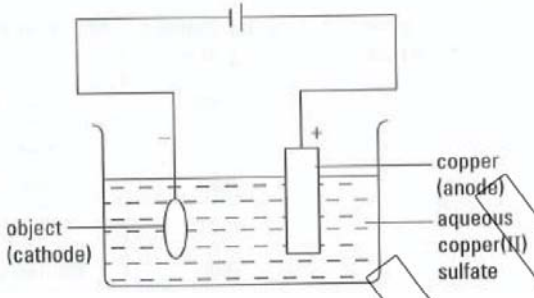
to be mobile / move / act as mobile charge carriers.

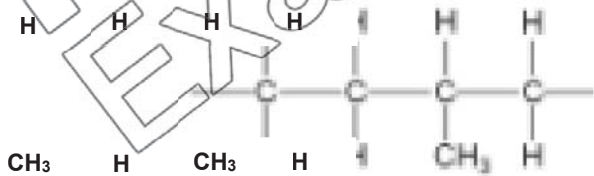
(g)

e, hence oxidation happens)

	<p>OR</p> <p>Silvery [1] substance [1]</p> <p>R: Solid. Because it is molten state.</p>	
(iii)	Lead <u>metal conducts electricity</u> [1]	[1]
B7 (a) (i)	Raw materials are renewable / Does not use crude oil	[1]
(a) (ii)	Alcohol <u>does not need to be distilled</u> [1] as <u>alcohol produced is pure</u> [1]	[2]
(b) (i)	<p>The healthier oil is sunflower oil. [1]</p> <p>It has <u>less saturated fat</u> than olive oil and corn oil [1] / it has the <u>highest value of polyunsaturated fat</u> compared with all the other oils. [1]</p> <p>OR</p> <p>Rapeseed oil is healthiest [1] because it has the <u>lowest value of saturated fat</u> compared with the other oils. [1] / it has more polyunsaturated fat than both olive and corn oil [1]</p>	[2]
(b) (ii)	<p>No, hydrogen adds to the unsaturated fat and <u>reduces the number of carbon carbon double bonds</u>. [1]</p> <p>Hence there will be less polyunsaturated fat [1]</p>	[2]
(b) (iii)	<p>Heat of combustion decreases as the number of carbon atom increases. [1]</p> <p>More <u>bonds are broken</u> during the combustion of longer chain alkanes, <u>hence less energy is released</u>. [1]</p>	[2]
(b) (iv)	Melting point increases as the number of carbon atoms increase.	[1]
B8 (a)	The mixture would have a lower melting point. [1] this allow the oxide to melt at a lower temperature and make the process more economical. [1] / Save money from electrical energy that is reduced. [1]	[2]
(b)	Anode: $2\text{O}^{2-}(\text{l}) \rightarrow \text{O}_2(\text{g}) + 4\text{e}^-$	[2]

	Cathode: $\text{Al}^{3+}(\text{l}) + 3\text{e}^- \rightarrow \text{Al}(\text{l})$	
(c)		[1]
(d)	<p>The overall equation is</p> $2\text{Al}_2\text{O}_3 \rightarrow 4\text{Al} + 3\text{O}_2$ <p>No. of moles of Al = <math>540 / 27</math></p> <p style="padding-left: 40px;">= 20 mol</p> <p>No. of moles of oxygen produced</p> <p style="padding-left: 40px;">= <math>20 / 4 \times 3 = \underline{15 \text{ mol [1]}}</math></p> <p>Volume of oxygen produced = <math>15 \times 24 \text{ dm}^3</math></p> <p style="padding-left: 40px;">= <u><b>360 dm<sup>3</sup> [1]</b></u></p>	[2]
(e)	<p>The presence of oxygen gas <u>reacts with the carbon anode</u> to form <u>oxides of carbon [1]</u>.</p> <p>Or</p> <p><u>Oxidises the carbon electrode and reduce the mass. [1]</u></p>	[1]

(f)	 <p>1m – correct terminals and label of anode and cathode</p> <p>1m – correct label of materials</p> <p>(Copper and copper sulfate solution)</p>	[2]
Either B9 (a) (i)	Larger surface area [1] for collision to occur, hence higher rate of reaction [1].	[2]
(a) (ii)	$2\text{ZnS} + 3\text{O}_2 \rightarrow 2\text{ZnO} + 2\text{SO}_2$	[1]
(b) (i)	<p>[1]</p> <p>heat produced by carbon/ coke (burning in) oxygen/ air;</p> <p>[1]</p> <p><math>\text{C} + \text{O}_2 \rightarrow \text{CO}_2</math> produces heat/ exothermic;</p> <p>OR</p> <p><math>2\text{C} + \text{O}_2 \rightarrow 2\text{CO}</math> produces heat/ exothermic</p> <p>[1]</p> <p><math>\text{ZnO} + \text{CO} \rightarrow \text{Zn} + \text{CO}_2</math>;</p> <p>OR</p>	[3]

	$\text{ZnO} + \text{C} \rightarrow \text{Zn} + \text{CO};$ OR $2\text{ZnO} + \text{C} \rightarrow 2\text{Zn} + \text{CO}_2$	
(b) (ii)	<u>Temperature (inside the furnace) is above 907 °C</u> OR <u>Temperature (inside the furnace) is above the boiling point (of zinc)</u> OR <u>1000°C is above the boiling point (of zinc)</u>	[1]
(b) (iii)	Condensation	[1]
(c)	<u>Zinc is more reactive than iron</u> / Zinc is <u>higher in the reactivity series</u> than iron / Zinc <u>reacts more readily with oxygen</u> than iron. [1] <u>Zinc loses electrons more easily</u> and it is able to react with the air and water [1]	[2]
OR B9 (a)	Fractional distillation [1] and cracking [1]	[2]
(b) (i)	Addition polymerization <b>[R: Additional polymerization]</b>	[1]
(ii)	CH <sub>2</sub>	[1]
(iii)		[2]



	<p>[1] chain of 4 carbon atoms with single bonds and continuation bonds;</p> <p>[1] correctly positioned CH<sub>3</sub> side chains;</p>	
(c)	<p><b>any 2 from</b></p> <ul style="list-style-type: none"> <li>- similar chemical properties</li> <li>- same functional group</li> <li>- trend each consecutive member differ by CH<sub>2</sub></li> </ul>	[2]
(d)	<p>1-chloropropane      2-chloropropane</p> <p>Cl either at first or second carbon atom.</p>	[2]





Name:	Index Number:	Class:
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## HUA YI SECONDARY SCHOOL

Mid Year Examination 2018

**4E**

**4E**

### CHEMISTRY

**6092/1**

Paper 1

9 May 2018

1 hour

Candidates answer on the Multiple Choice Answer Sheet provided.  
Additional Materials: Multiple Choice Answer Sheet

### READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you have done.

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

**Read the instructions on the Answer Sheet very carefully.**

Each correct answer will score one mark. A mark will not be deducted for a wrong answer. Any rough working should be done in this booklet.

A copy of the Periodic Table is printed on page 15.

For Examiner's Use	
Paper 1	

This document consists of **15** printed pages including the cover page.

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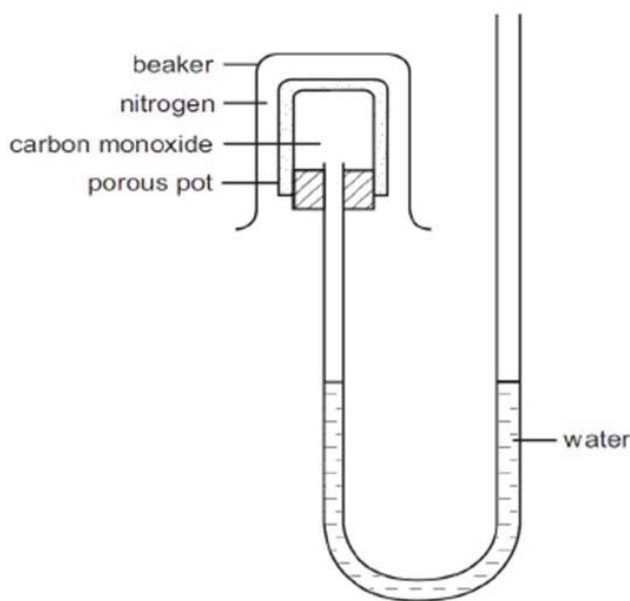
**[Turn Over]**

Setter: Ms Tok Peilin

- 1 When iodine crystals were heated in a test tube, the iodine sublimed. How did the movement of the iodine particles change?

A particles slide over one another → particles move freely  
 B particles slide over one another → particles vibrate about fixed positions  
 C particles vibrate about fixed positions → particles move freely  
 D particles vibrate about fixed positions → particles slide over one another

- 2 A beaker of nitrogen is inverted over a porous pot containing carbon monoxide as shown.



The water level does **not** change.

Which statement is correct?

A Both gases are diatomic.  
 B Nitrogen is an unreactive gas.  
 C The gas particles are too large to pass through the porous pot.  
 D The two gases have the same relative molecular mass.

- 3 In which of the following do both gases change the colour of damp red litmus paper?

A ammonia and chlorine  
 B ammonia and sulfur dioxide  
 C carbon dioxide and chlorine  
 D carbon dioxide and sulfur dioxide

- 4 A solid can be purified by crystallisation from its aqueous solution.

Which of the following properties does the solid have?

A It dissolves in cold water, but not in hot water.  
 B It is equally soluble in hot and cold water.  
 C It is more soluble in hot water than in cold water.  
 D It is very soluble in cold water.

- 5 The table shows some information about the solubilities of three solids.

solid	solubility in water	solubility in propanol
P	insoluble	soluble
Q	soluble	insoluble
R	insoluble	insoluble

The following operations could be carried out to obtain pure P from a mixture of P, Q and R.

- 1 evaporate filtrate to dryness
- 2 add propanol
- 3 filter
- 4 add water
- 5 collect residue

In what order should the operations be carried out?

- A** 2, 3, 4, 5, 1  
**B** 2, 3, 5 only  
**C** 4, 1, 2, 3 only  
**D** 2, 3, 1 only
- 6 An element E forms a negative ion,  $E^{2-}$ , with the electronic structure 2,8,8. What is the proton number of E?
- A** 16  
**B** 17  
**C** 18  
**D** 20
- 7 Which statements correctly describes the properties of mixtures of iron and sulfur, and the compound iron(II) sulfide,  $FeS$ ?

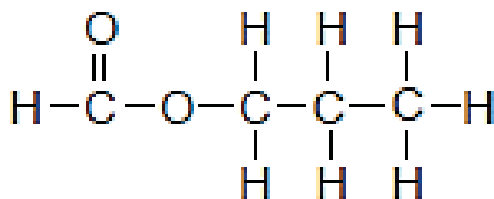
	mixtures of iron and sulfur	compound iron(II) sulfide
1	iron and sulfur mix without chemically reacting	iron and sulfur combine in a chemical reaction to form iron(II) sulfide
2	the ratio of iron to sulfur in mixture can vary	the ratio of iron to sulfur in iron(II) sulfide is always the same
3	the mixtures do not have the properties of iron or sulfur	iron(II) sulfide has the properties of iron and sulfur

- A** 1 only  
**B** 1 and 2  
**C** 2 and 3  
**D** 3 only

- 8 Deuterium (chemical symbol D) is an isotope of hydrogen. An atom of deuterium contains one neutron.

Which of the following statements is **not** true?

- A An atom of deuterium is heavier than an atom of hydrogen.  
 B An atom of deuterium has a relative atomic mass of 1.  
 C An atom of deuterium has one valence electron.  
 D The formula of the compound formed between deuterium and oxygen is D<sub>2</sub>O.
- 9 The diagram shows the structural formula of propyl methanoate.



What is the total number of electrons that are **not** involved in chemical bonding in the molecule?

- A 8  
 B 14  
 C 20  
 D 28
- 10 The table shows four elements W, X, Y and Z with their atomic numbers.

element	W	X	Y	Z
atomic number	6	8	11	17

What are the likely formulae of ionic compound and covalent compound formed from the four elements?

	formula of ionic compound	formula of covalent compound
A	W X	YZ
B	Y <sub>2</sub> X	WX <sub>2</sub>
C	YW	WZ <sub>4</sub>
D	YZ	ZX

11 Which particles are responsible for the conduction of electricity through metals?

- A electrons only
- B electrons and positive ions
- C negative ions only
- D negative ions and positive ions

12 The table shows some of the physical properties of P, Q, R and S.

substance	melting point / °C	boiling point / °C	electrical conductivity		solubility in water
			solid	liquid	
P	122	550	poor	poor	insoluble
Q	690	1790	poor	good	soluble
R	1510	2489	poor	poor	insoluble
S	1453	2730	good	good	insoluble

Which of the following statements about the four substances is correct?

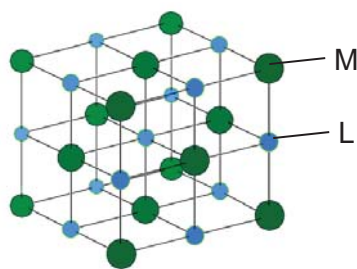
- A P is a simple molecular compound held by weak covalent bonds.
- B Q is an ionic compound with mobile electrons in the liquid state.
- C R is a macromolecule held by strong electrostatic forces of attraction between ions.
- D S has a giant lattice structure with mobile electrons.

13 The melting points of magnesium oxide and calcium oxide are given below.

metal oxide	melting point/ °C
magnesium oxide	2852
calcium oxide	2572

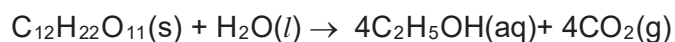
- A The charge of the calcium ion is higher than that of the magnesium ion.
- B The charge of the magnesium ion is higher than that of the calcium ion.
- C The radius of the calcium ion is smaller than that of the magnesium ion.
- D The radius of the magnesium ion is smaller than that of the calcium ion.

- 14 Element L and M form a compound which has a structure shown below.



Based on the structure shown above, deduce the chemical formula of the compound formed between element L and M.

- A** LM  
**B** L<sub>2</sub>M  
**C** LM<sub>2</sub>  
**D** L<sub>14</sub>M<sub>13</sub>
- 15 When sugar, C<sub>12</sub>H<sub>22</sub>O<sub>11</sub>, (M<sub>r</sub> = 342) is fermented using yeast, the following reaction takes place.



1kg of sugar is completely fermented.

Which expression shows the volume of carbon dioxide produced?

- A**  $\frac{342 \times 4 \times 24}{1000} \text{ dm}^3$                       **B**  $\frac{1000 \times 24}{342 \times 4} \text{ dm}^3$   
**C**  $\frac{342 \times 24}{1000 \times 4} \text{ dm}^3$                       **D**  $\frac{1000 \times 4 \times 24}{342} \text{ dm}^3$
- 16 A sample of nitrogen gas contains the same number of atoms as found in 4.00 g of methane gas.

What is the mass of the sample of nitrogen gas?

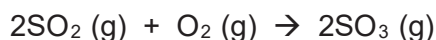
- A** 7.00 g  
**B** 14.0 g  
**C** 17.5 g  
**D** 35.0 g

- 17 In an experiment carried out at room conditions, 1.0 dm<sup>3</sup> of carbon dioxide was collected when an excess of dilute hydrochloric acid was added to 5.0 g of calcium carbonate.



What is the percentage yield of carbon dioxide gas?

- A 4.16%  
 B 12.0%  
 C 41.6%  
 D 83.3%
- 18 What is the total volume of gas, measured at room temperature and pressure, that remains if 20 cm<sup>3</sup> of sulfur dioxide reacts with 20 cm<sup>3</sup> of oxygen to form sulfur trioxide?

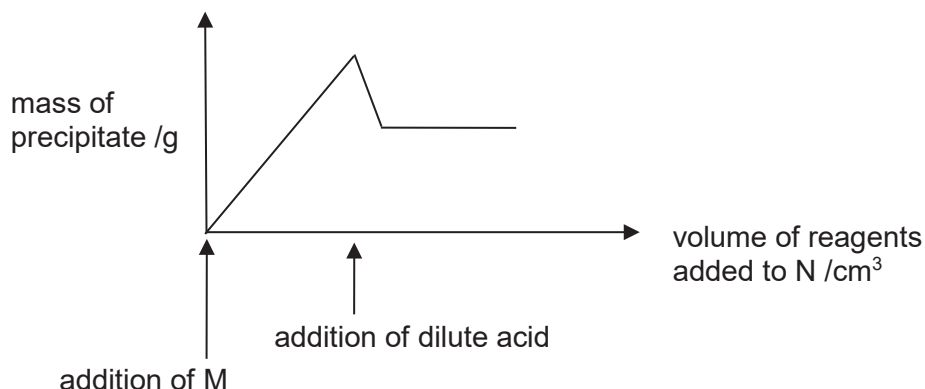


- A 10 cm<sup>3</sup>  
 B 20 cm<sup>3</sup>  
 C 30 cm<sup>3</sup>  
 D 60 cm<sup>3</sup>
- 19 An excess sample of an alloy, containing two metals, was dissolved in dilute sulfuric acid. Aqueous sodium hydroxide was then added to the solution. A precipitate was formed. An excess of the alkali caused the mass of the precipitate to decrease leaving a dirty green solid and a colourless solution.

What were the two metals present in the alloy?

- A calcium and zinc  
 B copper and iron  
 C copper and lead  
 D iron and zinc
- 20 Which equation shows the most suitable reaction for the production of lead(II) sulfate in the school laboratory with good yield?
- A  $\text{Pb} + \text{H}_2\text{SO}_4 \rightarrow \text{PbSO}_4$   
 B  $\text{Pb}(\text{OH})_2 + \text{H}_2\text{SO}_4 \rightarrow \text{PbSO}_4 + 2\text{H}_2\text{O}$   
 C  $\text{Pb}(\text{NO}_3)_2 + \text{H}_2\text{SO}_4 \rightarrow \text{PbSO}_4 + 2\text{HNO}_3$   
 D  $\text{PbCO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{PbSO}_4 + \text{CO}_2 + \text{H}_2\text{O}$

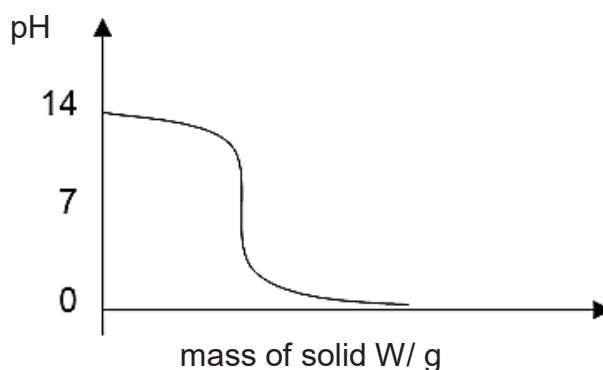
- 21 In a qualitative analysis, reagent M is gradually added to a salt solution N followed by the addition of a dilute acid. The graph below shows how the mass of the precipitate formed changes with the reagents added.



Which of the following set of anions would produce the given results?

	reagents (M and acid) added	anion(s) in N
<b>A</b>	add silver nitrate, followed by dilute nitric acid	$\text{Cl}^-$ , $\text{CO}_3^{2-}$
<b>B</b>	add silver nitrate, followed by dilute nitric acid	$\text{I}^-$
<b>C</b>	add aqueous barium nitrate, followed by dilute hydrochloric acid	$\text{Cl}^-$ , $\text{CO}_3^{2-}$
<b>D</b>	add aqueous barium nitrate, followed by dilute hydrochloric acid	$\text{CO}_3^{2-}$

- 22 Solid W is gradually added to solution X. The changes in pH are shown on the graph.



What are W and X?

	solution X	solid W
<b>A</b>	nitric acid	insoluble metal oxide
<b>B</b>	hydrochloric acid	soluble metal oxide
<b>C</b>	aqueous ammonia	soluble non-metal oxide
<b>D</b>	sodium hydroxide	soluble non-metal oxide



23 In which of the reactions is the underlined substance acting as a reducing agent?

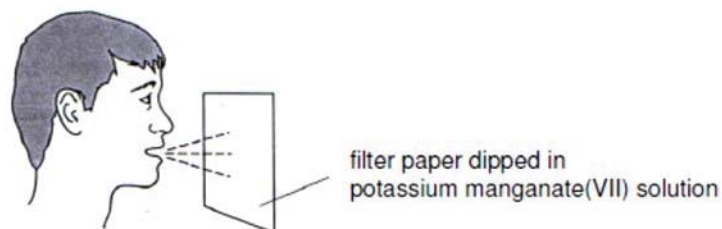
- A  $\underline{\text{Cl}_2} + 2\text{FeCl}_2 \rightarrow 2\text{FeCl}_3$   
 B  $2\text{HCl} + \underline{\text{MgO}} \rightarrow \text{MgCl}_2 + \text{H}_2\text{O}$   
 C  $\text{H}_2 + \underline{\text{CuO}} \rightarrow \text{Cu} + \text{H}_2\text{O}$   
 D  $\text{ZnO} + \underline{\text{CO}} \rightarrow \text{Zn} + \text{CO}_2$

24 Disproportionation is a reaction in which the same element is both oxidised and reduced.

Which reaction is an example of disproportionation?

- A  $\text{Cl}_2 + \text{H}_2\text{O} \rightarrow \text{HClO} + \text{HCl}$   
 B  $2\text{Pb}(\text{NO}_3)_2 \rightarrow 2\text{PbO} + 4\text{NO}_2 + \text{O}_2$   
 C  $\text{Cu} + 2\text{H}_2\text{SO}_4 \rightarrow \text{CuSO}_4 + 2\text{H}_2\text{O} + \text{SO}_2$   
 D  $\text{Cu} + 4\text{HNO}_3 \rightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{H}_2\text{O} + 2\text{NO}_2$

25 Acidified potassium manganate(VII) can be used to detect the presence of ethanol vapour in the breath of a person who has consumed alcohol.



A colour change of the filter paper is observed.

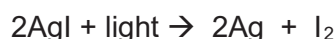
Which of the following conclusion about ethanol is observed?

- A It is a reducing agent because it reduces the oxidation state of the manganese.  
 B It is an alkali because the final colour is purple.  
 C It is an oxidising agent because the manganese atoms gain oxygen atoms.  
 D It is neutralised by acidified potassium manganate(VII) solution.

26 Which of the following substances could be used to reduce atmospheric pollution caused by flue gases?

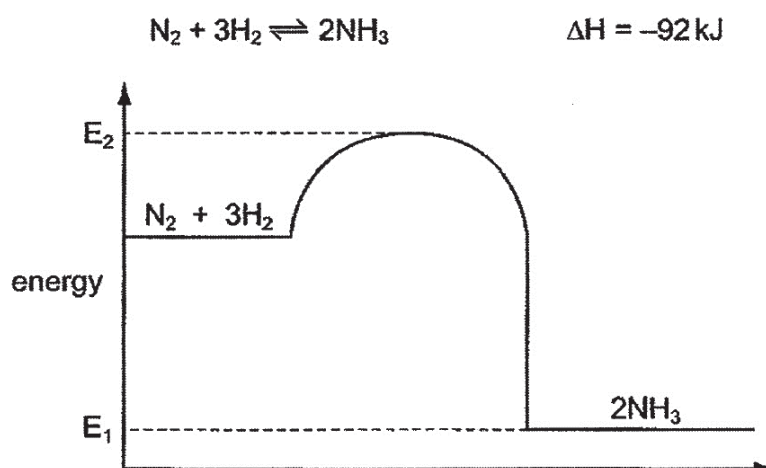
- A ammonium carbonate and ammonium sulfate  
 B ammonium sulfate and calcium carbonate  
 C calcium carbonate and calcium oxide  
 D calcium oxide and ammonium sulfate

- 27 The equation for a particular reaction is shown below.



Why is this an endothermic reaction?

- A Energy is required to vaporise iodine.
  - B It involves the formation of covalent I – I bonds.
  - C It involves the transfer of electrons from iodide ions to silver ions.
  - D Light energy is absorbed when the reaction takes place.
- 28 The energy profile diagram is that for the Haber process.



What does the energy change  $E_2 - E_1$  represent?

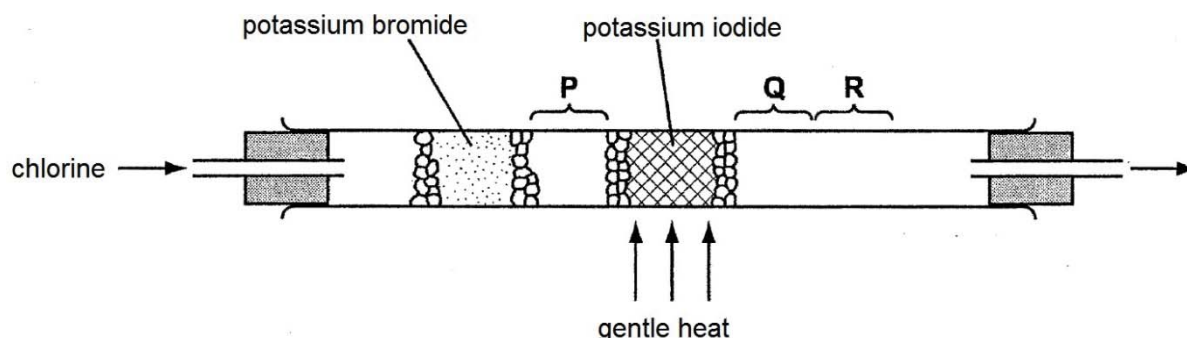
- A activation energy of the forward reaction
  - B activation energy of the reverse reaction
  - C enthalpy change of the forward reaction
  - D enthalpy change of the reverse reaction
- 29 Caesium is an element in the same group of the Periodic Table as lithium, sodium and potassium.

Which statements about caesium are likely to be **false**?

- I It reacts explosively with cold water.
- II It forms a soluble carbonate salt.
- III It forms a carbonate with a formula of  $\text{CsCO}_3$ .
- IV It can be extracted via electrolysis of concentrated aqueous  $\text{CsCl}$ .

- A I and II
- B I and III
- C II and III
- D III and IV

- 30 Using the apparatus shown, chlorine is passed through the tube. After a short time, coloured substances are seen at **P**, **Q** and **R**.



What are these coloured substances?

	<b>P</b>	<b>Q</b>	<b>R</b>
<b>A</b>	reddish-brown vapour	violet vapour	black solid
<b>B</b>	reddish-brown vapour	reddish-brown vapour	reddish-brown vapour
<b>C</b>	green gas	violet vapour	black solid
<b>D</b>	green gas	reddish-brown vapour	reddish-brown liquid

- 31 The table below gives some information about element Y.

density / g/cm <sup>3</sup>	6.2
melting point / °C	1280
formulae of oxides	YO (white) Y <sub>2</sub> O <sub>3</sub> (brown)
chemical properties	reacts readily with O <sub>2</sub> or Cl <sub>2</sub>

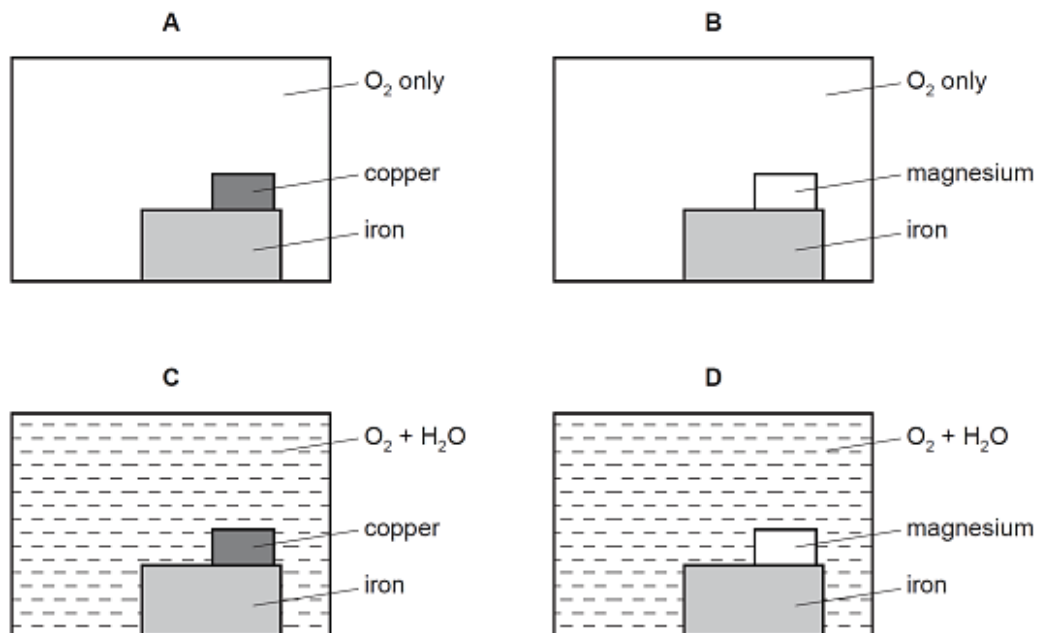
Which of the following statements about element Y is likely to be correct?

- A** It is a metal in Group III.  
**B** It is a transition metal.  
**C** It is an alkali metal.  
**D** It forms oxides that are amphoteric in nature.
- 32 A new element, Hb, placed in Group VII of the Periodic Table, has a higher relative atomic mass than astatine.

Which statement about element Hb is **not** correct?

- A** Hb atom gains electrons less readily than a chlorine atom.  
**B** Hb displaces astatine out from aqueous potassium astatide.  
**C** Hb has a higher boiling point than bromine.  
**D** Hb is a less powerful oxidizing agent than iodine.

- 33 Which diagram correctly shows the conditions necessary for rusting of iron and also the metal that can be used to prevent rusting by sacrificial protection?

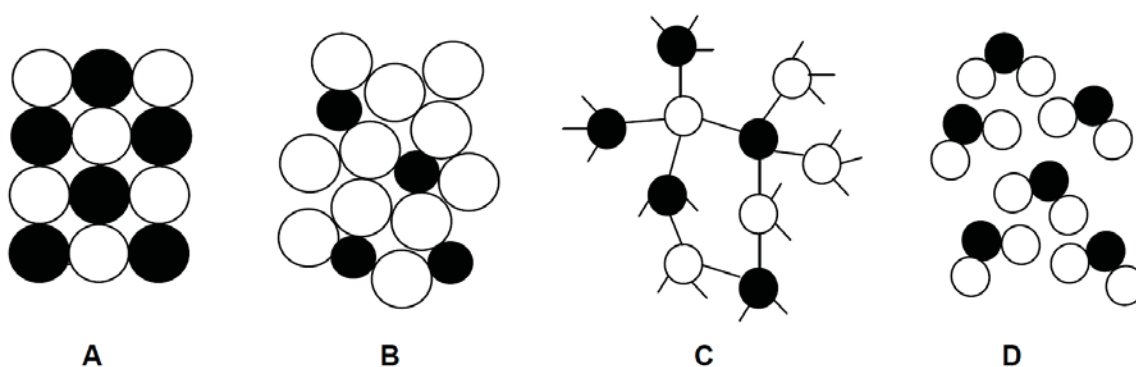


- 34 Scrap iron is often recycled.

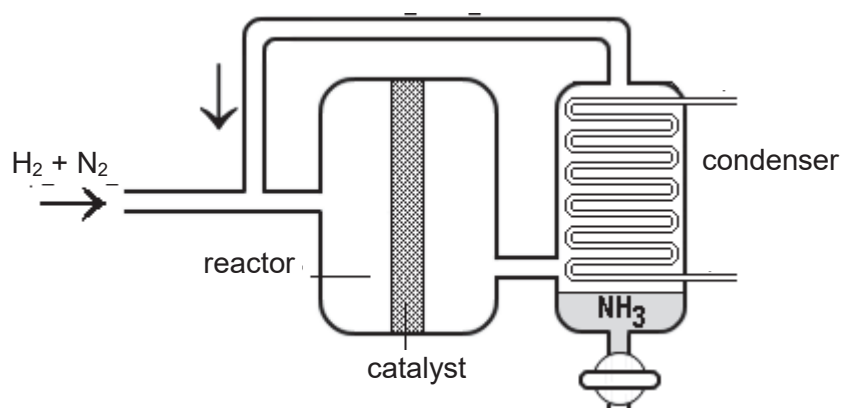
Which reason for recycling is **not** correct?

- A** It reduces the amount of pollution at the site of the ore extraction.
- B** It reduces the amount of waste taken to landfill sites.
- C** It reduces the need to collect the scrap iron.
- D** It saves natural resources.

- 35 Which diagram below shows the structure of an alloy?



- 36 Ammonia is produced by Haber process as shown in the diagram.



Which one of the following processes separates ammonia from the reaction mixture?

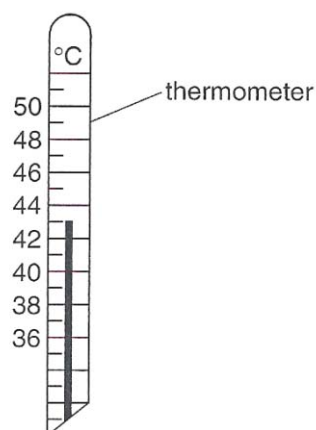
- A** cooling the gaseous mixture  
**B** distillation of the gaseous mixture  
**C** filtering out the other two gases  
**D** passing the gaseous mixture through fused calcium oxide
- 37 Which solution(s) would produce hydrogen gas at the cathode upon electrolysis?
- 1 dilute nitric acid  
 2 aqueous potassium hydroxide  
 3 aqueous sodium chloride
- A** 1 only  
**B** 1 and 2  
**C** 2 and 3  
**D** all of the above
- 38 The table shows the energy released by complete combustion of some compounds used as fuels.

compound	$M_r$	$\Delta H$ (kJ/mol)
methane	16	-880
ethanol	46	-1380
propane	44	-2200
heptane	100	-4800

Which fuel produces the least energy when 1 g of the compound is completely burned?

- A** methane  
**B** ethanol  
**C** propane  
**D** heptane

- 39 A thermometer is placed in warm water and the temperature is measured as shown.



When a solid is dissolved in the water, an exothermic change takes place. The temperature changes by 5°C.

What is the final temperature?

- A 38.0 °C
  - B 38.5 °C
  - C 48.0 °C
  - D 48.5 °C
- 40 In which reaction is the pressure **not** likely to affect the rate of reaction?
- A  $3\text{H}_2 (\text{g}) + \text{N}_2 (\text{g}) \rightarrow 2\text{NH}_3 (\text{g})$
  - B  $\text{CuO} (\text{s}) + \text{H}_2 (\text{g}) \rightarrow \text{Cu} (\text{s}) + \text{H}_2\text{O} (\text{l})$
  - C  $\text{Fe}_2\text{O}_3 (\text{s}) + 3\text{CO} (\text{g}) \rightarrow 2\text{Fe} (\text{s}) + 3\text{CO}_2 (\text{g})$
  - D  $\text{H}_2\text{SO}_4 (\text{aq}) + 2\text{NaOH} (\text{aq}) \rightarrow \text{Na}_2\text{SO}_4 (\text{aq}) + 2\text{H}_2\text{O} (\text{l})$

**End of Paper**

# The Periodic Table of Elements

Group																		
I	II	1 H hydrogen 1										III	IV	V	VI	VII	0	
		<div>Key</div> <div>proton (atomic) number atomic symbol name relative atomic mass</div>																
3 Li lithium 7	4 Be beryllium 9																	
11 Na sodium 23	12 Mg magnesium 24																	
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84	
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131	
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids		72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium -	85 At astatine -	86 Rn radon -
87 Fr francium -	88 Ra radium -	89 – 103 actinoids		104 Rf Rutherfordium -	105 Db dubnium -	106 Sg seaborgium -	107 Bh bohrium -	108 Hs hassium -	109 Mt meitnerium -	110 Ds darmstadtium -	111 Rg roentgenium -	112 Cn copernicium -	114 Fl flerovium -	116 Lv livermorium -				-
lanthanoids																		
57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium -	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175				-
actinoids																		
89 Ac actinium -	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium -	94 Pu plutonium -	95 Am americium -	96 Cm curium -	97 Bk berkelium -	98 Cf californium -	99 Es einsteinium -	100 Fm fermium -	101 Md mendelevium -	102 No nobelium -	103 Lr lawrencium -				-

Name	Index Number	Class
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## HUA YI SECONDARY SCHOOL

Mid Year Examination 2018

# 4E

### CHEMISTRY

Paper 2

Candidates answer on the Question Paper.  
Additional Materials: NIL

# 4E

6092/2

7 May 2018

1 hr 45 min

### READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.  
Write in dark blue or black pen.  
You may use a pencil for any diagrams, graphs, tables or rough working.  
Do not use staples, paper clips, highlighters, glue or correction fluid.

#### Section A

Answer **all** questions.  
Write your answers in the spaces provided on the question paper.

#### Section B

Answer **all** questions.  
Write your answers in the spaces provided on the question paper.

The number of marks is given in brackets [ ] at the end of each question or part question.  
A copy of the Periodic Table is printed on page 21.

The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use	
Section A	
Section B	
Total	

This document consists of **21** printed pages including the cover page.

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**[Turn Over]**

Setter: Ms Tok Peilin



## Section A

Answer **all** the questions in this section in the spaces provided.  
The total mark for this section is **50**.

**A1** The following compounds are used in manufacturing chemicals for agriculture.

<b>A</b>	$K_3PO_4$
<b>B</b>	$H_2SO_4$
<b>C</b>	$NH_3$
<b>D</b>	$Ca(OH)_2$
<b>E</b>	$NH_4NO_3$

Use the letters **A**, **B**, **C**, **D** and **E** to answer the following questions.

(a) Which solid compound is added to increase the pH of soil?

..... [1]

(b) Two raw materials are used to make a compound.

- One of the raw materials is made by cracking petroleum.
- The other raw material is obtained by fractional distillation of air.

Which compound is manufactured from these two raw materials?

..... [1]

(c) Which **two** compounds can be reacted together to form an ammonium salt?

.....and..... [1]

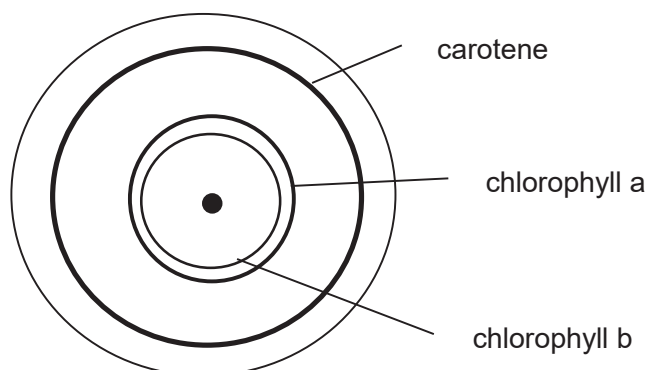
(d) NPK fertilisers are solid fertilisers that contain compounds of nitrogen, phosphorus and potassium.

Which **two** compounds could be mixed to produce an NPK fertiliser?

.....and..... [1]

[Total: 4]

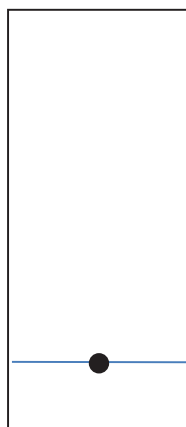
- A2** Spinach is an edible plant that has a deep green colour. The following chromatogram is obtained when water-acetone mixture is added to a drop of spinach extract in the centre of a piece of filter paper.



- (a) State the property which allows the components of the spinach extract to be separated using chromatography.

.....  
 ..... [1]

- (b) The experiment was repeated using a typical chromatography paper as shown below.



Draw and label the expected positions of the components of spinach extract on the chromatogram. [2]

- (c) State one experimental procedure that should be followed to obtain a good **separation** of the components.

.....  
 ..... [1]

- (d) Suggest why a water-acetone mixture is used as the solvent, instead of just a pure water or pure acetone solvent.

.....

..... [1]

[Total: 5]

**A3** One of the ways to reduce air pollution is to curb the number of vehicles on the road.

- (a) Name **two** air pollutants produced by motor vehicles.

..... [2]

- (b) Catalytic converters are fitted in cars to reduce the amount of air pollutants emitted by motor vehicles. In the catalytic converter, nitrogen monoxide and carbon monoxide react together to form harmless products.

- (i) Write a chemical equation to show how air pollutants are removed by catalytic converters.

..... [1]

- (ii) Explain why catalytic converters do **not** solve all the environmental problems caused by motor vehicles.

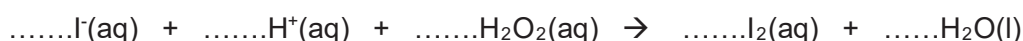
.....

.....

..... [2]

[Total: 5]

**A4** The reaction below is an example of a redox reaction.



- (a) Balance the equation by inserting numbers (if necessary) on the dotted lines provided. [1]

- (b) Identify the oxidising agent in this reaction. Explain your answer using oxidation states.

.....

.....

..... [2]

- (c) What colour change will be seen when this reaction is carried out?

.....

..... [1]

[Total: 4]

**A5** The table shows some data about the different components of air.

components	melting point / °C	boiling point / °C
argon	– 189	– 186
carbon dioxide	– 78	– 78
krypton	– 157	– 153
neon	– 249	– 246
nitrogen	– 210	– 196
oxygen	– 219	– 183
water vapour	0	100

- (a) State the percentage by volume of nitrogen and oxygen in air.

nitrogen..... oxygen.....

[2]

- (b) Air is a source of nitrogen, oxygen and the noble gases. These are obtained by the fractional distillation of liquid air. Before air is liquefied, carbon dioxide and water are removed.

- (i) Suggest why air is dried before it is liquefied.

.....

..... [1]

- (ii) At – 200 °C, liquid air is fractionally distilled by allowing it to warm up gradually. List the order of the fractions (elements) obtained, starting from the first fraction

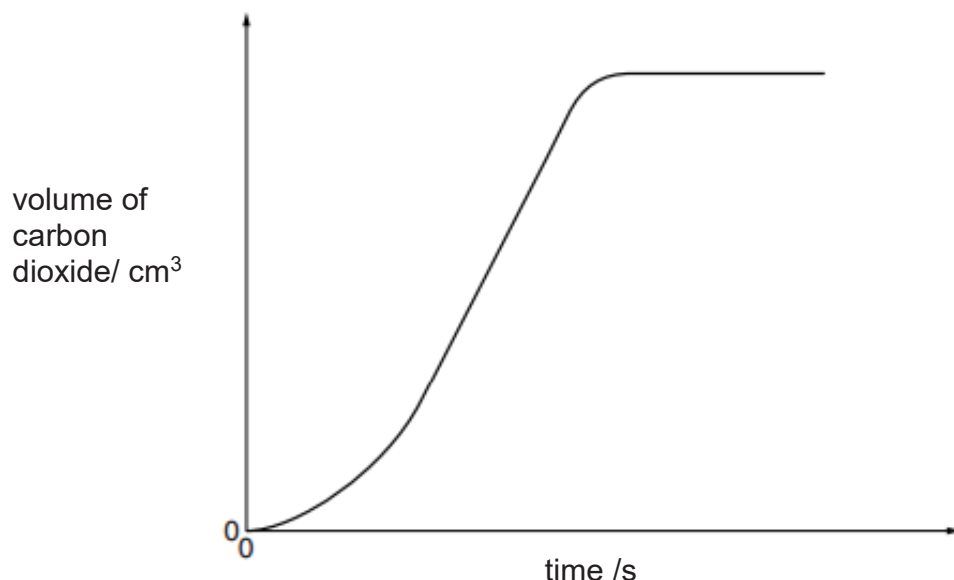
.....

..... [1]

[Total: 4]

- A6** In **Experiment I**, a sample of magnesium carbonate is heated in a test-tube using a hot plate at 300 °C. The total volume of carbon dioxide formed is measured every 10 seconds.

The graph shows his results.



- (a) Suggest why there is **no significant** increase in the volume of carbon dioxide when magnesium carbonate is first heated.

.....  
 ..... [1]

- (b) In **Experiment II**, the same mass of magnesium carbonate is heated in a test-tube using a hot plate at a **higher temperature** of 500 °C.

Sketch a curve on the graph above to show the results for this experiment.

Explain your answer.

.....  
 .....  
 .....  
 ..... [3]

- (c) Ron wishes to investigate how the thermal stability of metal carbonates is related to the position of their metal in the reactivity series.

To ensure a fair experiment, he repeated **Experiment I** using different metal carbonates, while keeping all other variables constant.

The table below shows the results of the experiment after the first 60 seconds.

metal carbonate	total volume of gas collected/ cm <sup>3</sup>
$X_2CO_3$	0
$YCO_3$	0
$CaCO_3$	2
$FeCO_3$	7
$ZnCO_3$	5

- (i) Write a balanced equation, with state symbols, for the thermal decomposition of  $FeCO_3$ .

..... [2]

- (ii) Explain why  $X_2CO_3$  and  $YCO_3$  do **not** decompose.

.....  
 .....  
 ..... [2]

- (iii) A solution containing 0.002 mol of sulfuric acid is titrated with a solution containing 9.2 g/dm<sup>3</sup> of  $X_2CO_3$ . The volume of  $X_2CO_3$  solution needed to exactly neutralise the acid is 23.2 cm<sup>3</sup>.

1 mole of sulfuric acid reacts with 1 mole of  $X_2CO_3$ .

Calculate the relative atomic mass,  $A_r$ , of  $X$  and suggest its identity.

$A_r$  of  $X$  = .....  
 identity of  $X$  ..... [3]

[Total:11]

**A7** The reaction between magnesium and steam is an exothermic reaction.

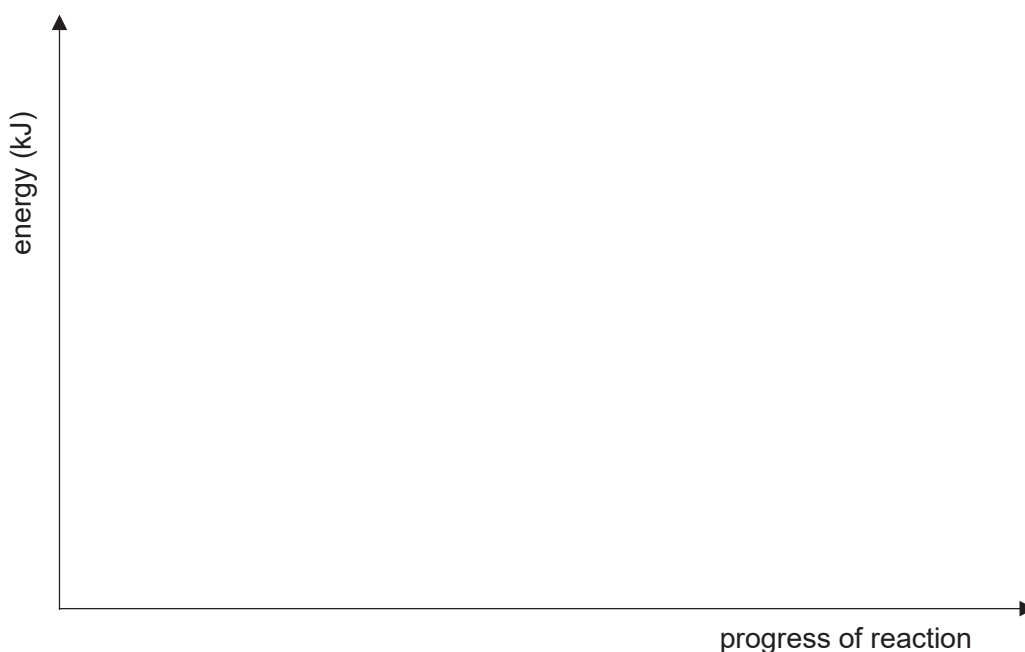
- (a) Write a balanced equation, with state symbols, to represent the reaction between magnesium and steam.

..... [2]

- (b) The energy output of the reaction between magnesium and steam can be shown using an energy profile diagram.

Draw an energy profile diagram for the reaction.

Your diagram should include names of the reactants and products, labels for the reaction enthalpy change and activation energy.



[3]

- (c) Explain, using ideas about bond breaking and bond making, why the overall reaction is exothermic.

.....  
.....  
..... [2]

[Total: 7]

**A8** Molten lead(II) bromide was electrolysed using carbon electrodes.

(a) (i) Write the ionic equation for the reaction at the cathode.

..... [1]

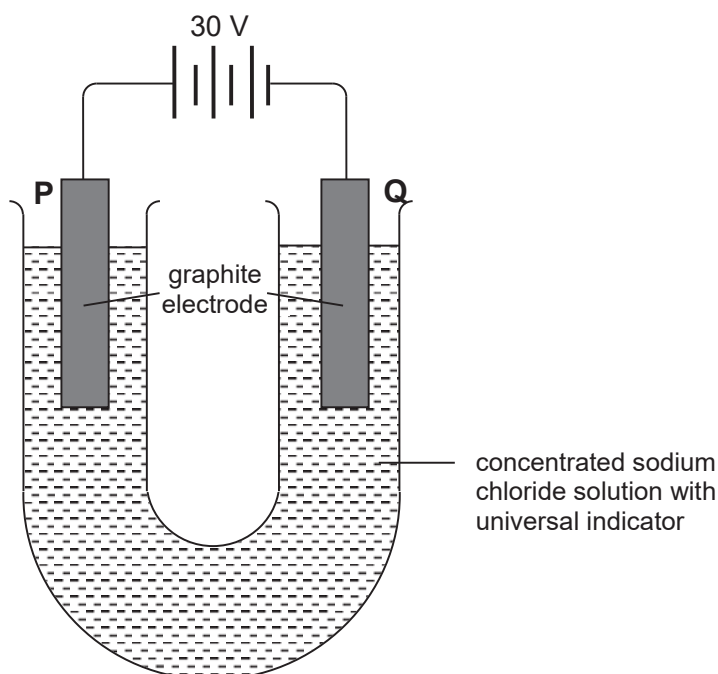
(ii) Write the ionic equation for the reaction at the anode.

..... [1]

(iii) State the observation at the cathode during the electrolysis.

.....  
 ..... [1]

(b) The setup shows the electrolysis of concentrated sodium chloride solution.



(i) Describe the observations at the electrodes of **P** and **Q**.

Electrode **P**: .....

.....

.....

Electrode **Q**: .....

.....

..... [4]



- (ii) How does the pH of the electrolyte change as the electrolysis proceeds?  
Explain your answer.

.....  
.....  
..... [2]

- (iii) Suggest why iron is **not** suitable to be used as an electrode for this experiment.

.....  
..... [1]

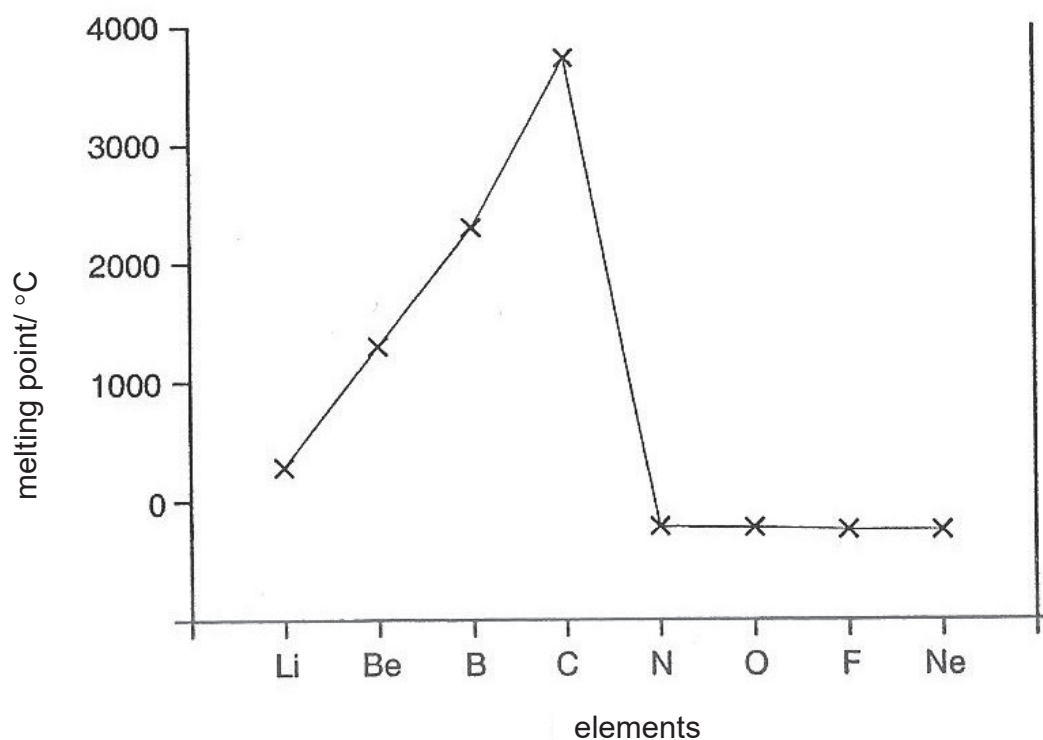
[Total:10]

## Section B

Answer all **three** questions in this section.

The last question is in the form of an either/or and only one of the alternatives should be attempted.

**B9** This information is about the elements in **Period 2** of the Periodic Table.



element	electrical conductivity (at room temperature and pressure)
Li	good
Be	good
B	poor
C	good
N	does not conduct
O	does not conduct
F	does not conduct
Ne	does not conduct

- (a) (i) Use the information to describe the trends in melting point and electrical conductivity across Period 2.

.....  
 .....  
 ..... [2]

- (ii) How does the data show that the first four elements in Period 2 are solids at room temperature and pressure?

.....  
 ..... [1]

- (b) (i) Does the electrical conductivity of carbon fit the general pattern across the period? Justify your answer.

.....  
 .....  
 .....  
 ..... [2]

- (ii) There are two forms of carbon: diamond and graphite.

Which form of carbon does the data refer to?  
 Explain your answer with reference to the structure of the substance you have chosen.

.....  
 .....  
 .....  
 ..... [2]

(c) Draw a sketch graph to show how atomic number changes across the period.

(d) An element in **Period 3** has the following properties. [1]

melting point/ °C	98
conductivity	good

Use the information given in the question to suggest the element that this data is most likely to refer to.

Explain your answer.

.....  
 .....  
 ..... [2]

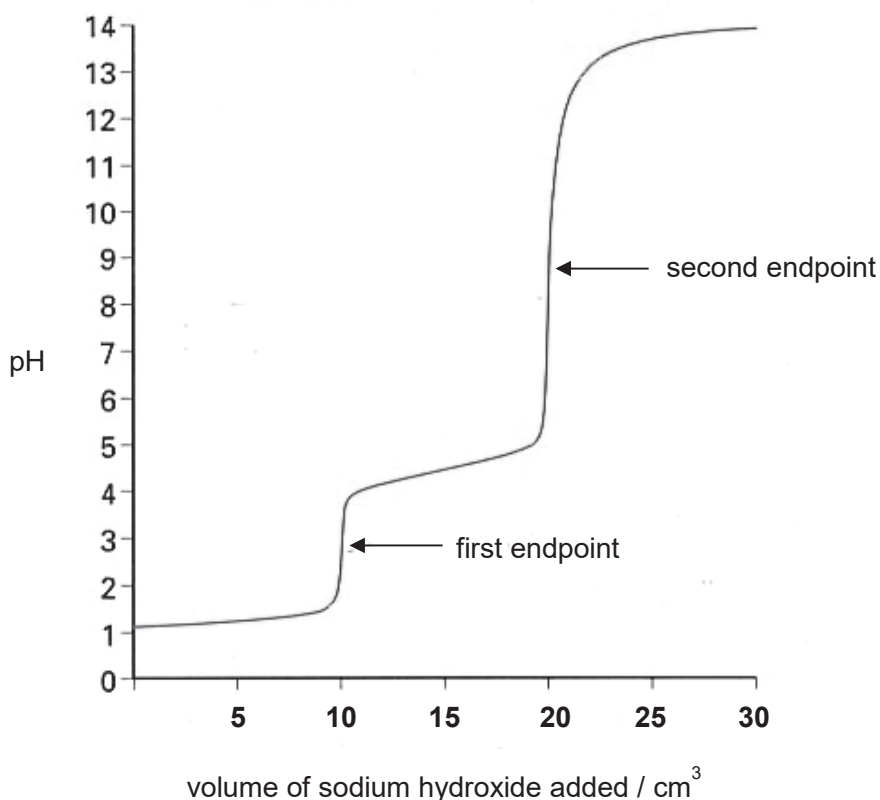
[Total: 10]

**B10** Different experiments were set up to investigate the reactions of sulfuric acid.

25.0 cm<sup>3</sup> of 0.10 mol/dm<sup>3</sup> sulfuric acid was transferred to a conical flask and sodium hydroxide was added from a burette.

After each addition of sodium hydroxide, the pH of the solution was recorded using a pH probe attached to a data logger.

The display from the data logger shows the results below. The pH curve has two endpoints, which resulted because H<sub>2</sub>SO<sub>4</sub> undergoes two stages of ionisation in water to produce hydrogen sulfate ions, and sulfate ions respectively.



- (a) (i) Sulfuric acid ionises in water in two stages. In stage I, it ionises to produce HSO<sub>4</sub><sup>-</sup> ions.



Write an equation to show the second stage of ionisation of HSO<sub>4</sub><sup>-</sup> in water.

..... [1]

- (ii) State the chemical formula and name of the salt formed at the first endpoint.

chemical formula .....

chemical name .....

[2]

- (iii)  $\text{H}_2\text{SO}_4$  is completely neutralised when the second endpoint is reached.

Use the information from the pH curve to calculate the concentration of sodium hydroxide used in the experiment.

[3]

- (b) Describe how you would show that iron(II) sulfate rather than iron(III) sulfate is formed when iron is dissolved in dilute sulfuric acid.

.....

.....

.....

[2]

- (c) In an experiment, hydrated iron(II) sulfate was gently heated to constant mass, leaving behind anhydrous iron(II) sulfate.

The following table shows the results obtained.

mass of hydrated salt at the start	27.8 g
mass of anhydrous salt at the end	15.2 g

Use the results to work out the empirical formula of the hydrated iron(II) sulfate used in this experiment.

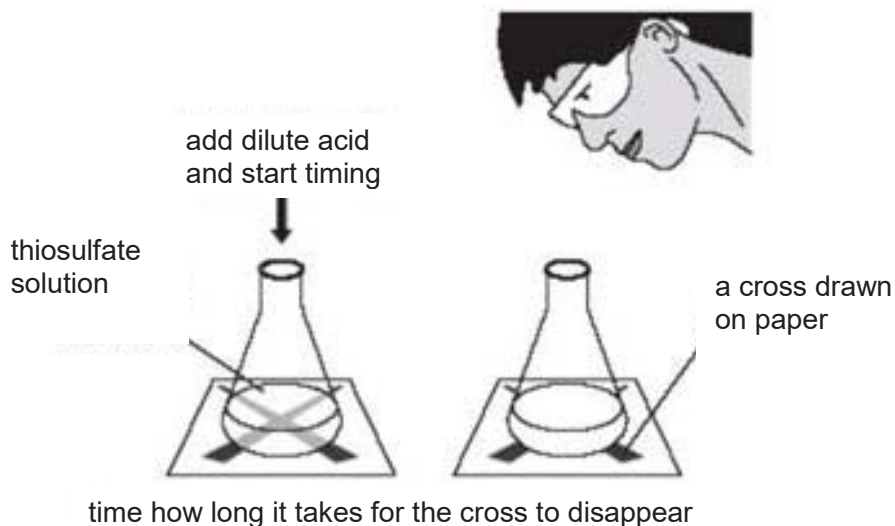
[2]

[Total: 10]

Either

**B11** Aqueous sodium thiosulfate,  $\text{Na}_2\text{S}_2\text{O}_3$ , reacts with dilute hydrochloric acid. The reaction was used in an experiment to determine the effects of varying concentration and temperature on the speed of the reaction.

The equation for the reaction is:



A cloudy suspension of sulfur forms and covers the cross (X) slowly. When the cross completely disappears from top view, the time taken is recorded.

The table below shows the results obtained in different experiments using  $10 \text{ cm}^3$  of acid and  $10 \text{ cm}^3$  of  $1 \text{ mol/dm}^3$  aqueous sodium thiosulfate.

experiment	concentration of acid / $\text{mol/dm}^3$	temperature / $^{\circ}\text{C}$	time taken / s	$1/\text{time} / \text{s}^{-1}$
<b>A</b>	0.15	20	65	
<b>B</b>	0.10	30	45	
<b>C</b>	0.10	20	85	
<b>D</b>	0.05	30	55	
<b>E</b>	0.05	20	105	

- (a) (i) Complete the table by calculating the values of  $1/\text{time}$  for each experiment. [1]  
Leave your answers to 3 significant figures.

- (ii) Explain the significance of  $1/\text{time}$ .

.....  
 .....  
 ..... [2]

- (b) Which of the experiments (**A** to **E**) are suitable to be used to show the effect of concentration on the speed of the reaction? Explain your answer.

.....  
 .....  
 ..... [2]

- (c) Explain, using the collision theory, the effect of concentration on the speed of the reaction.

.....  
 .....  
 .....  
 ..... [2]

- (d) In trying to explain the effect of temperature on the speed of the reaction, a student said, "The higher the temperature, the faster is the speed of the reaction. This is because at a higher temperature, the activation energy of the reaction is lowered. Thus, more effective collisions can occur."

Is the student correct? Justify your answer.

.....  
 .....  
 .....  
 .....  
 ..... [3]

[Total: 10]



OR  
B11

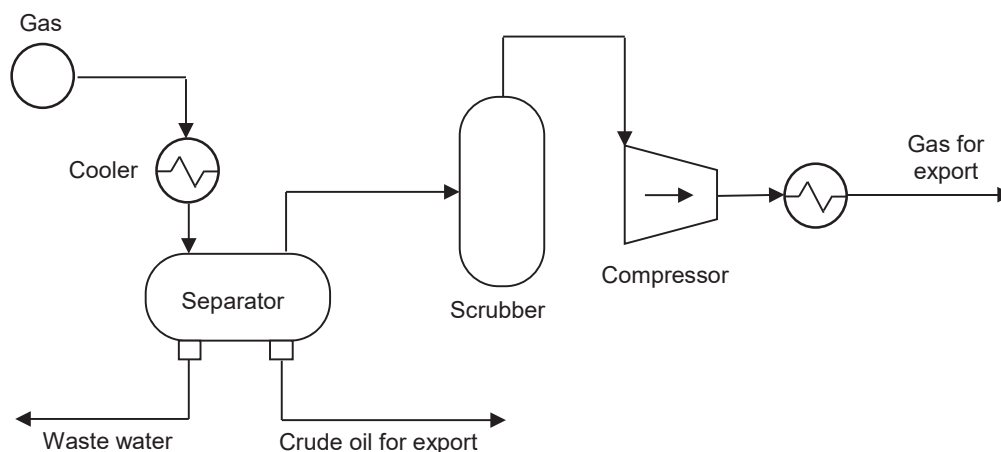
Natural gas is a mixture of hydrocarbon compounds formed from the remains of dead plants and animals over a long period of time. It is often found together with other fossil fuels such as crude oil.

An example of components of natural gas is shown in the table.

name	formula	percentage composition / %	boiling point / °C	liquid density / g/cm <sup>3</sup>
methane	CH <sub>4</sub>	70	- 162	0.423
ethane	C <sub>2</sub> H <sub>6</sub>	10	- 89	0.546
propane	C <sub>3</sub> H <sub>8</sub>	10	- 42	0.493
others (carbon dioxide, hydrogen sulfide, etc.)	-	10	-	-

*Adapted from: [www.naturalgas.org](http://www.naturalgas.org)*

Natural gas that is extracted from the ground must be purified before it can be used. A simplified diagram showing the process of purification is given in the diagram below. The first step is to cool the mixture and remove water and other dense components like crude oil. The raw gas is then sent to a series of scrubbers, compressors and coolers. Finally, the gas is either compressed or liquefied, and then exported.



Compressed natural gas (CNG) is compressed to 200 to 250 times atmospheric pressure, such that it occupies about 1% of the volume it would otherwise have occupied, and stored in high-pressure tanks. Liquefied natural gas (LNG) is cooled to about -170°C, where it occupies about 1/600<sup>th</sup> of the volume it would otherwise have occupied, and stored in special insulated tanks.

- (a) (i) What is the main component of natural gas?

..... [1]

- (ii) Draw a dot and cross diagram to show the bonding of one molecule of the main component of natural gas stated in (a) (i).  
You only need to show the outer shell electrons.

[2]

- (iii) Explain, using ideas about bonding and structure, why natural gas is volatile.

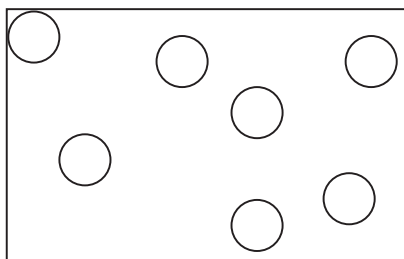
.....  
.....  
.....  
.....  
.....  
.....  
.....

[2]

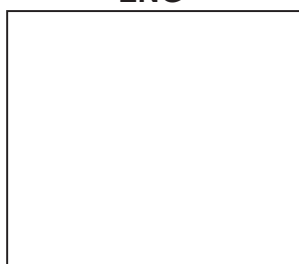
- (b) Name a piece of apparatus found in the school laboratory which functions on the similar principle as the separator shown in the diagram.

..... [1]

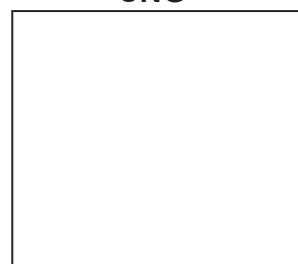
- (c) (i) The diagram shows the arrangement of particles in natural gas at room temperature and pressure. Draw similar diagrams to show the arrangement of the same number of particles in liquefied natural gas (LNG) and compressed natural gas (CNG).



LNG



CNG



[2]

- (ii) Using the information given, suggest **one** advantage of using liquefied natural gas (LNG) over compressed natural gas (CNG).

.....

.....

.....

.....

.....

.....

[2]

[Total: 10]

**End of Paper**

# The Periodic Table of Elements

Group																							
I	II	1 H hydrogen 1										III	IV	V	VI	VII	0						
		<div>Key</div> <div>proton (atomic) number atomic symbol name relative atomic mass</div>																					
3 Li lithium 7	4 Be beryllium 9																	5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24																	13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84						
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131						
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium -	85 At astatine -	86 Rn radon -						
87 Fr francium -	88 Ra radium -	89 – 103 actinoids	104 Rf Rutherfordium -	105 Db dubnium -	106 Sg seaborgium -	107 Bh bohrium -	108 Hs hassium -	109 Mt meitnerium -	110 Ds darmstadtium -	111 Rg roentgenium -	112 Cn copernicium -		114 Fl flerovium -		116 Lv livermorium -								

lanthanoids		57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium -	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids		89 Ac actinium -	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium -	94 Pu plutonium -	95 Am americium -	96 Cm curium -	97 Bk berkelium -	98 Cf californium -	99 Es einsteinium -	100 Fm fermium -	101 Md mendelevium -	102 No nobelium -	103 Lr lawrencium -

lanthanoids

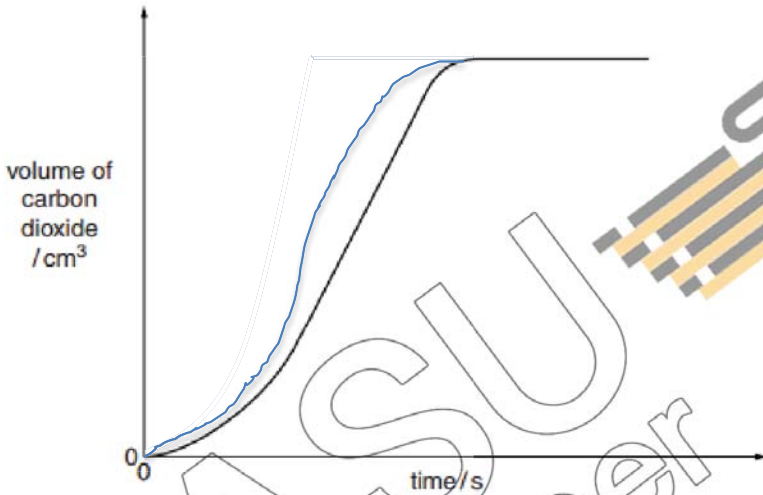
actinoids



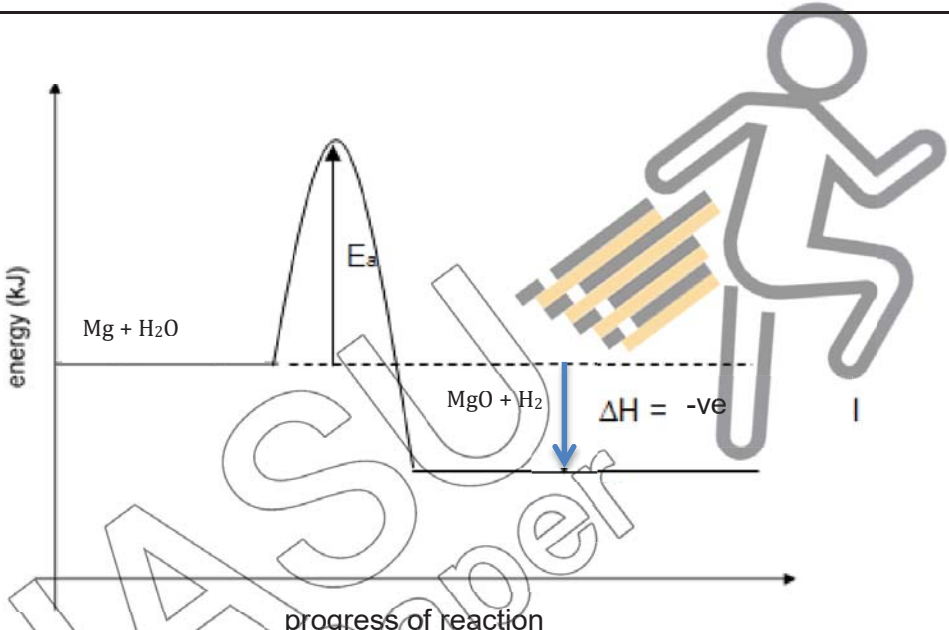
Q1	C
Q2	D
Q3	A
Q4	C
Q5	D
Q6	A
Q7	B
Q8	B
Q9	C
Q10	B
Q11	A
Q12	D
Q13	D
Q14	A
Q15	D
Q16	C
Q17	D
Q18	C
Q19	D
Q20	C

Q21	A
Q22	D
Q23	D
Q24	A
Q25	A
Q26	C
Q27	D
Q28	B
Q29	D
Q30	A
Q31	B
Q32	B
Q33	D
Q34	C
Q35	B
Q36	A
Q37	D
Q38	B
Q39	C
Q40	D

A1		
(a)	D	[1]
(b)	C	[1]
(c)	B and C	[1]
(d)	A and E	[1]
		Total: 4
A2		
(a)	The components have <u>different solubilities</u> in the solvent.	[1]
(b)	3 components [1] correct distance (relative height): <ul style="list-style-type: none"> <li>chlorophyll b – 0.8 to 1 cm</li> <li>chlorophyll a – 1.0 to 1.2 cm</li> <li>carotene – 1.8 to 2.1 cm [1]</li> </ul>	[2]
(c)	<ul style="list-style-type: none"> <li>The chromatography should be allowed to run until the solvent front almost reaches the top of the filter paper/</li> <li>The drop of extract spotted on the filter paper should be as small as possible.</li> <li>Cover with a lid to ensure consistent acetone/water composition.</li> <li>Use a longer chromatography paper.</li> </ul> <p>NB: Do not award: solvent level should be below starting line/ starting line should be drawn in pencil</p>	[1]
(d)	Spinach extract consists of substances that are soluble only in acetone-water mixture.	[1]
		Total: 5
A3		
(a)	carbon monoxide, nitrogen oxides, sulfur dioxide, unburnt hydrocarbons (No chemical formula) Any two answers. [1] each.	[2]
(b)	(i) $2\text{CO} + 2\text{NO} \rightarrow 2\text{CO}_2 + \text{N}_2$	[1]
	(ii) <u>Carbon dioxide</u> [1 mk pt] is produced by the reactions in the catalytic converters and it is a <u>greenhouse gas</u> [1 mk pt] that causes <u>global warming</u> . [1 mk pt] 3 mk pts – [2] 1-2 mk pts – [1]	[2]
		Total:5
A4		
(a)	$2 \quad 2 \quad (1) \rightarrow (1) \quad 2$	[1]
(b)	<u>H<sub>2</sub>O<sub>2</sub></u> is the oxidizing agent. It oxidizes <u>I<sup>-</sup> to I<sub>2</sub></u> which increases in oxidation number from <u>-1 (I<sup>-</sup>) to 0 (I<sub>2</sub>)</u> .	[1] [1]
(c)	<u>Colourless</u> solution turns <u>yellow/ brown</u> .	[1]
		Total:4
A5		
(a)	Nitrogen – 78% [1] Oxygen – 21% [1]	[2]
(b)	(i) At low temperature (for fractional distillation of liquefied air), <u>water is a solid</u> [1]. {Hence, it would block the flow of liquid air through the pumps and pipes.}	[1]
	(ii) (distilled first) Nitrogen , Argon, Oxygen, Krypton.	[1]

		NB: 0 M if students include Ne or compounds.	
			Total:4
A6			
(a)	<p><u>Not much</u> magnesium carbonate has achieved <u>activation energy</u> required. [1]</p> <p>Accept: The flame is not hot enough to decompose much magnesium carbonate.</p> <p><i>Note: Many students' responses reflect a poor understanding of the question The question involves decomposition and hence responses that revolve around rate of effective collision is invalid as there's no collision of reactants involve here. Other responses which are inaccurate include 'There wasn't enough energy to overcome the activation energy'.</i></p>		[1]
(b)	 <p>Correct graph [1]</p> <p>At higher temperature, rate of reaction increases because more zinc carbonate particles have sufficient energy to overcome the activation energy. [1]</p> <p>Volume of carbon dioxide stays constant as it is dependent on the number of moles/ mass of zinc carbonate which did not change. [1]</p>		[3]
(c)	(i)	$\text{FeCO}_3(\text{s}) \rightarrow \text{FeO}(\text{s}) + \text{CO}_2(\text{g})$ Correct state symbols – 1M Correct formula – 1M	[2]
	(ii)	X and Y are <u>highly reactive metals</u> [1], thus forming <u>highly stable metal carbonates</u> [1] that do not decompose on heating	[2]
	(iii)	Mass of $\text{X}_2\text{CO}_3$ used = $9.2 \times 0.0232 = 0.2134 \text{ g}$ [1] $M_r$ of $\text{X}_2\text{CO}_3 = 0.2134/0.002 = 106.72$ $A_r$ of X = $(106.72 - 12 - 16 \times 3)/2 = 23.4$ [1] (3 s.f.) $A_r$ of X = 23.4 identity of X <u>sodium</u> [1]	[3]
			Total: 11
A7			
(a)	$\text{Mg}(\text{s}) + \text{H}_2\text{O}(\text{g}) \rightarrow \text{MgO}(\text{s}) + \text{H}_2(\text{g})$		[2]

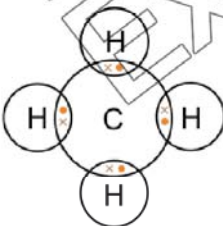


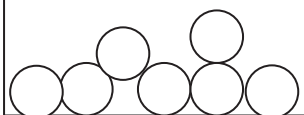
	1M for all accurate formula 1M for all accurate state symbols		
(b)	 <ul style="list-style-type: none"> <li>• Correct shape [1]</li> <li>• Labels (<math>E_a</math>, <math>\Delta H</math>); directions must be both correct [1]</li> <li>• Reactants and products (correct indicators of reactants and products) [1]</li> </ul>		[3]
(c)	Heat energy <b>released</b> for <b>bond forming</b> in <u>1 mole of magnesium oxide and 1 mole of hydrogen</u> is <b>greater</b> than heat <b>absorbed</b> for <b>bond breaking</b> in <u>1 mole of water and 1 mole of magnesium</u> .  [1] – underlined phrases i.e. where the bonds are broken and formed; [1] – bold words i.e. connecting energy released/gained to bond forming/breaking  <i>Note: This question involves the overcoming of ionic bonds and the phrasing proves to be difficult for students. Students who gave responses such as Mg-O will be marked down as this is a denotation for covalent bond.</i>		[2]
			Total: 7
A8			
(a)	(i)	$\text{Pb}^{2+}(\text{l}) + 2\text{e}^- \rightarrow \text{Pb}(\text{l})$	[1]
	(ii)	$2\text{Br}(\text{l}) \rightarrow \text{Br}_2(\text{g}) + 2\text{e}^-$	[1]
	(iii)	Shiny, silvery globule was found at the bottom of the beaker.	[1]
(b)	(i)	<b>P:</b> Green Universal indicator turned blue/violet. [1] / <b>bubbling / effervescence</b> of pale green gas [1] [max 2]  <b>Q:</b> Green Universal indicator turned red. [1] / <b>bubbling / effervescence</b> of colourless gas [1]	[4]
	(ii)	pH will increase. [1] Hydrogen ions preferentially discharged at cathode results in decreasing concentration of hydrogen ions / concentration of hydroxide ions	[2]

		higher than that of hydrogen ions. [1]  NB: reject if students write gas instead of ions are discharged.	
	(iii)	<b>Chlorine</b> gas formed at anode will oxidise iron anode away/ hydrogen ions at cathode will react iron cathode away  Reject: chloride ions will react with iron. [Reaction of chloride ions with iron is slow]  NB: reject if students write gas instead of ions are discharged.	[1]
			Total: 10

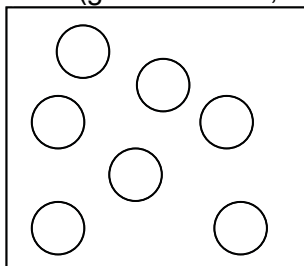
B9			
(a)	(i)	The melting points increase across Period 2 from Li to C, then decrease sharply from C to N. The melting points decreases gradually from N to Ne. [1]  The electrical conductivity is high for the first elements in the period and is low for the last four elements. Boron is the exception as it is one of the first few elements in the period, yet it has poor electrical conductivity. [1]  NB: X Wrong: merely restating the table information in sentence form, for example, "lithium, beryllium and carbon are good conductors, boron is poor and the other elements do not conduct."  ✓ Right: answers that identified a general trend, "the conductivity is high for the first elements in the period and is low for the last four elements" and then highlighted the exception 'except for boron' or 'except for carbon'. [1]	[2]
	(ii)	They have high melting points that are above room temperature.	[1]
(b)	(i)	No. Electrical conductivity generally decreases across Period 2. [1] (specific mention of a trend)  However, carbon is a good electrical conductor despite the preceding element, boron, being a poor conductor, and the following element, nitrogen, being a non-conductor. [1]  NB: Only ans that presents the idea of a <u>general pattern</u> will be accepted.	[2]
	(ii)	Graphite. [no marks]  Graphite has a giant molecular structure consisting of layers of carbon atoms. <u>Each carbon atom</u> is covalently bonded to <u>three other carbon</u> atoms. This leaves each carbon atom with <u>one valence electron not involved in bonding</u> . [1] This electron becomes <u>delocalised</u> and can <u>move freely</u> along the layers of carbon atoms, [1] thus conducting electricity.  NB: Reject if students write each atom is bonded to 3 other electrons. Concept must be entirely correct.	[2]

(c)	<div><p>NB: reject if axes are unlabeled.</p></div>	[1]												
(d)	Sodium. [no mark] A relatively low melting point (compared to other metals) [1] and good electrical conductivity are properties of Group I/alkali metals.[1]	[2]												
		Total: 10												
B10														
(a)	(i) $\text{HSO}_4^- (\text{aq}) \rightarrow \text{H}^+ (\text{aq}) + \text{SO}_4^{2-} (\text{aq})$	[1]												
	(ii) $\text{NaHSO}_4$ [1] sodium hydrogensulfate [1]	[2]												
	(iii) No. of mol $\text{H}_2\text{SO}_4$ $= (25.0/1000) \times 0.10$ $= 0.0025 \text{ mol}$ [1]  $\text{H}_2\text{SO}_4 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$ From equation, 1 mol $\text{H}_2\text{SO}_4$ : 2 mol NaOH 0.0025 mol $\text{H}_2\text{SO}_4$ :0.005 mol NaOH [1]  Concentration of NaOH $= 0.005 / (20.0/1000)$ $= 0.250 \text{ mol/dm}^3$ [1]	[3]												
(b)	Add 2 to 3 drops, and then, excess of NaOH solution [1]. If a <u>dirty green precipitate</u> that is <u>insoluble in excess NaOH</u> is formed, iron (II) sulfate is formed. [1]	[1] [1]												
(c)	<table><tr><td>compound</td><td><math>\text{FeSO}_4</math></td><td><math>\text{H}_2\text{O}</math></td></tr><tr><td>mass/g</td><td>15.2</td><td><math>27.8 - 15.2</math> <math>= 12.6</math></td></tr><tr><td>no. of moles</td><td><math>15.2 / 152</math> <math>= 0.1 \text{ mol}</math></td><td><math>12.6 / 18</math> <math>= 0.7 \text{ mol}</math></td></tr><tr><td>simplest ratio</td><td><math>0.1 / 0.1 = 1</math></td><td><math>0.7 / 0.1 = 7</math></td></tr></table> Empirical formula is <b><math>\text{FeSO}_4 \cdot 7\text{H}_2\text{O}</math></b> . 1m for simplest ratio 1m empirical formula	compound	$\text{FeSO}_4$	$\text{H}_2\text{O}$	mass/g	15.2	$27.8 - 15.2$ $= 12.6$	no. of moles	$15.2 / 152$ $= 0.1 \text{ mol}$	$12.6 / 18$ $= 0.7 \text{ mol}$	simplest ratio	$0.1 / 0.1 = 1$	$0.7 / 0.1 = 7$	[2]
compound	$\text{FeSO}_4$	$\text{H}_2\text{O}$												
mass/g	15.2	$27.8 - 15.2$ $= 12.6$												
no. of moles	$15.2 / 152$ $= 0.1 \text{ mol}$	$12.6 / 18$ $= 0.7 \text{ mol}$												
simplest ratio	$0.1 / 0.1 = 1$	$0.7 / 0.1 = 7$												
		Total:10												

B11	EITHER								
(a)	(i)	<table><tr><td>1/time/ (1/s)</td></tr><tr><td>0.0154</td></tr><tr><td>0.0222</td></tr><tr><td>0.0118</td></tr><tr><td>0.0182</td></tr><tr><td>0.00952</td></tr></table>	1/time/ (1/s)	0.0154	0.0222	0.0118	0.0182	0.00952	[1]
1/time/ (1/s)									
0.0154									
0.0222									
0.0118									
0.0182									
0.00952									
	(ii)	1/ time provides information about the speed of reaction. [1]  The longer the time taken, the slower is the speed of the reaction. / The shorter the time taken, the faster is the speed of the reaction. [1]	[2]						
(b)	The results of experiments A, C and E can be used. / The results of experiments B and D can be used. [1] These experiments were conducted using <u>different concentrations of acid</u> but the <u>temperature was kept constant</u> . [1]		[2]						
(c)	The higher the concentration, the faster is the speed of the reaction. No marks awarded.  With a higher concentration, there are <u>more reactant particles in a unit volume</u> . [1] Thus, there are <u>more collisions</u> between reactant particles. This results in a <u>higher frequency of effective collisions</u> occurring. [1]		[2]						
(d)	The student is not correct. The activation energy of the reaction is not lowered with higher temperature. [1]  Must mention what is wrong with the student's explanation.  At higher temperatures, reactant particles possess <u>greater amount of kinetic energy</u> . Thus, they are able <u>move more quickly</u> [1] and <u>collide into one another more frequently</u> . This results in a <u>higher frequency of effective collisions</u> occurring. [1]		[3]						
			Total:10						
B11	OR								
(a)	(i)	Methane	[1]						
	(ii)		[2]						
	(iii)	<ul style="list-style-type: none"><li>Natural gas is a mixture of <u>covalent</u> compounds which have a <u>simple molecular structure</u>.</li><li>There are <u>weak intermolecular/ van der Waals forces of attraction between the molecules</u>. [1]</li><li>hence <u>little energy</u> must be supplied to <u>overcome these forces of attraction</u>, and natural gas has a <u>low boiling point</u>, which makes it volatile. [1]</li></ul>	[2]						
(b)	Separating funnel		[1]						
(c)	(i)	LNG (liquid state) [1]	[2]						



CNG (gaseous state, but closer together than original diagram) [1]



(ii)

Data quoted:

- Compared to the original volume of natural gas, LNG occupies **1/600<sup>th</sup>** / **0.167%** of the original volume, which is **100 times/ significantly less** than CNG, which occupies **1%** of the original volume. [1]

\*Student must quote the data of both CNG and LNG

Implication:

- Hence,
  - LNG is likely to be **easier to transport** than CNG, [1] **OR**
  - for the same volume, LNG **contains more natural gas** than CNG [1] **OR**
  - LNG is **safer** to use than CNG because CNG is compressed but LNG is not, hence if a pressurised CNG cylinder is damaged, the danger of an explosion is much greater [1]

1m for comparison of volume/ evidence

1m for stating implication

Accept any reasonable implication of the difference in volume

[2]

[Total:10]



Name

Reg. No

Class



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4EX

## CHEMISTRY

6092/01

Paper 1 Multiple Choice [40 Marks]

### SEMESTRAL ASSESSMENT ONE

May 2018

#### Additional Materials

Approved Calculator

1 hour

OTAS answer sheet

Soft clean eraser

Soft pencil (type B or HB is recommended)

#### **INSTRUCTIONS TO CANDIDATES:**

**Do not start reading the questions until you are told to do so.**

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name, class, and index number on the OTAS provided.

#### **INFORMATION FOR CANDIDATES**

There are **forty** questions on this paper. Answer **all** questions.

For each question there are four possible answers **A, B, C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the **OTAS**.

**Read the instructions on the OTAS very carefully.**

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

A copy of the Periodic Table can be found on **page 22**.

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This question paper consists of **22** printed pages.

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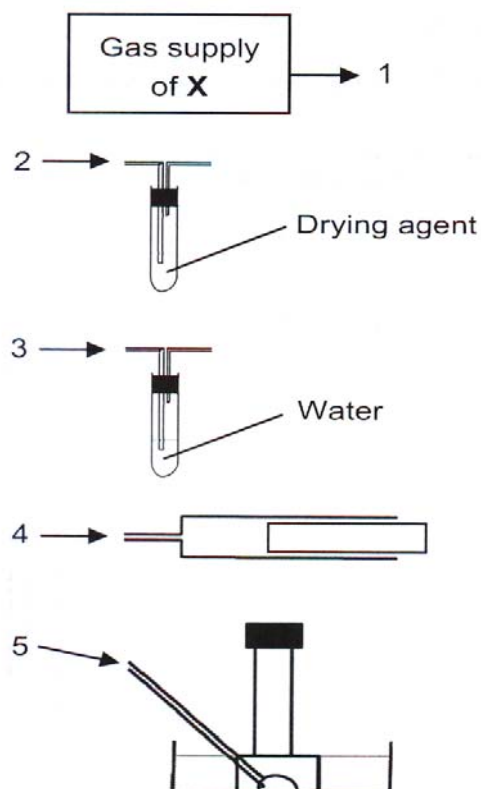
Setter: Mr Mohamad Gaddafi Annuar

Vetter: Mdm Jarina

**Paper 1 (40 marks)**

Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**. Choose the **one** you consider correct and record your choice in **soft pencil** on the **OTAS**

- 1 A gas **X** is insoluble in water and less dense than air. An impure supply of **X** contains water vapour and a water-soluble impurity.

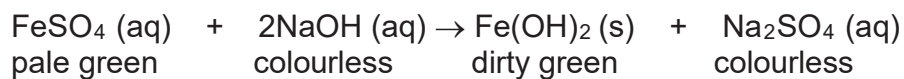


Which of the following order can be used to collect a pure dry sample of gas **X**?

- A** 1, 2, 3, 4
- B** 1, 3, 2, 4
- C** 1, 2, 3, 5
- D** 1, 3, 2, 5

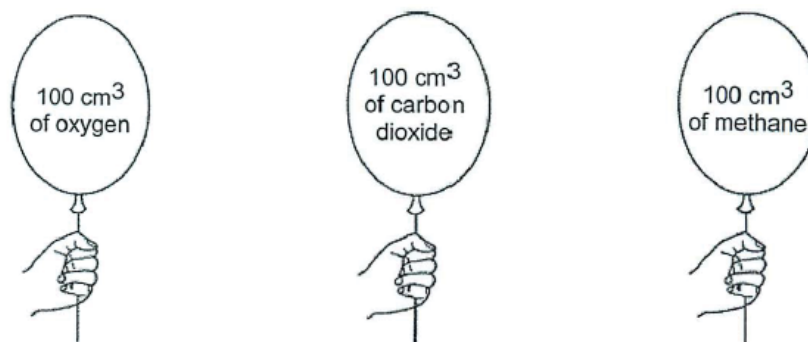


- 2 The reaction between aqueous iron(II) sulfate and aqueous sodium hydroxide is shown below.



Which method could be used to separate the products?

- A crystallization  
 B distillation  
 C filtration  
 D separatory funnel
- 3 The diagram shows three balloons filled with different gases held by students.



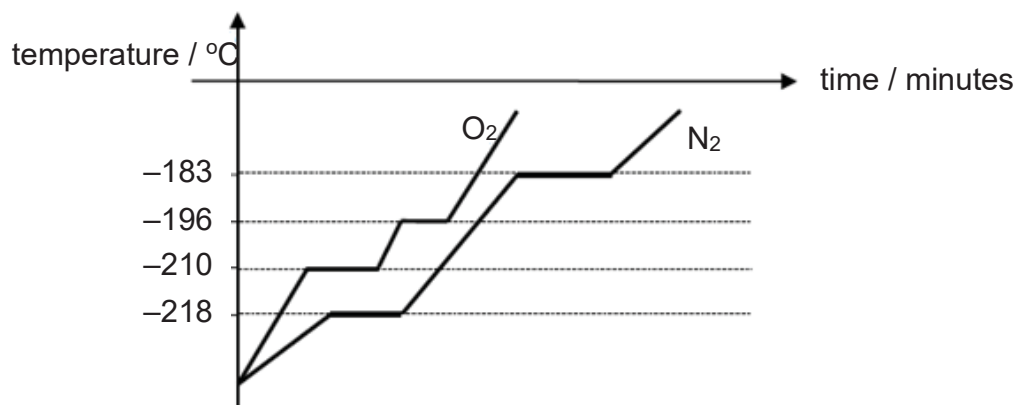
Which statements are correct?

- 1 The number of moles of gases in the 3 balloons is the same.  
 2 The number of molecules in the 3 balloons is different.  
 3 The mass of gases in the 3 balloons is different.

- A 1 and 2 only  
 B 1 and 3 only  
 C 2 and 3 only  
 D 1, 2 and 3

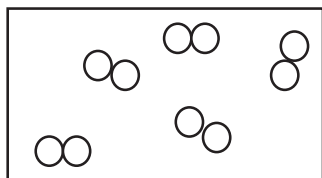
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- 4 The graphs (not drawn to scale) show the heating curves of oxygen and nitrogen over a period of time.

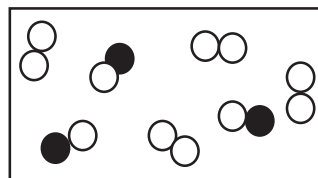


At what temperature will there be two different phases (states) of matter co-existing at the same time, in a mixture of oxygen and nitrogen under room conditions?

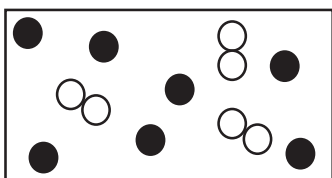
- A -180  $^{\circ}C$   
 B -195  $^{\circ}C$   
 C -200  $^{\circ}C$   
 D -210  $^{\circ}C$
- 5 Which of the following diagrams shows a pure hydrogen gas?



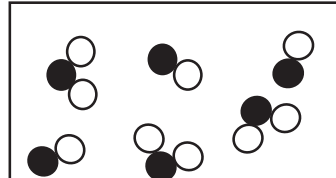
A



B



C



D

- 6 An element **X** has two isotopes of 16 and 18. Its relative atomic mass is 16.4. Which statement correctly states the proportion of isotope-16 in the sample?

A 20 %  
B 40 %  
C 60 %  
D 80 %

- 7 Elements **X**, **Y** and **Z** have consecutive, increasing proton numbers.

If element **X** is a noble gas, what is the symbol for the ion of element **Z** in its compounds?

A  $Z^+$   
B  $Z^{2+}$   
C  $Z^{2-}$   
D  $Z^{3+}$

- 8 Which molecule has the largest number of electrons involved in covalent bonds?

A  $C_2H_4$   
B  $CO_2$   
C  $CH_3OH$   
D  $N_2$

- 9 Substance **X** has the following properties:

- melting point above  $500^\circ C$
- insoluble in water
- conducts electricity only when molten.

What would substance **X** be?

A aluminium oxide  
B copper  
C graphite  
D sodium chloride

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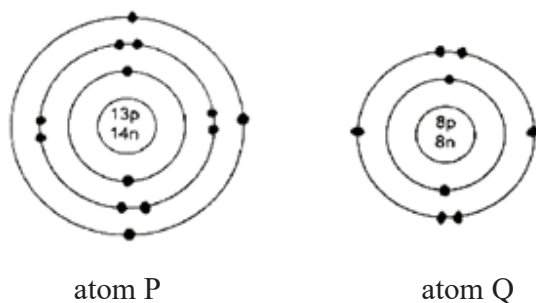
- 10 1.97 g of an unknown metal carbonate,  $\text{MCO}_3$ , reacts completely with  $50.0 \text{ cm}^3$  of  $0.400 \text{ mol/dm}^3$  hydrochloric acid.

What is the relative atomic mass of **M**?

- A 35.0  
B 94.5  
C 137  
D 150
- 11 A metal **Y** forms a sulfate salt with the formula,  $\text{YSO}_4$  while a non-metal **Z** forms an ammonium salt with the formula,  $(\text{NH}_4)_3\text{Z}$ .

What is the formula of the substance formed between **Y** and **Z**?

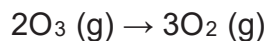
- A **YZ**  
B  **$\text{Y}_3\text{Z}$**   
C  **$\text{YZ}_3$**   
D  **$\text{Y}_3\text{Z}_2$**
- 12 The electronic structure of two atoms P and Q are shown.



What is the type of chemical bonding and the mass of one mole of compound formed between these two elements?

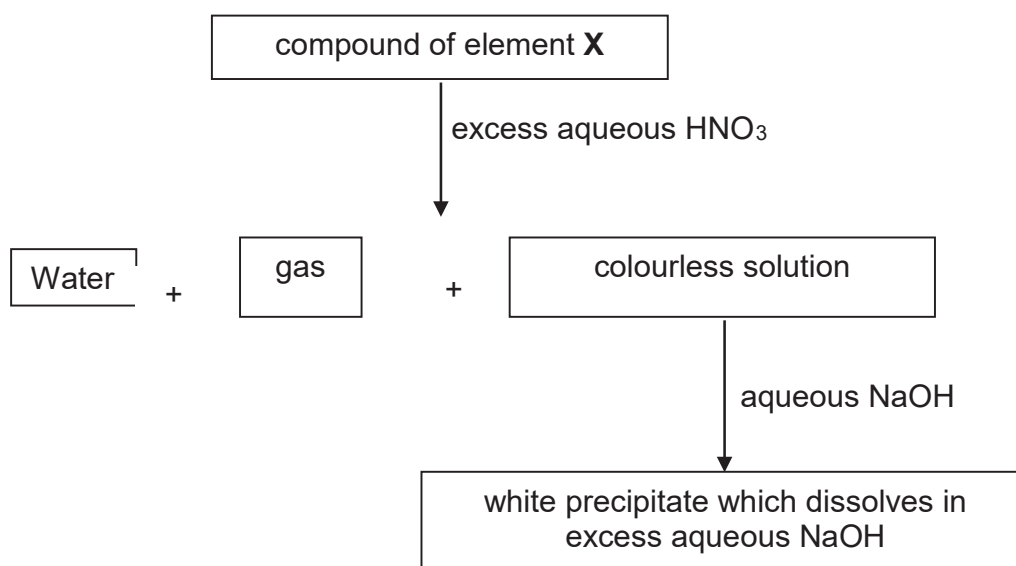
	type of bonding	mass of one mole of compound / g
A	covalent bonding	70
B	covalent bonding	113
C	ionic bonding	43
D	ionic bonding	102

- 13** Ozone, a gas found in stratosphere, helps to filter the harmful ultraviolet rays from the sun. CFCs from aerosol sprays can cause the ozone layer to decompose as follows:



Which one of the following statements is correct at room temperature and pressure?

- A** 2 mol of ozone produce  $9 \times 10^{23}$  oxygen molecules.  
**B**  $24 \text{ dm}^3$  of ozone produce  $24 \text{ dm}^3$  of oxygen.  
**C**  $48 \text{ dm}^3$  of ozone produces 32 g of oxygen.  
**D** 48 g of ozone produce 48 g of oxygen.
- 14** The scheme below shows some reactions of a compound of element **X**.



What could the compound of element **X** have been?

- A** aluminium sulfate  
**B** calcium sulfate  
**C** copper(II) carbonate  
**D** lead(II) carbonate

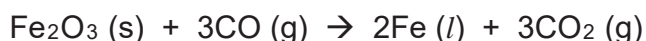
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- 15 Chlorine gas is a severe irritant to the eyes and respiratory system. The maximum safe toleration level of chlorine gas is  $0.005 \text{ mg/dm}^3$ .

How many molecules of chlorine gas are present in  $1 \text{ dm}^3$  of air at this toleration level?

- A  $\frac{0.005}{6 \times 10^{23}} \times 71$   
 B  $\frac{0.005}{1000} \times \frac{1}{71} \times 6 \times 10^{23}$   
 C  $\frac{0.005}{71} \times 6 \times 10^{23}$   
 D  $\frac{0.005}{1000} \times 71 \times 6 \times 10^{23}$

- 16 The equation for the reduction of iron ore in the blast furnace is shown below.

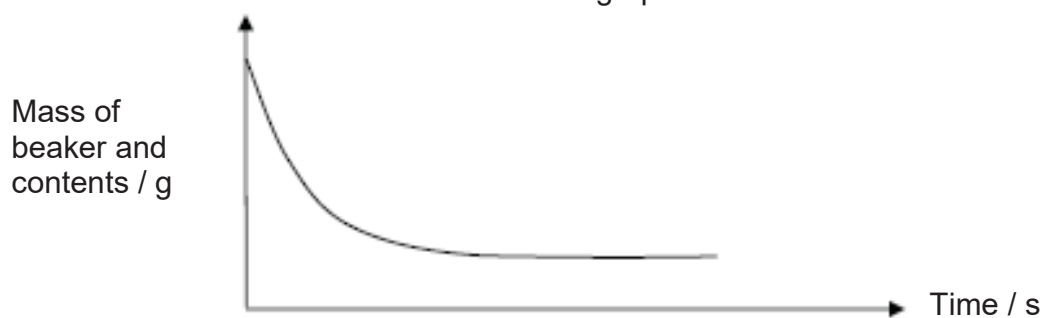


When 20 tonnes of the iron ore were reduced, 7 tonnes of molten iron were produced.

What is the percentage yield of this reduction?

- A 17.5 %  
 B 54 %  
 C 50 %  
 D 70 %
- 17 Which of the following reactions is **NOT** a redox reaction?
- A  $\text{KI} + \text{Br}_2 \rightarrow \text{KBr} + \text{I}_2$   
 B  $\text{CuO} + \text{H}_2\text{SO}_4 \rightarrow \text{CuSO}_4 + \text{H}_2\text{O}$   
 C  $\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$   
 D  $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$

- 18** Two solutions were mixed in a beaker and the mass of the beaker and contents was then recorded at various times. The graph shows the results.



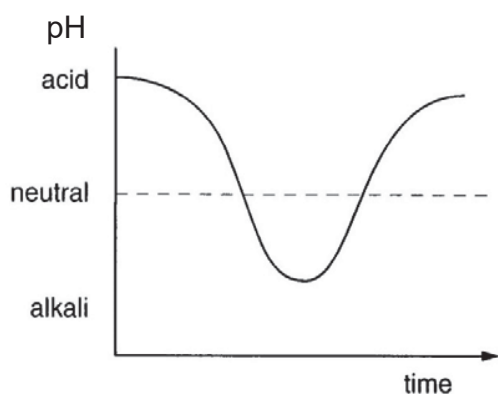
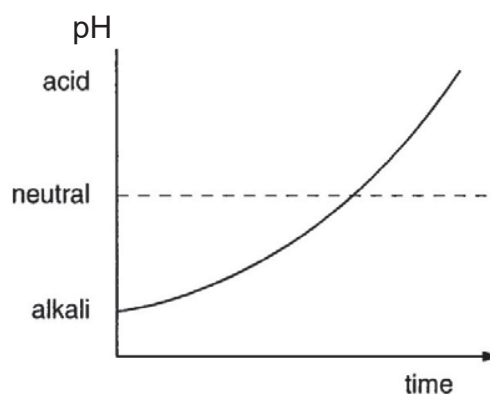
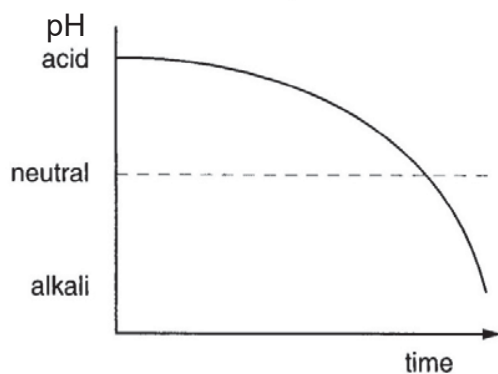
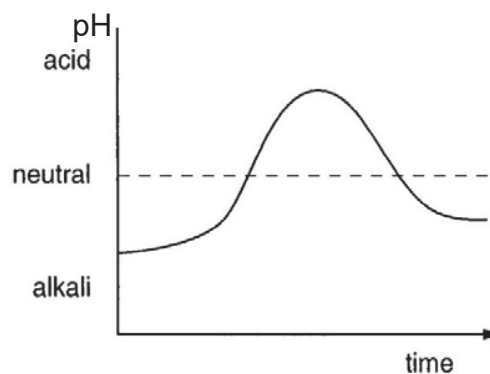
What could the two solutions be?

- A** aqueous ammonia and aqueous iron(II) nitrate
- B** dilute hydrochloric acid and aqueous potassium hydroxide
- C** dilute nitric acid and solid copper(II) carbonate
- D** dilute sulfuric acid and aqueous barium nitrate

[Turn Over

- 19 The mouth contains saliva which is a weak alkali. When sweets containing sugar are eaten, bacteria in the mouth change the sugar into acids.

Which graph best shows how the acidity in the mouth changes during and after the eating of sweets?

**A****B****C****D**



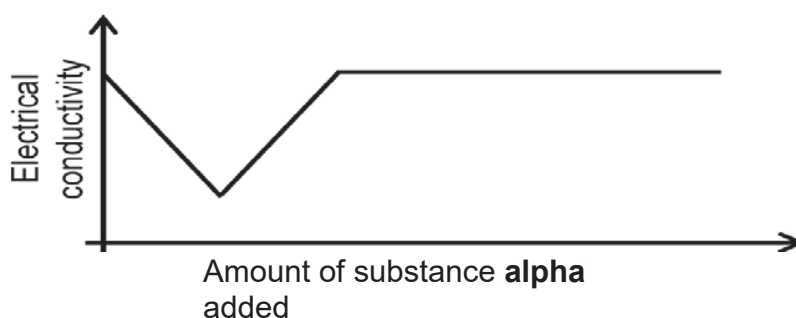
- 20** Solid **Z** was dissolved in dilute sulfuric acid to give a colourless solution and a gas that combusts with a blue flame. When aqueous ammonia solution was added to the colourless solution, a white precipitate was obtained, which dissolved in excess aqueous ammonia. The same colourless solution gave a white precipitate with barium nitrate solution.

What is the identity of solid **Z**?

- A** calcium metal
  - B** zinc metal
  - C** calcium chloride
  - D** zinc sulfate
- 21** The presence of ethanol vapour in the breath of a person who has very recently consumed alcohol can be detected using a filter paper moistened with acidified potassium dichromate(VI).

If ethanol vapour is present, orange potassium dichromate(VI) spot will turn green. What does this suggest about the property of ethanol?

- A** Ethanol acts as an indicator.
  - B** Ethanol acts as a drying agent.
  - C** Ethanol is a reducing agent.
  - D** Ethanol is an oxidising agent.
- 22** A substance alpha is added to lead(II) nitrate solution. The change of conductivity is plotted as shown below.

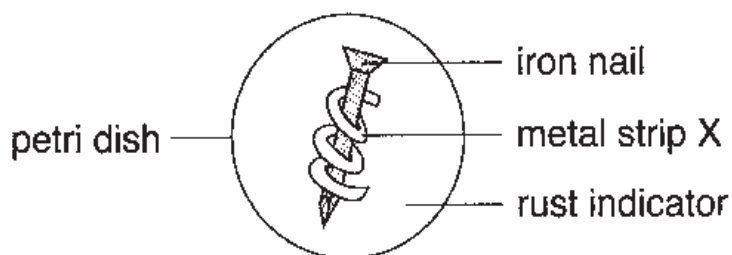


What could substance alpha be?

- A** potassium
- B** potassium iodide solution
- C** potassium manganate(VII) solution
- D** potassium nitrate solution

[Turn Over

- 23 Consider the following set-up.



The rust indicator will turn blue in the presence of rust.

Some statements concerning the experiment are given below.

- (I) If **X** is copper, the iron nail will not corrode readily.
- (II) If **X** is iron, the iron nail will not corrode readily.
- (III) If **X** is silver, a blue colour is observed around the iron nail.

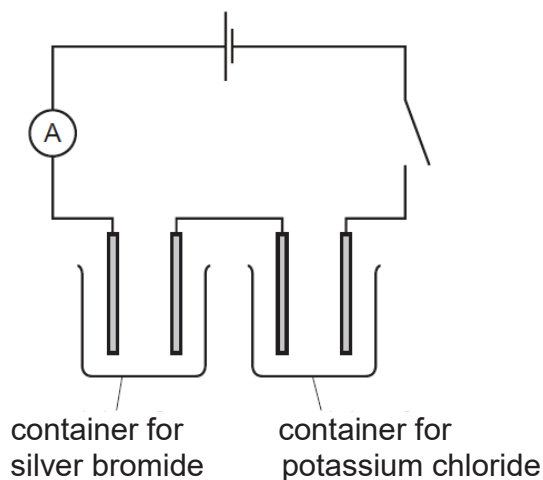
Which of the following statements is/are correct?

- A (I) only
  - B (III) only
  - C (I) and (II) only
  - D (II) and (III) only
- 24 During the electrolysis of an aqueous solution of a *cerium* salt, 70 g of *cerium* ( $A_r = 140$ ) is deposited at the cathode by 1 mole of electron.

What is the formula of the cerium ion?

- A  $\text{Ce}^+$
- B  $\text{Ce}^{2+}$
- C  $\text{Ce}^{3+}$
- D  $\text{Ce}^{4+}$

- 25 The diagram shows the circuit for electrolysis of silver bromide and potassium chloride to produce the metal.



To produce a metal, what form must these salts be?

	silver bromide	potassium chloride
A	concentrated solution	molten
B	dilute solution	concentrated solution
C	molten	molten
D	molten	molten

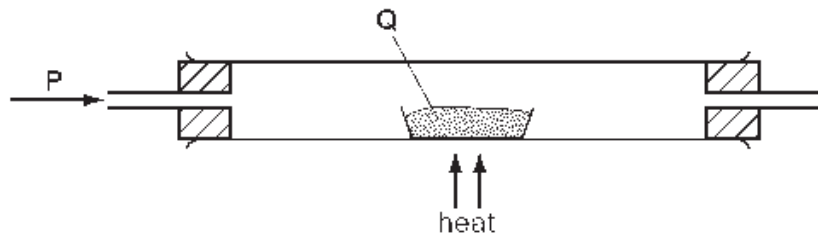
- 26 Many properties of an element and its compounds can be predicted from the position of the element in the Periodic Table.

What property could **not** be predicted in this way?

- A the formula of its oxide
- B the nature of its oxide
- C the number of isotopes it has
- D the number of electron shells of its atom

[Turn Over

- 27 In the apparatus shown, gas **P** is passed over solid **Q**.



Which of the following identities of **P** and **Q** would **not** result in a reaction?

	<b>P</b>	<b>Q</b>
<b>A</b>	carbon monoxide	copper (II) oxide
<b>B</b>	carbon monoxide	lead (II) oxide
<b>C</b>	hydrogen	iron (III) oxide
<b>D</b>	hydrogen	zinc oxide

- 28 Three elements **X**, **Y** and **Z** belong to the same period in the Periodic Table. The properties of their oxides are given below.

oxide of **X**: soluble in both nitric acid and aqueous sodium hydroxide

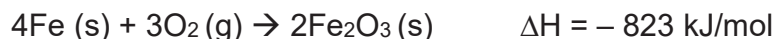
oxide of **Y**: insoluble in water and aqueous sodium hydroxide but dissolves readily in nitric acid

oxide of **Z**: changes acidified potassium manganate(VII) from purple to colourless

Based on the statements above, arrange **X**, **Y** and **Z** in order of decreasing atomic number in the Periodic Table.

- A** **X**, **Y**, **Z**  
**B** **Y**, **X**, **Z**  
**C** **Z**, **X**, **Y**  
**D** **Z**, **Y**, **X**

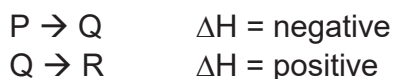
- 29 A hand warmer bag purchased by skiers consists of powdered iron, water, salt and sawdust. When the bag is shaken, it becomes hot because the following reaction occurs.



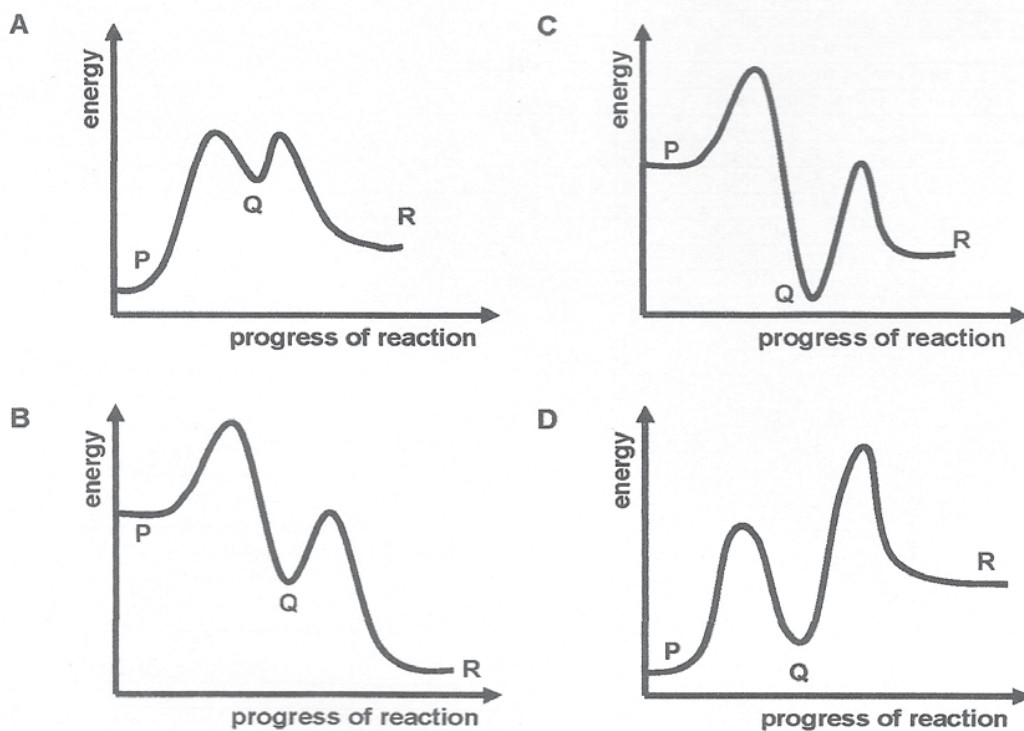
Which statement is **not** true about the reaction above?

- A The energy change involved in bond-forming is more than that in bond-breaking.
  - B The energy level of products is lower than that of the reactants.
  - C The energy level of reactants is lower than that of the products.
  - D The temperature of the reaction mixture increases.
- 30 In the conversion of compound P into compound R, it was found that the reaction proceeded by way of compound Q, which could be isolated.

The steps involve were:

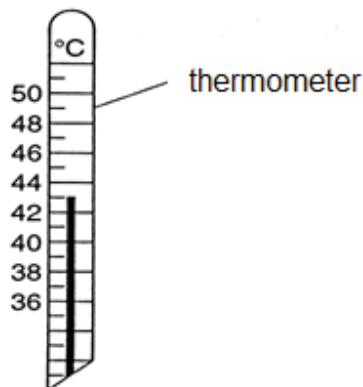


Which one of the following reaction profiles agrees with this data?



[Turn Over

- 31** A thermometer is placed in water and the temperature measured is shown.



An endothermic change takes place as a solid is dissolved in the water. The temperature change is 4.5 °C.

What would be the temperature reading immediately after the reaction?

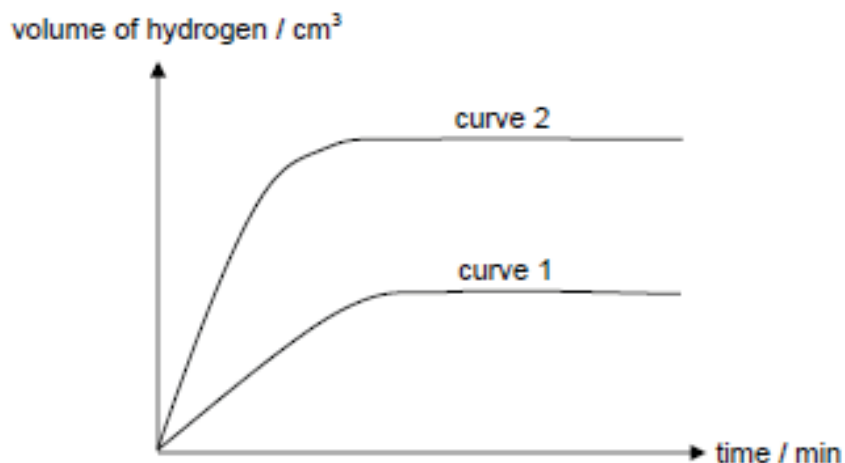
- A** 38.0 °C
  - B** 38.5 °C
  - C** 47.0 °C
  - D** 47.5 °C
- 32** A sample of hydrogen peroxide is decomposed by a metal oxide catalyst.



What will become larger if the experiment is repeated using a better catalyst?

- A** The total volume of gas produced at the end of the reaction.
- B** The amount of hydrogen peroxide left over at the end of the reaction.
- C** The initial gradient of a graph of total volume of gas produced against time.
- D** The time needed to produce a particular volume of gas.

- 33** In the graph below, curve 1 was obtained when  $25.0 \text{ cm}^3$  of  $1.0 \text{ mol/dm}^3$  of dilute hydrochloric acid is reacted with an excess of magnesium ribbons at  $30^\circ\text{C}$ .



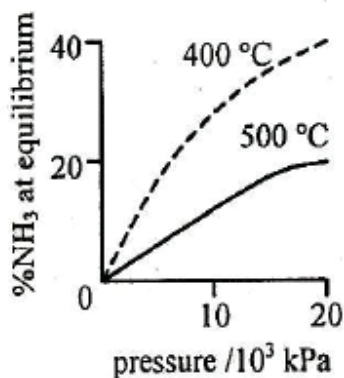
Which of the following changes would result in curve 2?

- A** adding a catalyst to the reaction
- B** heating the acid to a higher temperature
- C** using  $25.0 \text{ cm}^3$  of  $2.0 \text{ mol/dm}^3$  of dilute hydrochloric acid
- D** using finely powdered magnesium metal of the same mass

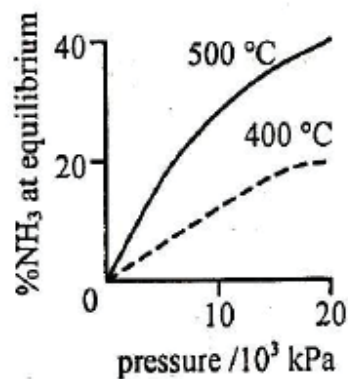
[Turn Over

- 34 The percentage of ammonia obtained at equilibrium in the Haber Process is plotted against pressure for two temperatures, 400 °C and 500 °C.

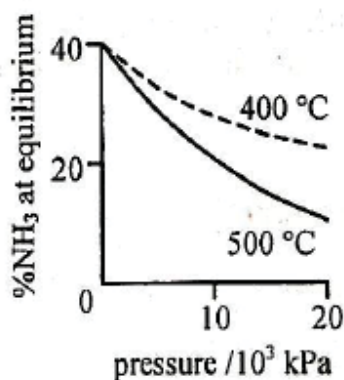
Which of the following correctly represents the two graphs obtained?



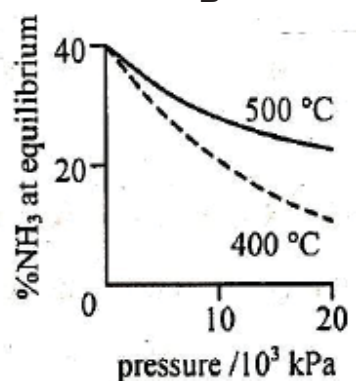
A



B



C



D

- 35 Which statement about the properties of ammonia is correct?
- A It decomposes on heating at high temperature to form nitrogen gas and hydrogen gas.
  - B It dissolves in water to form an acidic solution.
  - C It is formed by heating ammonium salts with sulfuric acid.
  - D It reacts with alkalis to form salts.



- 36** The table shows the boiling points of four fractions when crude oil is distilled.

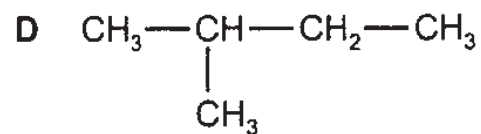
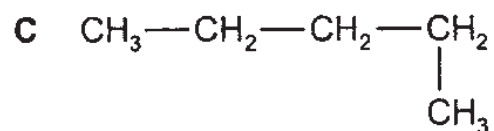
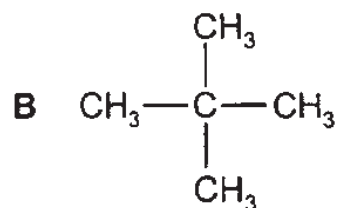
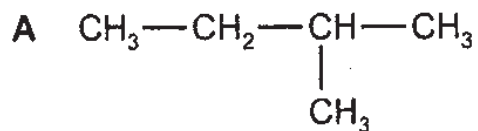
fraction	W	X	Y	Z
boiling point /°C	35 – 75	80 – 145	150 – 250	greater than 250

Which statement regarding the fractions is true ?

- A** Fraction W is more flammable than fraction Y.
  - B** Fraction W is more viscous than fraction Z
  - C** The density of fraction X is greater than that of fraction Z.
  - D** The molecules in X have a longer chain length than those in fraction Z.
- 37** Which of the following statements about air are true?
- I** Clean air has a lower density than carbon dioxide.
  - II** Clean air has a constant composition of oxygen and water vapour.
  - III** Clean air contains mainly argon.
  - IV** Clean air is a mixture of elements and compounds.
- A** I and III only
  - B** I, II and III only
  - C** I, III and IV only
  - D** all of the above

[Turn Over

**38** Which structure is not an isomer of the structure shown?

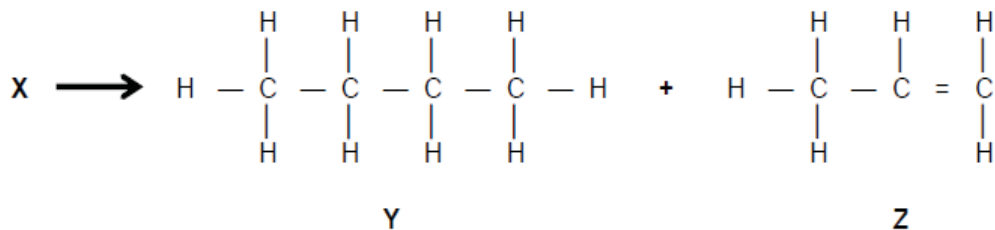


**39** Some unsaturated compounds contain more than one carbon-carbon double bond. An example is the compound with the formula  $C_{21}H_{26}$ .

How many carbon-carbon double bonds are present in one molecule of this compound?

- |          |   |
|----------|---|
| <b>A</b> | 3 |
| <b>B</b> | 5 |
| <b>C</b> | 8 |
| <b>D</b> | 9 |

- 40 A chemist carried out a cracking reaction on a hydrocarbon, **X** and obtained two products, **Y** and **Z**.



The chemist then wrote the following statements in his notebook.

- (1) A molecule of **X** has 7 carbon atoms.
- (2) **Y** is unsaturated.
- (3) **Z** will decolourise bromine water.

Which statement(s) is/are correct?

- A** (3) only
- B** (1) and (2)
- C** (1) and (3)
- D** (1), (2) and (3)

--- End of Paper 1 ---

[Turn Over

# The Periodic Table of Elements

Group																		
I	II	1 H hydrogen 1										III	IV	V	VI	VII	0	
		Key																
		proton (atomic) number atomic symbol name relative atomic mass																
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20	
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40	
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84	
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131	
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium -	85 At astatine -	86 Rn radon -	
87 Fr francium -	88 Ra radium -	89 – 103 actinoids	104 Rf rutherfordium -	105 Db dubnium -	106 Sg seaborgium -	107 Bh bohrium -	108 Hs hassium -	109 Mt meitnerium -	110 Ds darmstadtium -	111 Rg roentgenium -	112 Cn copernicium -		114 Fl flerovium -		116 Lv livermorium -			

lanthanoids

57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
La lanthanum 139	Ce cerium 140	Pr praseodymium 141	Nd neodymium 144	Pm promethium -	Sm samarium 150	Eu europium 152	Gd gadolinium 157	Tb terbium 159	Dy dysprosium 163	Ho holmium 165	Er erbium 167	Tm thulium 169	Yb ytterbium 173	Lu lutetium 175
89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
Ac actinium -	Th thorium 232	Pa protactinium 231	U uranium 238	Np neptunium -	Pu plutonium -	Am americium -	Cm curium -	Bk berkelium -	Cf californium -	Es einsteinium -	Fm fermium -	Md mendelevium -	No nobelium -	Lr lawrencium -

actinoids

The volume of one mole of any gas is  $24 \text{ dm}^3$  at room temperature and pressure (r.t.p.).

Name

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Class



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4EX

**CHEMISTRY****6092/02**

Paper 2 [80 Marks]

**SEMESTRAL ASSESSMENT ONE**

May 2018

Additional Materials**1 hr 45 mins**

Approved Calculator

**INSTRUCTIONS TO CANDIDATES:****Do not open this booklet until you are told to do so.**

Write your name, index number and class in the spaces at the top of this page and on any separate answer paper used.

Write in dark blue or black pen on both sides of the paper.

You may use a soft pencil for any diagrams, graphs, tables or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

**Section A**Answer **all** questions.

Write your answers in the spaces provided on the question paper.

**Section B**Answer **all** three questions, the last question is in the form of either/or.

Write your answers in the spaces provided.

**INFORMATION FOR CANDIDATES**

The number of marks is given in brackets [ ] at the end of each question or part question.

A copy of the Periodic Table can be found on **page 23**.

At the end of the examination, fasten all your work securely together.

Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of chemistry than for correct answers.

This question paper consists of **23** printed pages.

Setter: Mr Mohamad Gaddafi Annuar

Vetter: Mdm Jarina

**Section A [50 Marks]****Answer ALL questions in the spaces provided.****A1** Name the following chemical processes.

	reaction	name of process
(i)	$\text{SiO}_2 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SiO}_3 + \text{H}_2\text{O}$	
(ii)	$\text{H}_2\text{SO}_4 + \text{CaCl}_2 \rightarrow 2\text{HCl} + \text{CaSO}_4$	
(iii)	$\text{Fe}^{2+} \rightarrow \text{Fe}^{3+} + \text{e}^-$	
(iv)	$\text{MgBr}_2 + \text{F}_2 \rightarrow \text{MgF}_2 + \text{Br}_2$	
(v)	$\text{CuCO}_3 \rightarrow \text{CuO} + \text{CO}_2$	

[5]

**[Total: 5 marks]****A2** This question concerns the chemistry of carbon and silicon, elements from Group IV of the Periodic Table.**Table 2.1** provides some information on two different forms of carbon (allotropes) and silicon:**Table 2.1**

Substance	Melting point / °C	Electrical conductivity	Uses
Carbon allotrope <b>A</b>	Above 3000	Poor	Cutting tools, drill bits
Carbon allotrope <b>B</b>	Above 3000	Good	Lubricant
Silicon	1414	Good	Semiconductors in electronics

- (a) Carbon tends to form covalent compounds.

By drawing the dot-and-cross diagram of a carbon compound of your choice, describe how a covalent bond is formed. You only need to show valence electrons.

.....  
.....  
.....  
.....[3]

- (b) Explain, in terms of structure and bonding, why carbon allotrope **A** can be used as a drill bit while carbon allotrope **B** can be used as a lubricant.

.....  
.....  
.....  
.....[2]

- (c) Carbon is commonly used as a reducing agent. For example, it can reduce zinc oxide to form zinc.

Explain, using oxidation states, how carbon is acting as a reducing agent in the reduction of zinc oxide.

.....  
.....  
.....[1]

[Total: 6 marks]

[Turn Over]

- A3** Table 3.1 shows the results of some of the chemical reactions of **four** unknown metals.

**Table 3.1**

<b>Metals</b>	<b>Thermal decomposition of metal carbonates</b>	<b>Reaction of metal with cold water</b>
<b>A</b>	Greenish-blue solid turns black. White precipitate formed when gas produced is being passed through limewater	No reaction
<b>B</b>	White solid remains. No gas was produced.	Very vigorous reaction
<b>C</b>	White solid turns yellow, turns back to white after when cooled. White precipitate formed when gas produced is being passed through limewater	No reaction
<b>D</b>	White solid remains white. White precipitate formed when gas produced is being passed through limewater	Little bubbles formed on the surface of the metal.

- (a) Arrange the metals in ascending order of their chemical reactivity.  
 .....[1]
- (b) Metal **A** and **D** are placed into two separate beakers of iron(III) sulfate solution. Describe the observations you will see in each beaker.  
 .....  
 .....  
 .....[3]
- (c) Pure iron can be extracted using the Blast furnace in the presence of carbon monoxide.
- (i) Write a balanced equation for the reaction mentioned above.  
 .....[1]



- (ii) State and explain if the reaction written in (ci) is a redox reaction.

.....  
.....[1]

- (d) Iron oxidises to form iron(III) oxide, which is a reddish-brown deposit commonly known as rust.

Using your knowledge of the reactivity series of metals, describe and explain how rusting of iron can be prevented.

.....  
.....  
.....[2]

**[Total: 8 marks]**

**[Turn Over]**

- A4** A student carried out a series of experiments to determine the rate of reaction between excess zinc and dilute hydrochloric acid (HCl) by measuring the volume of gas produced per unit time.

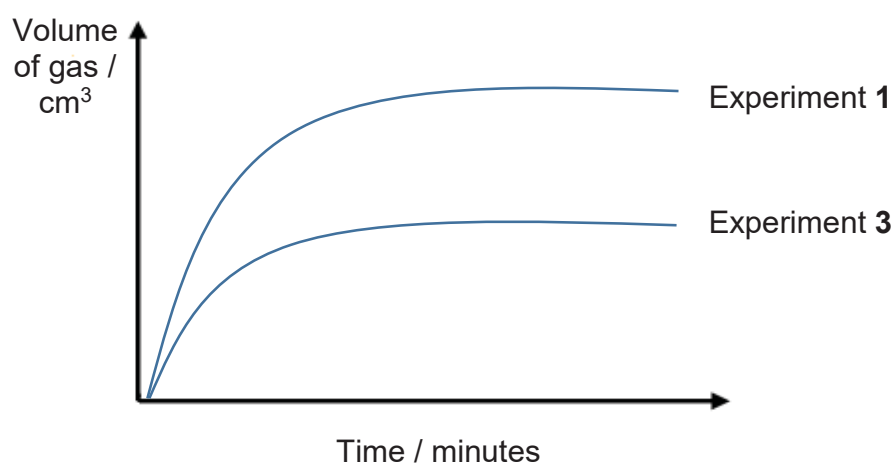
In Experiment 1 (conducted at 25 °C), he used 5 g of zinc granules and 30 cm<sup>3</sup> of 0.5 mol/dm<sup>3</sup> dilute hydrochloric acid.

The experiments were repeated two more times, with different variables.

Experiment 2: 5 g of zinc powder and 30 cm<sup>3</sup> of 0.5 mol/dm<sup>3</sup> of HCl, 25 °C

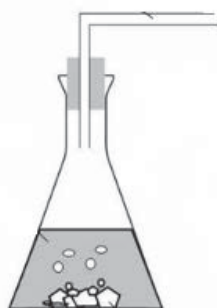
Experiment 3: 5 g of zinc granules and  $y$  cm<sup>3</sup> of  $z$  mol/dm<sup>3</sup> of HCl, 25 °C

Fig 4.1 shows the volume of gas produced over time.



**Fig 4.1**

- (a) Complete the diagram below with the appropriate apparatus used in the experiment.



[1]

- (b) Write a balanced equation for the reaction between zinc and dilute hydrochloric acid.

.....[1]

- (c) On **Fig 4.1** sketch and label the graph for Experiment 2.

[1]

- (d) Taking reference from the Fig 4.1, suggest appropriate values for **y** and **z** for Experiment 3.

**y** = ..... cm<sup>3</sup>

**z** = ..... mol/dm<sup>3</sup>

[2]

- (e) The student repeated the experiment at 50 °C. Explain in terms of energy and particle collisions how an increase in temperature increases the rate of a reaction.

.....  
 .....  
 .....  
 .....  
 .....[3]

**[Total: 8 marks]**

- A5** The table shows some information about a homologous series of organic compounds called ketones.

name	number of carbon atoms	formula
propanone	3	CH <sub>3</sub> COCH <sub>3</sub>
butanone	4	C <sub>2</sub> H <sub>5</sub> COCH <sub>3</sub>
pentanone	5	C <sub>3</sub> H <sub>7</sub> COCH <sub>3</sub>

**[Turn Over]**

- (a) Deduce the name and formula of the ketone that contains 6 carbon atoms.

name .....

formula .....

[2]

- (b) From (a), deduce the general formula for ketones.

.....[1]

- (c) The oxygen atom in a ketone forms a double bond with a carbon atom.

Draw the full structural formula of butanone.

[1]

- (d) Separate samples of propanone and propene were placed in separate test tubes and each shaken with bromine water.

Predict what will be seen in each test tube after shaken with bromine water.

.....

.....

.....[2]

**[Total: 6 marks]**

**A6** Ozone is considered a pollutant at ground level but is important in the stratosphere.

- (a) Explain why the ozone layer is important to us.

.....[1]

- (b) Explain why ozone is considered as a pollutant at ground level.

.....

.....[1]

- (c) Ozone is destroyed when chlorine atoms from CFCs attack the ozone molecules.



Explain, in terms of oxidation states which element is oxidised.

.....  
 .....  
 .....[2]

- (d) Nitrogen dioxide can also contribute to the depletion of the ozone layer and must be removed.

- (i) Besides breathing issues, describe **one** other harmful effect of nitrogen dioxide.

.....  
 .....[1]

- (ii) Write an equation to show how nitrogen dioxide can be removed in the catalytic converter.

.....[1]

**[Total: 6 marks]**

**A7** Table 7.1 shows the enthalpy of combustion of three fuels.

fuel	enthalpy change of combustion (kJ/mol)
ethanol	- 1370
hydrogen	- 256
octane	- 5510

combustion of ethanol:  $\text{C}_2\text{H}_5\text{OH} + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 3\text{H}_2\text{O}$

- (a) Use ideas about breaking and forming bonds to explain why the enthalpy change for combustion of ethanol is negative.

.....  
 .....[2]

**[Turn Over]**

- (b) Octane also undergoes combustion to produce carbon dioxide. The equation for the combustion of octane is given below.



Calculate the volume of carbon dioxide that will be produced when ethanol undergoes combustion to produce 100 kJ of energy.

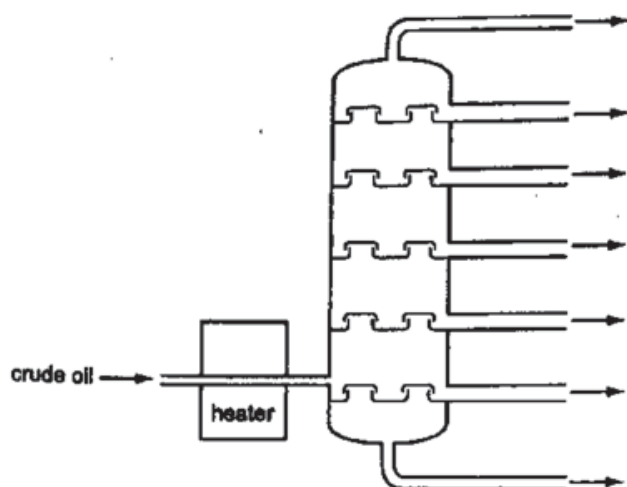
[2]

- (c) Explain why the combustion of hydrogen is considered a 'cleaner' alternative as compared to octane and ethanol.

.....  
 .....  
 .....[2]

[Total: 6 marks]

**A8** The diagram below shows how petroleum can be refined.



- (a) Briefly describe how fractions can be separated through the fractional distillation of crude oil.

.....

.....

.....

.....

.....

.....[3]

- (b) The flow chart below shows how a sweet smelling compound **Y** can be formed from petroleum (crude oil).



- (i) Explain why Stage **A** is an important process in the energy industry.

.....

.....

.....[1]

- (ii) A long chain alkane,  $C_{12}H_{26}$ , undergoes Stage **A** to form ethene, butane and an unsaturated compound **Z**.

Draw the structure of compound **Z** in the space given below.

[1]

[Total: 5 marks]

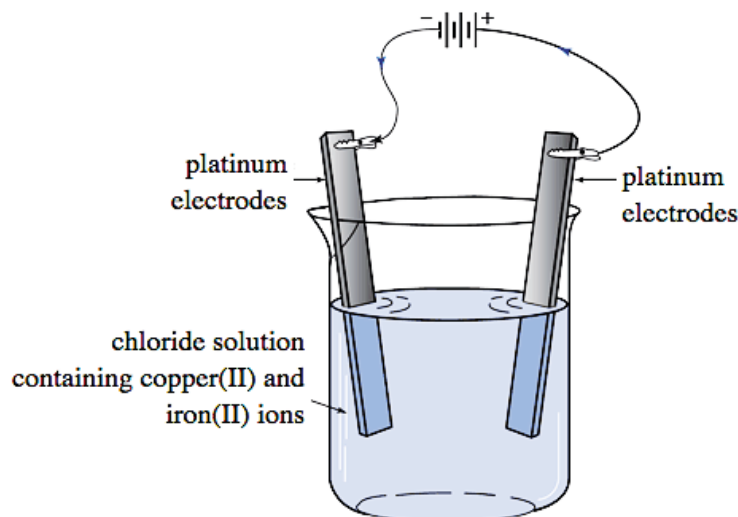
---End of Section A---

[Turn Over]

**Section B [30 Marks]**

Answer **all** questions. **Question B11** has a choice of section to answer. Write your answers on the spaces provided.

- B9** Fig 9.1 shows the set-up for the electrolysis of a chloride solution containing two metal ions, copper(II) and iron(II).



**Fig 9.1**

An electric current was passed through the cell for a period of time. The observations at different stages were recorded in the table.

**Table 9.2**

stage	observations
stage 1 – after 10 mins	A yellowish-green gas is observed at one of the electrodes while a brown solid is deposited at the other electrode. There was no visible change to the electrolyte.
stage 2 – after 1 hour	The same observations in stage 1 at the anode and cathode. The electrolyte became pale green.
stage 3 – after 2 hours	Colourless gases are both evolved at the anode and cathode. The pale green of the electrolyte becomes more visible.



- (a) (i) Write the equations for the reactions taking place at the respective electrodes in stage 1.

.....  
.....[2]

- (ii) The total mass of the brown solid deposited was 0.584 g.

Calculate the volume of the yellowish-green gas produced at the other electrode.

[2]

- (b) Explain why the electrolyte becomes pale green in stage 2 and then darker in stage 3.

.....  
.....  
.....  
.....[2]

- (c) A few drops of Universal Indicator were added **at the cathode** in stage 3.

State and explain the result of the test.

.....  
.....  
.....  
.....[2]

[Turn Over

- (d) A total of three different substances were produced at the cathode throughout the whole electrolysis process.

Identify and list the three substances in order of which they are produced.  
Explain your answer.

.....

.....

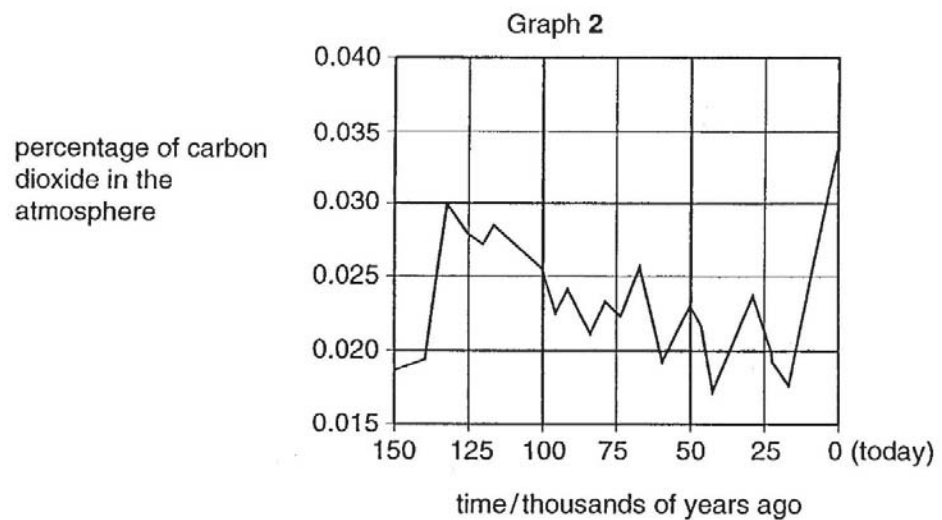
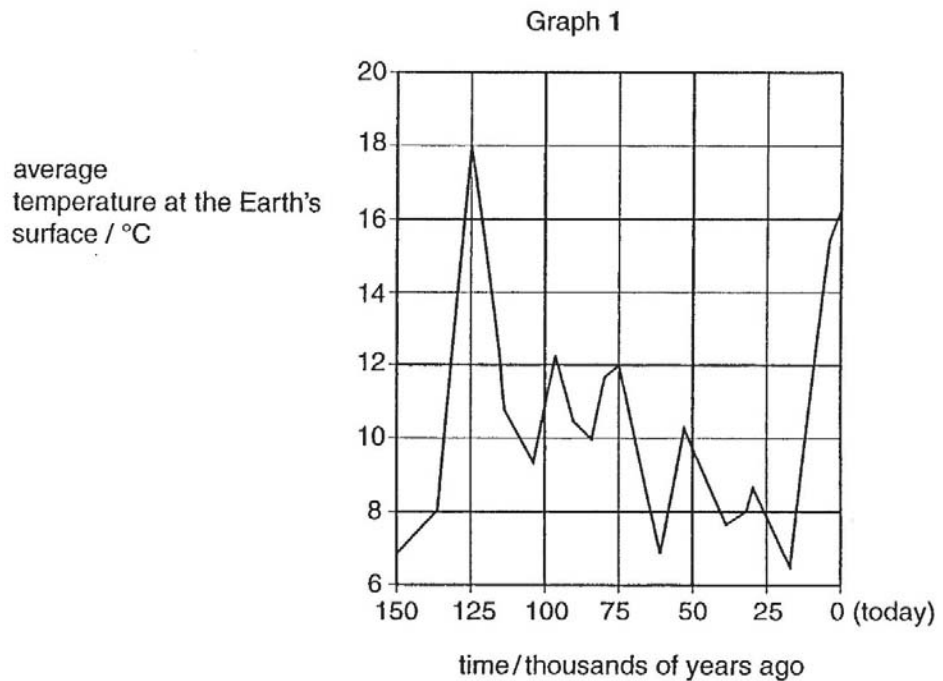
.....

.....[2]

**[Total: 10 marks]**

- B10** Graph 1 shows how the average temperature of the Earth's surface may have changed over the last 150 thousand years.

Graph 2 shows how the percentage of carbon dioxide in the atmosphere may have changed over the last 150 thousand years.



**[Turn Over**

- (a) Describe and explain the relationship between graph 1 and graph 2.

.....

.....

.....

.....[2]

- (b) State **two** consequences as a result of the changes in temperature levels shown in graph 1?

.....

.....

.....

.....[2]

- (c) Explain how the carbon cycle regulates the level of carbon dioxide in the atmosphere.

.....

.....

.....

.....[2]

- (d) Two most polluting emissions from cars are nitrogen monoxide and carbon monoxide. The actual concentration of each of these components depends on the mode of operation of the vehicle and the proportion of air present in the fuel mixture that is used.

Some typical figures are given in the table [ppm = parts per million].

mode of operation	proportion of air present in fuel mixture	nitrogen monoxide emissions / ppm	carbon monoxide emissions / ppm
idling engine	high	14	2000
Accelerating engine	high	3700	1000
idling engine	low	10	8000
accelerating engine	low	1000	5000

- (i) Suggest why

- (1) the concentration of nitrogen monoxide is high when the engine is in the accelerating mode; and
- (2) the concentration of carbon monoxide is low when the proportion of air present in the fuel mixture is high.

.....

.....

.....

.....

.....

.....[2]

[Turn Over

- (ii) Catalytic converters help reduce pollution by converting pollutants to non-polluting products.

The equation shows a typical reaction in a catalytic converter.



Complete and balance the equation. Explain why this equation represents a redox reaction.

.....  
 .....  
 .....[2]

**[Total: 10 marks]**

#### **EITHER**

- B11 (a)** Citric acid is a white crystalline powder with formula  $\text{C}_5\text{H}_7\text{O}_5\text{COOH}$ . Two samples of  $0.1 \text{ mol/dm}^3$  citric acid were prepared, one in water and the other in propanol. It was noticed that when the acid dissolved in water, the solution felt cold.

Dissociation of citric acid in water:  $\text{C}_5\text{H}_7\text{O}_5\text{COOH} \rightarrow \text{C}_5\text{H}_7\text{O}_5\text{COO}^- + \text{H}^+$

A piece of magnesium ribbon was added to each of the two solutions. The results are summarised in Table 11.1

**Table 11.1**

<b>solution</b>	<b>action on magnesium ribbon</b>
citric acid in water	slow but steady formation of gas bubbles
citric acid in propanol	no reaction

- (i) What type of energy change takes place when citric acid was dissolved in water?

.....[1]

- (ii) Explain the **observations** for the reaction between a solution of citric acid in water and magnesium.

.....  
 .....  
 .....[2]

- (iii) Write a balanced chemical equation to show the reaction between magnesium and citric acid in water.

.....[1]

- (iv) Explain why there was no reaction between magnesium and a solution of citric acid in propanol.

.....  
 .....[1]

- (b) Fig 11.2 shows three experiments involving aluminium that were set up in the laboratory.

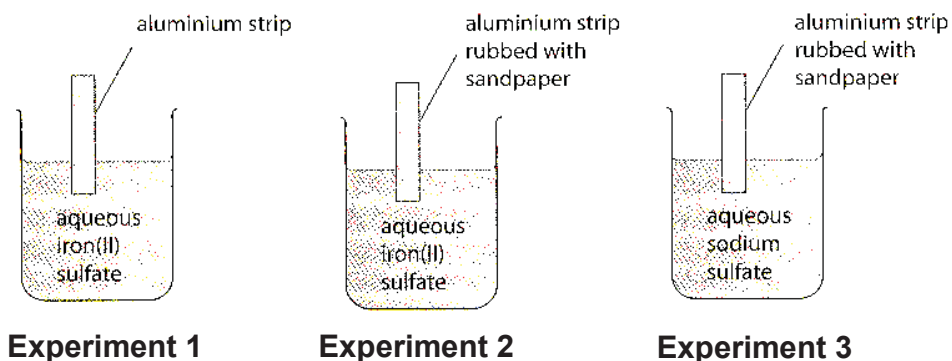


Fig 11.2

- (i) Explain why a reaction occurred in Experiment 2 but not in 1.

.....  
 .....  
 .....  
 .....[3]

[Turn Over

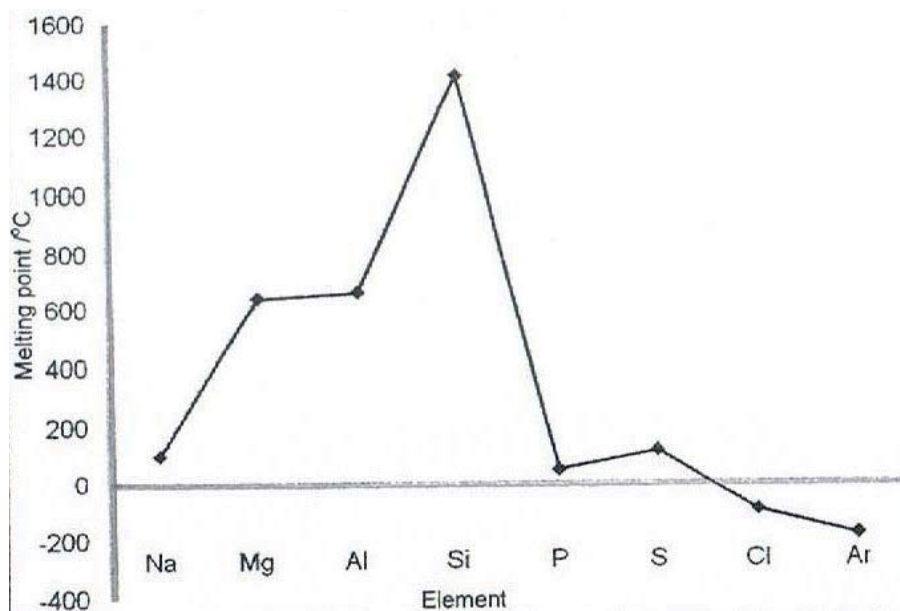
- (ii) State and explain the observation(s) if any, that will be seen in Experiment 3.

.....  
 .....  
 .....[2]

[Total: 10 marks]

OR

- B11** (a) The information in Fig 11.3 is about the elements in Period 3 of the Periodic Table.



**Fig 11.3**

- (i) Describe the general trends in melting point across Period 3.

.....  
 .....  
 .....  
 .....  
 .....[3]



- (ii) How does the data show that the first four elements in Period 3 are solids at room temperature and pressure?

.....  
 .....[1]

- (b) Silicon has a structure similar to that of diamond. Explain in terms of structure and bonding why silicon has such a high melting point in Period 3.

.....  
 .....  
 .....  
 .....[2]

- (c) Sketch a graph to show how proton number changes across Period 3.

[1]

- (d) Fluorine, chlorine, bromine and iodine are halogens found in Group VII of the Periodic Table. Table 11.4 lists the bond lengths and average bond energies of the halogens.

**Table 11.4**

covalent bond	bond length/ nm (1nm = 10 <sup>-9</sup> m)	average bond energy (kJ/mol)
F – F	0.142	158
Cl – Cl	0.199	242
Br – Br	0.228	193
I – I	0.267	151

**[Turn Over**

- (i) Describe the **general** relationship between bond length and the average bond energy within Group VII molecules.

.....  
.....[1]

- (ii) A student made the following comment about the reaction of gaseous propane, gaseous chlorine and gaseous bromine.

“When the same number of moles of gaseous propane is reacted with both gaseous bromine and gaseous chlorine, the rates for the two reactions will be the same.”

Do you agree with the student's comment? Explain your reasoning.

.....  
.....  
.....[2]

[Total: 10 marks]

---End of Section B---

---End of Paper 2---

Group																	
I	II											III	IV	V	VI	VII	0
																	4 <b>He</b> Helium 2
7 <b>Li</b> Lithium 3	9 <b>Be</b> Beryllium 4											11 <b>B</b> Boron 5	12 <b>C</b> Carbon 6	14 <b>N</b> Nitrogen 7	16 <b>O</b> Oxygen 8	19 <b>F</b> Fluorine 9	20 <b>Ne</b> Neon 10
23 <b>Na</b> Sodium 11	24 <b>Mg</b> Magnesium 12											27 <b>Al</b> Aluminium 13	28 <b>Si</b> Silicon 14	31 <b>P</b> Phosphorus 15	32 <b>S</b> Sulfur 16	35.5 <b>Cl</b> Chlorine 17	40 <b>Ar</b> Argon 18
39 <b>K</b> Potassium 19	40 <b>Ca</b> Calcium 20	45 <b>Sc</b> Scandium 21	48 <b>Ti</b> Titanium 22	51 <b>V</b> Vanadium 23	52 <b>Cr</b> Chromium 24	55 <b>Mn</b> Manganese 25	56 <b>Fe</b> Iron 26	59 <b>Co</b> Cobalt 27	59 <b>Ni</b> Nickel 28	64 <b>Cu</b> Copper 29	65 <b>Zn</b> Zinc 30	70 <b>Ga</b> Gallium 31	73 <b>Ge</b> Germanium 32	75 <b>As</b> Arsenic 33	79 <b>Se</b> Selenium 34	80 <b>Br</b> Bromine 35	84 <b>Kr</b> Krypton 36
85 <b>Rb</b> Rubidium 37	88 <b>Sr</b> Strontium 38	89 <b>Y</b> Yttrium 39	91 <b>Zr</b> Zirconium 40	93 <b>Nb</b> Niobium 41	96 <b>Mo</b> Molybdenum 42	<b>Tc</b> Technetium 43	101 <b>Ru</b> Ruthenium 44	103 <b>Rh</b> Rhodium 45	106 <b>Pd</b> Palladium 46	108 <b>Ag</b> Silver 47	112 <b>Cd</b> Cadmium 48	115 <b>In</b> Indium 49	119 <b>Sn</b> Tin 50	122 <b>Sb</b> Antimony 51	128 <b>Te</b> Tellurium 52	127 <b>I</b> Iodine 53	131 <b>Xe</b> Xenon 54
133 <b>Cs</b> Caesium 55	137 <b>Ba</b> Barium 56	139 <b>La</b> Lanthanum 57 *	178 <b>Hf</b> Hafnium 72	181 <b>Ta</b> Tantalum 73	184 <b>W</b> Tungsten 74	186 <b>Re</b> Rhenium 75	190 <b>Os</b> Osmium 76	192 <b>Ir</b> Iridium 77	195 <b>Pt</b> Platinum 78	197 <b>Au</b> Gold 79	201 <b>Hg</b> Mercury 80	204 <b>Tl</b> Thallium 81	207 <b>Pb</b> Lead 82	209 <b>Bi</b> Bismuth 83	<b>Po</b> Polonium 84	<b>At</b> Astatine 85	<b>Rn</b> Radon 86
<b>Fr</b> Francium 87	226 <b>Ra</b> Radium 88	227 <b>Ac</b> Actinium 89 +															

\*58-71 Lanthanoid series  
+90-103 Actinoid series

Key

a  
X  
b

a = relative atomic mass  
X = atomic symbol  
b = proton (atomic) number

140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	<b>Pm</b> Promethium 61	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	157 <b>Gd</b> Gadolinium 64	159 <b>Tb</b> Terbium 65	162 <b>Dy</b> Dysprosium 66	165 <b>Ho</b> Holmium 67	167 <b>Er</b> Erbium 68	169 <b>Tm</b> Thulium 69	173 <b>Yb</b> Ytterbium 70	175 <b>Lu</b> Lutetium 71
232 <b>Th</b> Thorium 90	<b>Pa</b> Protactinium 91	238 <b>U</b> Uranium 92	<b>Np</b> Neptunium 93	<b>Pu</b> Plutonium 94	<b>Am</b> Americium 95	<b>Cm</b> Curium 96	<b>Bk</b> Berkelium 97	<b>Cf</b> Californium 98	<b>Es</b> Einsteinium 99	<b>Fm</b> Fermium 100	<b>Md</b> Mendelevium 101	<b>No</b> Nobelium 102	<b>Lr</b> Lawrencium 103



**Paper 1 MCQ: 40 MCQs (40 marks)**


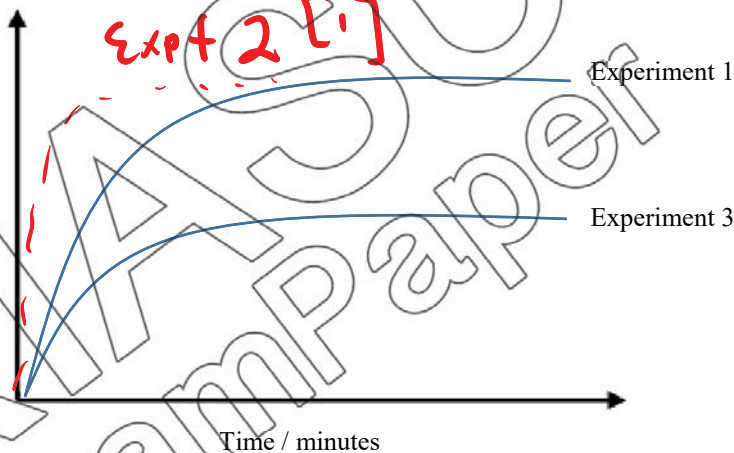
1.	B	9.	A	17.	B	25.	A	33.	C
2.	C	10.	C	18.	C	26.	C	34.	A
3.	B	11.	D	19.	D	27.	D	35.	A
4.	B/D	12.	D	20.	B	28.	C	36.	A
5.	A	13.	D-	21.	C	29.	C	37.	C
6.	D	14.	D	22.	B	30.	C	38.	C
7.	B	15.	B	23.	B	31.	B	39.	D
8.	A	16.	C	24.	B	32.	C	40.	C

**Paper 2 Section A:**

**Answer all questions (50 marks)**

Qn	Part	Answers	Mark allocated	Markers Feedback
1	(a)	neutralization	[1 mark]	Very
	(b)	precipitation	[1 mark]	
	(c)	oxidation	[1 mark]	
	(e)	displacement / redox	[1 mark]	
	(f)	thermal decomposition / decomposition	[1 mark]	
A2	(a)	Any appropriate compound 1 mark for correct number of electrons on carbon atom 1 mark for correct number of electrons on the other atom(s) Explanation: the carbon atom and X atom <u>share a pair of electrons to attain a noble gas electronic configuration</u> [1]	[3 mark]	

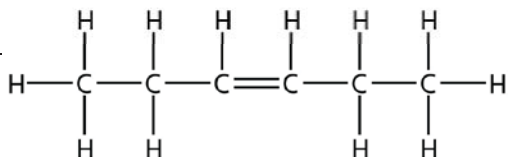
	(b)	In allotrope A, <u>every carbon atom is bonded to 4 other carbon atoms by strong covalent bonds</u> . This makes the whole structure very hard. In allotrope B, <u>every carbon atom is bonded to 3 other carbon atoms in hexagonal layers</u> . Little force is needed to overcome these <u>weak intermolecular forces of attraction between layers</u> , making B slippery.	[1 mark] [1 mark]	
	(c)	Carbon causes the <u>oxidation state of zinc to decrease from +2 in ZnO to 0 in Zn</u> , hence reducing zinc oxide / C itself is oxidized. O.S of C increases from 0 to +2. Hence it's a reducing agent.	[1 mark]	
A3	(a)	A,C,D,B	[1 marks]	
	(b)	Metal A: No visible observation [1] Metal D: Metal D dissolves/brown solution becomes colourless/Grey solid produced (Any 2 for 2 marks)	[3 marks]	
	(ci)	$\text{Fe}_2\text{O}_3(\text{s}) + 3\text{CO}(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 2\text{Fe}(\text{l})$	[1 marks]	
	(cii)	Yes it is redox as $\text{Fe}_2\text{O}_3$ loses oxygen to form Fe and CO gains oxygen to form $\text{CO}_2$ .	[1 marks]	
	(d)	Sacrificial Protection. A <u>more reactive metal</u> like magnesium or zinc can be <u>placed beside iron</u> . It will <u>corrode in place of iron</u>	[1 marks] [1 marks]	

A4	(a)		[1 marks]	
	(b)	$2\text{HCl}(\text{aq}) + \text{Zn}(\text{s}) \rightarrow \text{ZnCl}_2(\text{aq}) + \text{H}_2(\text{g})$	[1 marks]	
	(c)		[1 marks]	
	(d)	$Y = 30.0 \text{ cm}^3$ $Z = 0.25 \text{ mol/dm}^3$ Or $Y = 60.0 \text{ cm}^3$ $Z = 0.125 \text{ mol/dm}^3$	[2 marks]	

	(e)	Increase in temperature, <u>increases the kinetic energy of the particles [1], more particles have energy greater or equal to the activation energy [1], higher frequency of effective collision.</u> [1] increase speed of reaction	[3 marks]	
A5	(a)	name: hexanone formula: $C_6H_{12}O$	[1 marks] [1 marks]	
	(b)	$C_nH_{2n+1}COCH_3$	[1 marks]	
	(c)	$  \begin{array}{ccccccc}  & H & & H & & O & & H \\  &   & &   & &    & &   \\  H & - C & - & C & - & C & - & C - H \\  &   & &   & & & &   \\  & H & & H & & & & H  \end{array}  $	[1 marks]	
	(d)	Bromine water remains brown in propanone. Bromine water decolourizes / turns colourless in propene.	[1 marks] [1 marks]	
A6	(a)	<u>Shields / filters out harmful UV rays from the sun that can cause skin cancer / genetic mutations / eye damage. ;</u>	[1 marks]	
	(b)	Forms photochemical smog which irritates the eyes and lungs which can cause breathing problems.	[1 marks]	
	(c)	<u>Chlorine is oxidised. ;</u> <u>Its O.S. increases from 0 in <math>Cl_2</math> to +1 in <math>Cl_2O</math>. ;</u>	[1 marks] [1 marks]	
	d(i)	Pollutant reacts with rain water to form acid rain that corrodes buildings and harms aquatic life / plants.	[1 marks]	
	d(ii)	$2NO_2 + 4CO \rightarrow 4CO_2 + N_2$	[1 marks]	



A7	(a)	The <u>energy released</u> in the <u>formation of O-H and C=O bonds</u> is <u>larger</u> ; than the energy required to <u>break the C-H, O-H, C-C and H-H bonds</u> . ;	[1 marks] [1 marks]	
	(bi)	Moles of ethanol required to produce 100 kJ of energy $100 / 1370$ $= 0.07299$ moles ;  From the equation above, 1 mole of $C_2H_5OH = 2$ moles of $CO_2$ $0.07299$ moles of $C_2H_5OH = 0.1460$ moles of $CO_2$  Volume of $CO_2$ produced $= 3.50 \text{ dm}^3$ ;	[1 marks]   [1 marks]	
	(c)	<u>Combustion of hydrogen produces water</u> which does not contain carbon and <u>produce carbon monoxide</u> which is a <u>pollutant</u> or <u>carbon dioxide</u> which is responsible for <u>global warming</u> .	[1 marks] [1 marks]	
A8	(a)	Crude oil enters the heater and is <u>heated</u> up to form a <u>gaseous mixture</u> .;	[1 marks]	
		The gaseous mixture enters the distillation column and is cooled and then separated through <u>condensation</u> . ;	[1 marks]	
		The fractions with the <u>lower boiling points</u> / the <u>lighter fractions</u> will be <u>collected at the top</u> , while the <u>fractions with the higher boiling points</u> / the <u>heavier fractions</u> will be <u>collected at the bottom</u> of the distillation column.;	[1 marks]	
	(bi)	Longer hydrocarbons are cracked to <u>produce shorter hydrocarbons</u> / <u>smaller molecules</u> (e.g. petrol) that have <u>higher demand</u> in the industries.	[1 marks]	
	(bii)		[1 marks]	

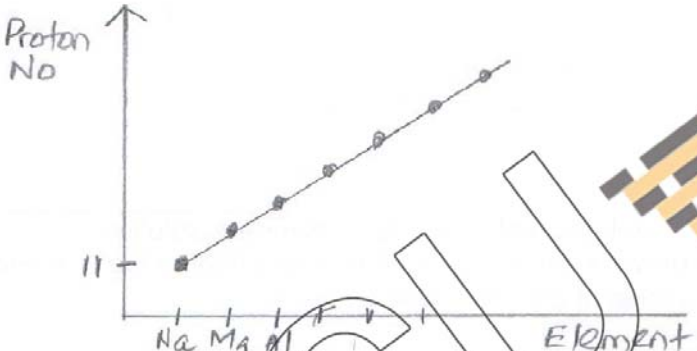


**Paper 2 Section B: (30 marks)**

<b>B9ai</b>	$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Cu}(\text{s})$ $2\text{Cl}^{-}(\text{aq}) \rightarrow \text{Cl}_2(\text{g}) + 2\text{e}^{-}$	[1 mark] [1 mark]	
<b>B9aii</b>	<p>Number of moles of Cu = <math>0.584 / 64 = \underline{0.009125 \text{ mol}}</math></p> <p>For the same amount of electricity (2 mol of <math>\text{e}^{-}</math>), 1 mol of Cu and 1 mol of <math>\text{Cl}_2</math> are produced. Hence, number of moles of <math>\text{Cl}_2</math> produced is also 0.009125 mol.</p> <p>Volume of <math>\text{Cl}_2</math> produced = <math>\underline{0.009125 \times 24 = 0.219 \text{ dm}^3}</math></p>	[1 mark]   [1 mark]	
<b>B9b</b>	<p>At stage 2, <u><math>\text{Cu}^{2+}</math> ions were preferentially discharged</u> leaving behind <math>\text{Fe}^{2+}</math> ions in the <u>electrolyte</u> which are pale green in colour.</p> <p>At stage 3, <u><math>\text{H}^{+}</math> and <math>\text{OH}^{-}</math> ions from water are discharged.</u></p> <p>Hence the concentration of the electrolyte increases and the solution becomes darker due to the <math>\text{Fe}^{2+}</math>.</p>	[1 mark]  [1 mark]	
<b>B9c</b>	<p>The Universal Indicator will change colour from <u>green to violet/blue</u>. <u><math>\text{H}^{+}</math> ions are preferentially discharged</u> at the cathode leaving behind <u><math>\text{OH}^{-}</math> ions in solution / concentration of <math>\text{H}^{+}</math> decreases which thus increases the concentration of <math>\text{OH}^{-}</math> in electrolyte</u> which makes the solution around the cathode alkaline.</p>	[1 mark] [1 mark]	

<b>B9d</b>	<p>The three substances are <u>copper, hydrogen gas and iron.</u></p> <p><u>Any one</u> of the following explanations :</p> <ul style="list-style-type: none"> <li>• Copper atoms are the least reactive, followed by hydrogen atoms, then iron atoms. Hence,</li> <li>• Copper(II) ions are preferentially discharged followed by hydrogen ions, then iron(II) ions</li> <li>• Copper(II) ions accept electrons most readily followed by hydrogen ions then iron(II) ions</li> </ul>	[2 marks]	
<b>B10a</b>	<p>When the percentage of carbon dioxide increases, the average temperature at the Earth's surface increases.</p> <p>Carbon dioxide is a greenhouse gas. It traps the infrared radiation from the sun and prevents it from going back to the atmosphere. This causes the earth's average temperature at the Earth's surface to increase.</p>	[1 mark] [1 mark]	
<b>b</b>	<p>More occurrences of unusual weather conditions such as warm spells, droughts and storms.</p> <p>Decrease in crop yields because areas covered by vegetation may become deserts.</p> <p>OR Melting of ice cap will cause ocean levels to rise and flood low-lying</p>	[1 mark] [1 mark]	
<b>c</b>	<p>Photosynthesis by plants lowers the level of carbon dioxide while combustion, respiration and decay increase the level of carbon dioxide.</p>	[1 mark] [1 mark]	
<b>di</b>	<p>When the engine is in the accelerating mode, the high temperature of the engine allows nitrogen in the air to react with oxygen to form nitrogen monoxide.</p> <p>When the proportion of air present in the fuel mixture is high, the fuel mixture will burn completely, there is less likelihood of incomplete combustion.</p>	[1 mark] [1 mark]	
<b>dii</b>	<p><math>2\text{NO} + 2\text{CO} \rightarrow \text{N}_2 + 2\text{CO}_2</math></p> <p>NO loses oxygen and is reduced to <math>\text{N}_2</math>. CO gains oxygen and is oxidised to <math>\text{CO}_2</math>.</p>	[1 mark] [1 mark]	

<b>Either B11ai</b>	Exothermic		
<b>aii</b>	Formation of bubbles is due to the hydrogen gas evolved when acid react with magnesium metal to form salt and H <sub>2</sub> . The reaction is slow as citric acid is a weak acid – less H <sup>+</sup> ions dissociated..	[1 mark] [1 mark]	
<b>aiii</b>	$\text{Mg(s)} + 2\text{C}_5\text{H}_7\text{O}_5\text{COOH} \rightarrow (\text{C}_5\text{H}_7\text{O}_5\text{COO})_2\text{Mg} + \text{H}_2$	[1 mark]	
<b>aiv</b>	Propanol is an organic solvent which will not result in hydrogen ions being produced.	[1 mark]	
<b>bi</b>	A reaction occurred in Experiment 2 because the aluminium strip is rubbed with sandpaper to remove the oxide layer and aluminium is more reactive than iron so displacement of iron from its salt solution can occur. A reaction does not occur in Experiment 1 as the aluminium strip is still covered by an inert(unreactive) oxide layer.	[1 marks] [1 marks] [1 marks]	
<b>bii</b>	There will be no reaction seen in Experiment 3 as aluminium is less reactive than sodium. Hence no displacement reaction will take place despite the aluminium strip being rubbed with sandpaper.	[1 mark] [1 mark]	
<b>OR B11ai</b>	1. Melting point increases from Na to Si. 2. It drops drastically from Si to P. 3. There is a gradual drop in melting point from S to Cl.	[1 mark] [1 mark] [1 mark]	
<b>aii</b>	Their melting points are above room temperature.	[1 mark]	
<b>b</b>	Silicon has a giant molecular structure with all the silicon atoms joined together with strong covalent bonds. A lot of heat energy is needed to break the strong covalent bonds between the silicon atoms.	[1 mark] [1 mark]	

c		[1 mark]	
di	as bond length <b>increases</b> , the bond energy <b>decreases</b> ; (with the exception of fluorine).	[1 mark]	
ii	No. Chlorine is <b>more reactive</b> than bromine; the <b>reactivity decreases</b> down Group VII.	[1 mark] [1 mark]	





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**CHEMISTRY**

**6092/01**

**Paper 1**

**1 hour**

**Question Booklet**

Additional Material: OTAS

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**READ THESE INSTRUCTIONS FIRST**

**Do not open the booklet until you are told to do so.**

Write your name, index number and class on the OTAS.

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.

You are not required to hand in this booklet at the end of the examination.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate answer sheet.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer. Any rough working should be done on this booklet.

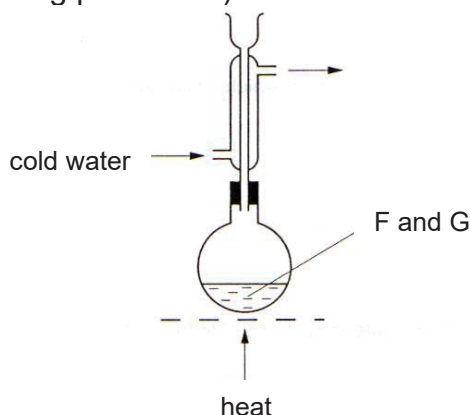
A copy of the **Periodic Table** is printed on **page 18**.

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This document consists of **18** printed pages.

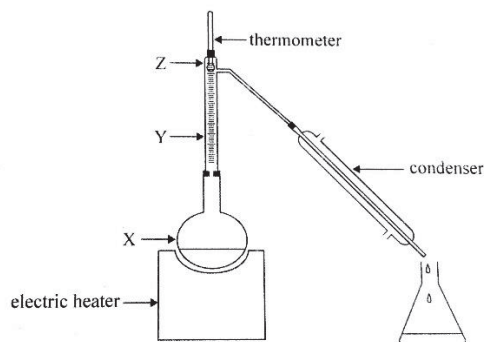


- 1 The diagram shows the apparatus used for the slow reaction between liquid F (boiling point  $57^{\circ}\text{C}$ ) and liquid G (boiling point  $80^{\circ}\text{C}$ ).



What is the purpose of the condenser?

- A to enable F and G to mix more efficiently
  - B to prevent the mixture from getting too hot
  - C to allow the product to escape as fast as it is formed
  - D to prevent F and G from escaping before the reaction is complete
- 2 A liquid mixture of 50% ethanol and 50% water was distilled in the apparatus shown below. The boiling point of ethanol is  $78^{\circ}\text{C}$  and that of water is  $100^{\circ}\text{C}$ . As the mixture was heated the temperature shown by the thermometer initially rose but then remained constant at  $78^{\circ}\text{C}$  for some time.



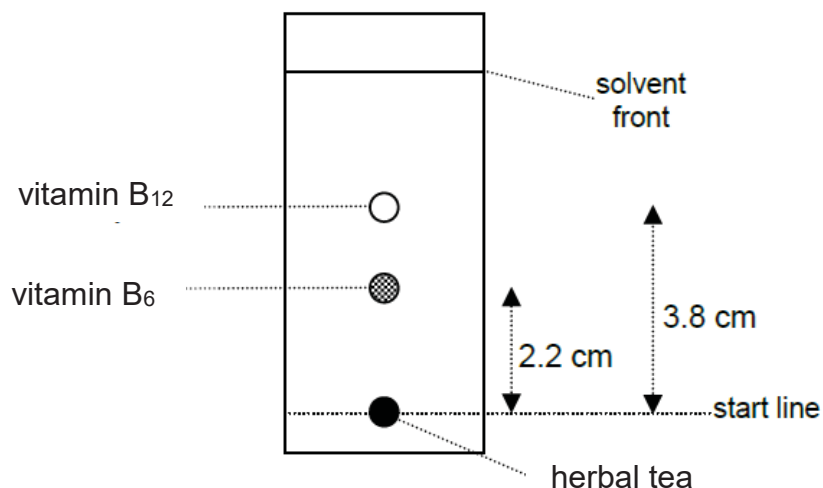
Which of the following statements about percentage of ethanol in the vapours shown at points X, Y and Z, when the temperature is at a constant  $78^{\circ}\text{C}$ , is true?

- A The percentage of ethanol in the vapour at X is equal to 50%.
- B The percentages of ethanol in the vapour increase in order at positions X, Y and Z.
- C The percentages of ethanol in the vapour at Y and Z are equal but greater than at X.
- D The percentages of ethanol in the vapour at X, Y and Z are equal but greater than 50%.

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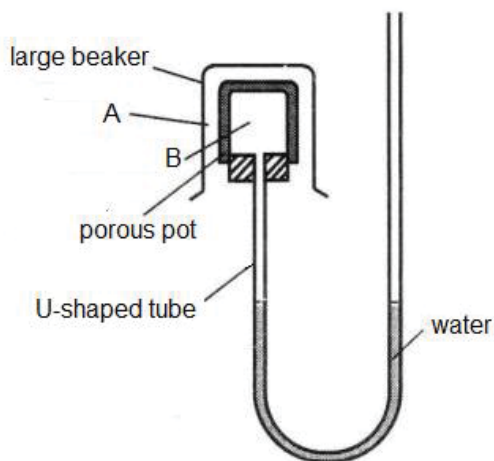


- 3 A sample of herbal tea containing two water-soluble vitamins was analysed during chromatography with water as a solvent. When the solvent front reached the position indicated, the chromatogram was placed under ultra-violet light. The following chromatogram was obtained.



Given that the  $R_f$  value of vitamin B<sub>12</sub> is 0.34, determine the  $R_f$  value of vitamin B<sub>6</sub>.

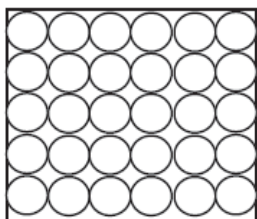
- A** 0.20                      **B** 0.50                      **C** 0.56                      **D** 0.73
- 4 The following diagram shows a set up.
- Which pair of gases would cause a fall in the water level at the right side of the U shaped tube?



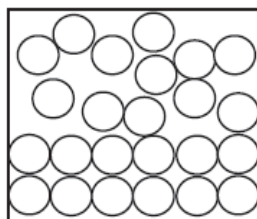
- |          | gas A            | gas B    |
|----------|------------------|----------|
| <b>A</b> | Nitrogen dioxide | Chlorine |
| <b>B</b> | Carbon Monoxide  | Nitrogen |
| <b>C</b> | Oxygen           | Neon     |
| <b>D</b> | Fluorine         | Argon    |

- 5 Bromine melts at  $-7^{\circ}\text{C}$  and boils at  $59^{\circ}\text{C}$ . A tank filled with bromine at  $30^{\circ}\text{C}$  is cooled to  $-7^{\circ}\text{C}$ .

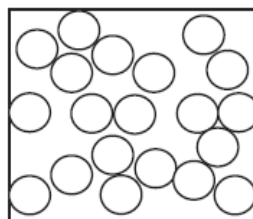
Which diagram below best represents the arrangement of bromine particles at  $-7^{\circ}\text{C}$  and at  $30^{\circ}\text{C}$ ?



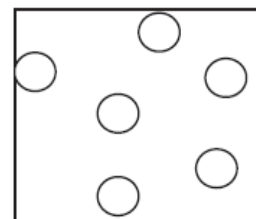
1



2



3



4

	$-7^{\circ}\text{C}$	$30^{\circ}\text{C}$
<b>A</b>	2	4
<b>B</b>	1	3
<b>C</b>	2	3
<b>D</b>	1	2

- 6 Fires are categorized into four different classes according to the type of fuel involved. The table below shows the various classes of fire.

class	fuel/heat Source	example
1	ordinarily combustible	solids like wood and coal on fire
2	flammable liquids	petrol, oil on fire
3	flammable gases	natural gas, carbon monoxide on fire
4	combustible metals	sodium or potassium on fire

In a selection test, a potential firefighter is required to match four substances according to their class of fire.

Which of the following has been incorrectly matched?  
(Assume room temperature and pressure).

	melting point/ $^{\circ}\text{C}$	boiling point/ $^{\circ}\text{C}$	class of fire
<b>A</b>	98	883	4
<b>B</b>	-184	-164	3
<b>C</b>	-117	78	1
<b>D</b>	5	80	2

- 7 The table gives data about three different particles.

particle	nucleon number	number of protons	number of neutrons	number of electrons
Xe	131	54	T	54
Se <sup>2-</sup>	79	U	45	36
Be <sup>2+</sup>	9	4	5	V

What are the correct values of T, U and V?

	T	U	V
<b>A</b>	54	36	4
<b>B</b>	54	34	2
<b>C</b>	77	36	4
<b>D</b>	77	34	2

- 8 The table shows details of the particles present in the following 4 atoms or ions.

atoms/ ions	number of neutrons	number of electrons
J <sup>-</sup>	17	18
K	16	16
L <sup>2+</sup>	20	18
M	20	17

Which of the following atoms is an isotope of J?

- A** K                      **B** L                      **C** M                      **D** None of the above

- 9 A table listing the atomic numbers of 4 elements P, Q, R and S is given below.

element	P	Q	R	S
atomic Number	5	12	15	18

Using the above information only, it can be deduced that

- A** one atom of Q is heavier than one atom of R.  
**B** the number of neutrons in one atom of R is more than that in one atom of Q.  
**C** R can be converted into Q by removing three electrons from each atom of R.  
**D** Q has a higher tendency to lose electrons than R.

- 10 The formulae of the ions of some elements are shown below:



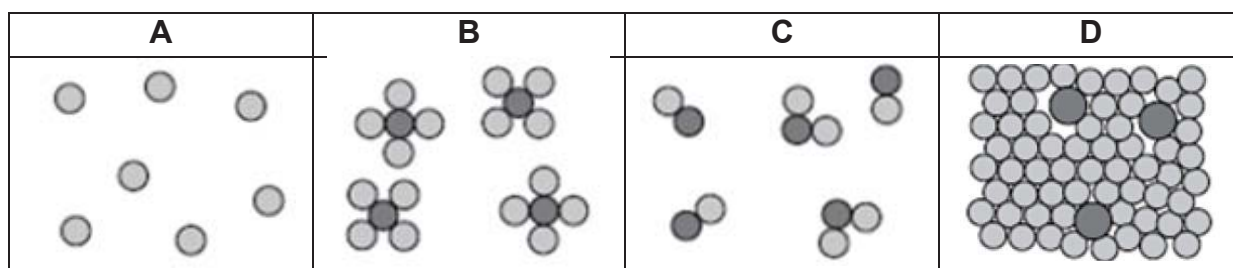
Which of the following statements about these ions is correct?

- A** All have stable noble gas configuration.
- B** All have the same number of electron shells.
- C** All have the same number of neutrons in their nuclei.
- D** All have more electrons than protons.
- 11 Solid iodine readily forms iodine vapour when heated.

What can be deduced about the nature of the particles in these two states of iodine?

	<b>solid</b>	<b>vapour</b>
<b>A</b>	atomic	ionic
<b>B</b>	atomic	molecular
<b>C</b>	molecular	atomic
<b>D</b>	molecular	molecular

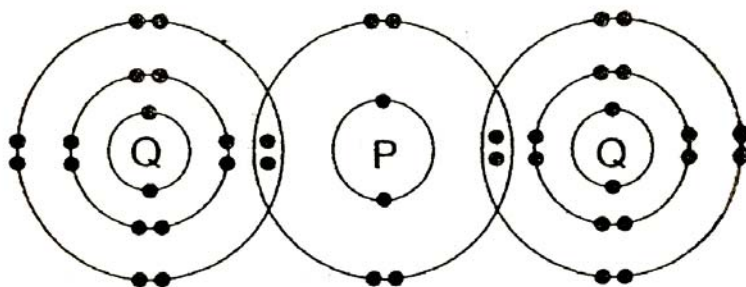
- 12 Which of the following diagrams represents a mixture of elements?



- 13** A sample of a white crystalline substance is heated in the absence of oxygen. It melts sharply at  $120^{\circ}\text{C}$ , but on further heating, gives off smoky fumes and a black solid remains.

From this information, we may deduce that the white crystalline substance is

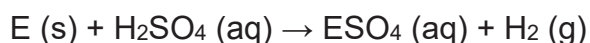
- A** an element which combusted to form two products.
- B** a mixture of substances which combined chemically.
- C** a compound which combusted to form two products.
- D** a compound which decomposed to form simpler substances.
- 14** The diagram below shows the bonding between P and Q in the covalent molecule,  $\text{PQ}_2$ .



What are the electronic structures of atoms P and Q before combining together to form the above molecule?

	P	Q
<b>A</b>	2.6	2.8.6
<b>B</b>	2.4	2.8.7
<b>C</b>	2.6	2.8.7
<b>D</b>	2.8	2.8.8

- 15** The equation below shows the reaction between a metal E and dilute sulfuric acid.

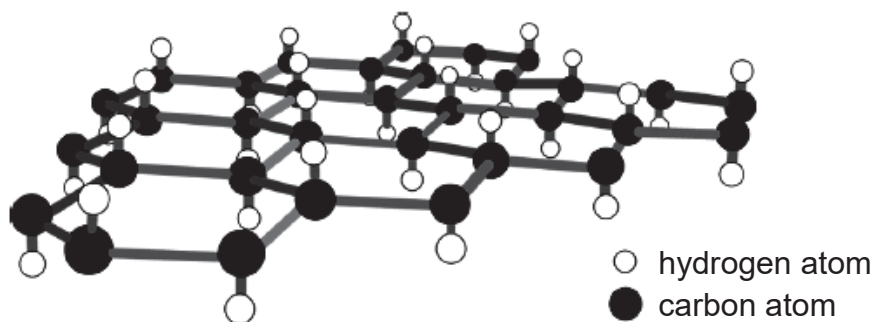


A test on electrical conductivity showed that both the reagents and the resulting solution are good conductors of electricity.

Which particles are responsible for the electrical conductivity in metal E, sulfuric acid and  $\text{ESO}_4$ ?

	Metal E	Sulfuric acid	ES <sub>4</sub> (aq)
<b>A</b>	Electrons	Cations	Cations and anions
<b>B</b>	Electrons	Cations and anions	Cations and anions
<b>C</b>	Cations	Electrons	Anions
<b>D</b>	Cations and anions	Cations	Electrons

- 16** Graphane has a similar structure to graphite, except that, it has an additional hydrogen atom attached to each carbon as shown in the diagram.



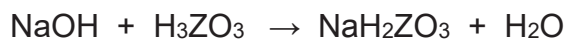
Which set of properties will graphane have?

1	It has a high melting and boiling point.
2	It has a giant molecular structure.
3	It conducts electricity in the solid state.

- A**    1 and 2  
**B**    1 and 3  
**C**    2 and 3  
**D**    1, 2 and 3

- 17** A solution contains  $12.60 \text{ g/dm}^3$  of the acid  $\text{H}_3\text{ZO}_3$ .

$25.0 \text{ cm}^3$  of this solution reacted with an equal volume of  $0.100 \text{ mol/dm}^3$  NaOH as shown in the equation.



What is element Z?

- |                  |                   |
|------------------|-------------------|
| <b>A</b> arsenic | <b>B</b> nitrogen |
| <b>C</b> silicon | <b>D</b> sulfur   |
- 18** A sample of insecticide DDT,  $\text{C}_{14}\text{H}_9\text{Cl}_5$ , was found to contain 0.120 g of carbon.

What mass of chlorine was present in the sample?

- |                  |                  |
|------------------|------------------|
| <b>A</b> 0.127 g | <b>B</b> 0.253 g |
| <b>C</b> 0.994 g | <b>D</b> 1.01 g  |
- 19** Nitrogen(II) oxide and chlorine react according to the equation shown below.



The activation energy for the forward reaction is 62 kJ.

What is activation energy for the reverse reaction?

- |                  |                 |
|------------------|-----------------|
| <b>A</b> - 62 kJ | <b>B</b> 24 kJ  |
| <b>C</b> 38 kJ   | <b>D</b> 100 kJ |

- 20** The conversion of graphite to diamond has an only small value for enthalpy change as shown.



However, the production of synthetic diamonds using this reaction is very difficult.

Which statement helps to explain this?

- A** Diamond has a larger number of covalent bonds than graphite.
  - B** Only exothermic reactions can occur readily.
  - C** The activation energy of the reaction is large.
  - D** The reaction between diamond and graphite is reversible.
- 21** Ammonium chloride dissolves in water according to the equation shown below.



When 0.2 moles of ammonium chloride dissolves in 50.0 cm<sup>3</sup> of water,

1	the concentration of the solution is 4.0 mol/dm <sup>3</sup> .
2	the energy level of NH <sub>4</sub> Cl increases.
3	the heat liberated is 3.0 kJ.
4	the temperature of the solution falls.

Which one of the following statements are correct?

- A** 1, 2 and 3
  - B** 1, 2 and 4
  - C** 1, 3 and 4
  - D** 2, 3 and 4
- 22** Disproportionation is a reaction in which the same element is both oxidised and reduced.

Which reaction is an example of disproportionation?

- A**  $3\text{Cu} + 8\text{HNO}_3 \rightarrow 3\text{Cu}(\text{NO}_3)_2 + 2\text{NO} + 4\text{H}_2\text{O}$
- B**  $2\text{KOH} + \text{H}_2\text{SO}_4 \rightarrow \text{K}_2\text{SO}_4 + 2\text{H}_2\text{O}$
- C**  $2\text{NO}_2 + \text{H}_2\text{O} \rightarrow \text{HNO}_3 + \text{HNO}_2$
- D**  $2\text{Pb}(\text{NO}_3)_2 \rightarrow 2\text{PbO} + 4\text{NO}_2 + \text{O}_2$

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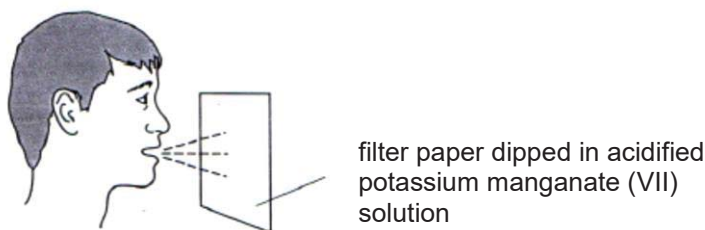


- 23 The equation below is one of the reactions which occur in catalytic converters.



Which statement is correct?

- A Carbon dioxide is formed by the reduction of carbon containing compounds.
  - B Nitrogen is produced by the oxidation of nitrogen monoxide.
  - C Nitrogen monoxide is a reducing agent.
  - D  $\text{C}_8\text{H}_{18}$  is a reducing agent.
- 24 Acidified potassium manganate(VII) can be used to detect the presence of ethanol vapour in the breath of a person who has consumed alcohol.



A colour change is observed. This shows that ethanol is

- A a reducing agent because it reduces the oxidation state of the manganese ions.
  - B an alkali because the final colour is purple.
  - C an oxidising agent because the manganese atoms gain oxygen atoms.
  - D neutralised by acidified potassium manganate(VII) solution.
- 25 In which of the following pairs is the oxidation number of chromium more than that of manganese?
- A  $\text{K}_2\text{CrO}_4$                        $\text{KMnO}_4$
  - B  $\text{CrCl}_3$                                $\text{MnO}_2$
  - C  $\text{Cr}_2(\text{SO}_4)_3$                        $\text{MnSO}_4$
  - D  $\text{K}_2\text{Cr}_2\text{O}_7$                        $\text{MnO}_4^-$

- 26** Which one of the following elements burns in excess oxygen to form a neutral oxide?

**A** carbon

**B** sulfur

**C** calcium

**D** hydrogen

- 27** The following steps were carried out to prepare magnesium chloride.

I	Add excess magnesium carbonate to hydrochloric acid.
II	Heat the solution until it is saturated.
III	Filter , wash and dry the crystals.

Which of the following steps should be taken to ensure that the procedure is successful in order to obtain the pure salt?

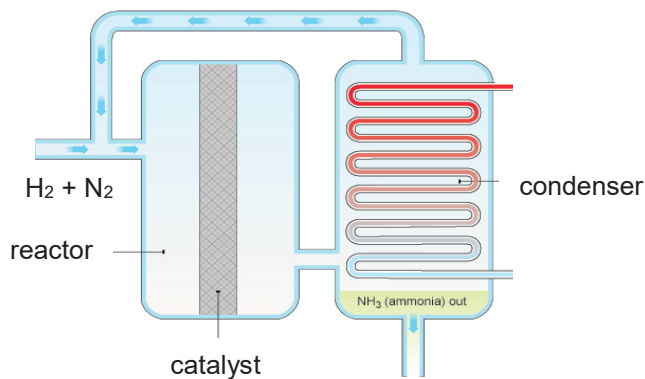
**A** Filter to get rid of the excess magnesium carbonate before carrying out step II.

**B** Add excess hydrochloric acid instead of magnesium carbonate in step 1.

**C** Evaporate the solution to dryness in step III.

**D** The crystals should not be washed in step III.

- 28** Ammonia is produced by Haber process as shown in the diagram.



Which one of the following processes separates ammonia from the reaction mixture?

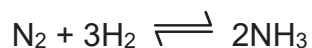
**A** cooling the gaseous mixture

**B** distillation of the gaseous mixture

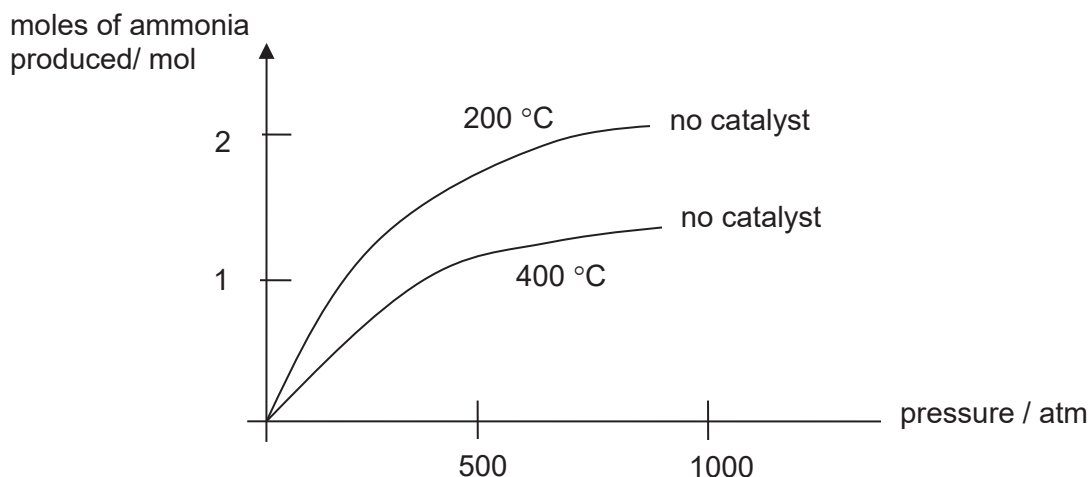
**C** filtering out the other gases by passing through the condenser

**D** pass the gaseous mixture through fused calcium oxide

- 29 When heated, nitrogen and hydrogen react according to the equation:



The graph below shows the number of moles of ammonia produced from 1 mole of nitrogen at different temperatures and pressures.

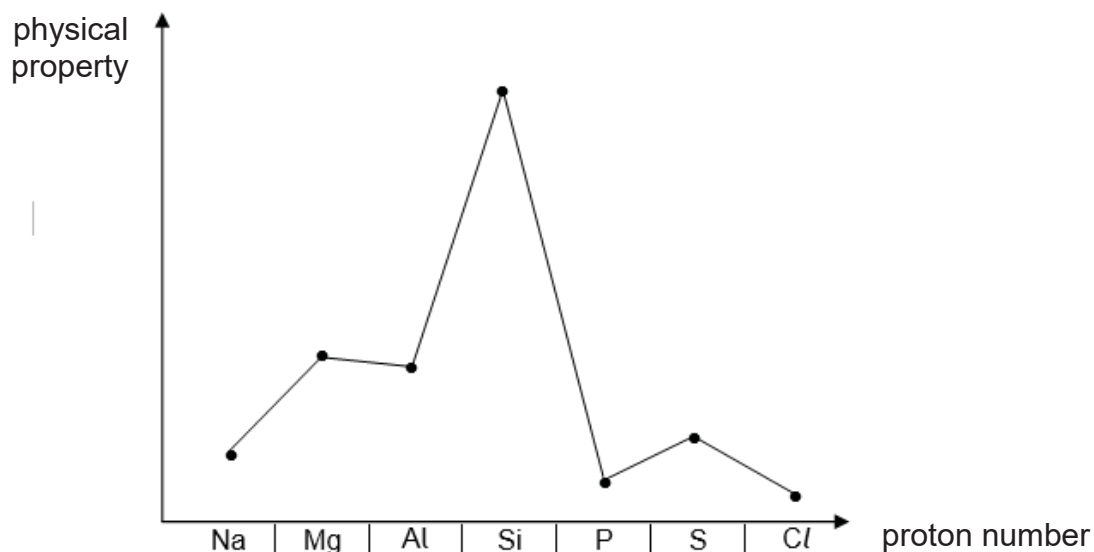


Which one of the following statements may be deduced from this information?

1	At 500 atm pressure, the number of moles of ammonia produced is greater at 200 °C than at 400 °C.
2	An increase of pressure increases the number of moles of ammonia produced both at 200 °C and at 400 °C.
3	At 500 atm pressure and 300 °C, the number of moles of ammonia produced is likely to be greater than one.

- A** 1, 2, and 3 are correct                      **B** 2 and 3 only are correct  
**C** 1 and 2 only are correct                      **D** 1 only is correct

- 30** The graph shows the variation of a physical property with proton number for the elements from sodium to chlorine in the Periodic Table.



What is the physical property that varies?

- A** atomic radius
- B** electrical conductivity
- C** melting point
- D** density

- 31** An element R forms compounds with the following chemical formulae:



In which group of the Periodic Table would element R be placed?

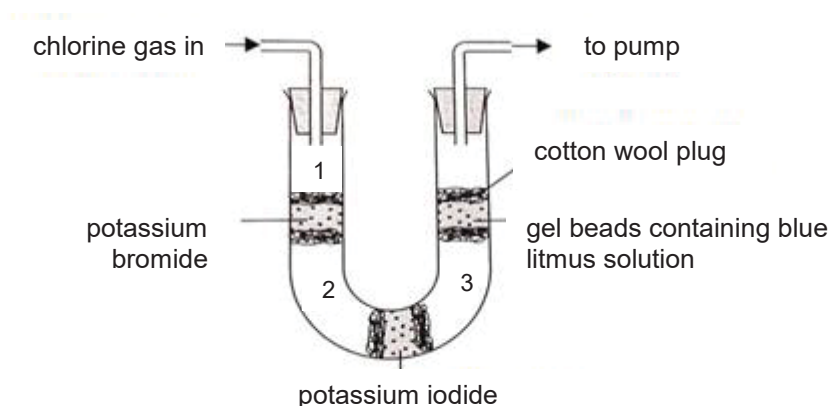
- A** Group II                                      **B** Group IV  
**C** Group V                                      **D** Group VI

- 32** Transition metals are often used as catalysts in industries.

Which of the following is not an example of a transition metal acting as a catalyst?

- A** platinum in catalytic converters
- B** iron in Haber Process
- C** aluminium in catalytic cracking
- D** nickel in making of margarine

- 33** Gaseous chlorine was passed through the following apparatus. The apparatus was continuously heated and the observations were recorded below.



Which of the following observations would be made at regions 1, 2 and 3?

	region 1	region 2	region 3
<b>A</b>	red-brown gas	black solid	violet gas
<b>B</b>	violet gas	red-brown gas	black solid
<b>C</b>	yellow-green gas	red-brown gas	violet gas
<b>D</b>	yellow-green gas	violet gas	brown gas

- 34** The diagram shows the positions of elements L, M, Q, R and T in the Periodic Table. These letters are not the chemical symbols of the elements.

[illegible]

Which statement about the properties of these elements is correct?

- A** M reacts more vigorously with water than does L.
- B** Q, R and T are all metals.
- C** T is more reactive than R.
- D** T exists as diatomic molecules.

- 35 Which of the following combinations below correctly states how the increase in the percentage of carbon in steel affects its properties?

	strength	malleability	melting point	brittleness	Key:  ↑ = increase  ↓ = decrease
A	↑	↑	↓	↓	
B	↑	↓	↑	↓	
C	↑	↓	↓	↑	
D	↓	↑	↑	↓	

- 36 The positions of three metals X, Y and Z are indicated in the reactivity series below.

Most reactive	potassium
	X
	sodium
	zinc
	Y
	iron
Least reactive	Z

How are the metals obtained from their ores?

	electrolysis	reduction with carbon	found uncombined
A	X	Y	Z
B	X	Z	Y
C	Y	X	Z
D	Z	X	Y

- 37 The table shows a list of metal carbonates and the time taken for a fixed volume of carbon dioxide to be collected upon heating a fixed mass of each metal carbonate.

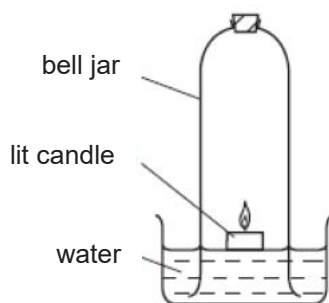
metal carbonate	time taken / min
WCO <sub>3</sub>	0.5
XCO <sub>3</sub>	2
Y <sub>2</sub> CO <sub>3</sub>	10
ZCO <sub>3</sub>	5

Using the results shown, arrange the order of the metals in order of increasing reactivity.

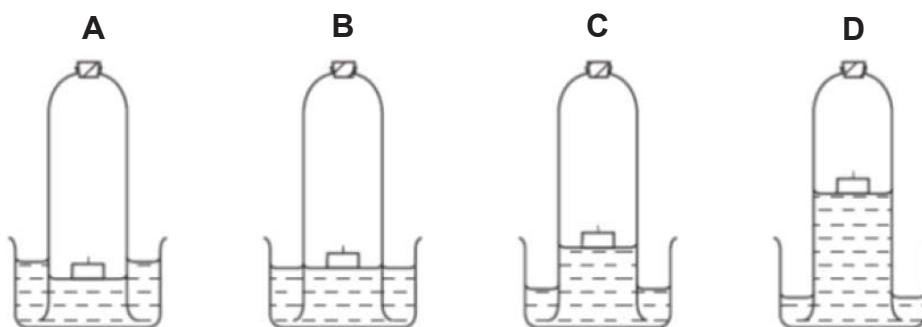
- A W, Z, X, Y                                      B W, X, Z, Y  
C Y, X, Z, W                                      D Y, Z, X, W

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- 38 The diagram shows an experiment to determine the percentage of oxygen in air.



Which diagram shows the correct level of water after the candle stops burning?



- 39 Acid rain contains sulfuric acid and can cause lakes to become acidic. Acidic lakes may be treated with powdered limestone, impure  $\text{CaCO}_3$ , to neutralize the acidity forming calcium sulfate. If large lumps of limestone are used, instead of powder, the reaction starts but soon stops, leaving most of the limestone unreacted.

Which statement explains why the reaction starts but soon stop?

- A Limestone only contains small amounts of calcium carbonate.
- B The acid reacts with calcium sulfate instead of the calcium carbonate.
- C Powdered limestone is more reactive than lumps of limestone.
- D A layer of insoluble calcium sulfate forms on the surface of the lumps.
- 40 Which of the following is not responsible for the destruction of the ozone layer in the stratosphere?
- A CFCs
- B fluorine atoms
- C chlorine atoms
- D UV light

**END OF PAPER 1**

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## The Periodic Table of Elements

Group																	
I	II	1 H hydrogen 1										III	IV	V	VI	VII	0
		Key															
		proton (atomic) number atomic symbol relative atomic mass															
3 Li lithium 7	4 Be beryllium 9																
11 Na sodium 23	12 Mg magnesium 24																
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium -	85 At astatine -	86 Rn radon -
87 Fr francium -	88 Ra radium -	89 – 103 actinoids	104 Rf rutherfordium -	105 Db dubnium -	106 Sg seaborgium -	107 Bh bohrium -	108 Hs hassium -	109 Mt meitnerium -	110 Ds darmstadtium -	111 Rg roentgenium -	112 Cn copernicium -		114 Fl flerovium -		116 Lv livermorium -		

lanthanoids

57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium -	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
89 Ac actinium -	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium -	94 Pu plutonium -	95 Am americium -	96 Cm curium -	97 Bk berkelium -	98 Cf californium -	99 Es einsteinium -	100 Fm fermium -	101 Md mendelevium -	102 No nobelium -	103 Lr lawrencium -

actinoids

The volume of one mole of any gas is  $24 \text{ dm}^3$  at room temperature and pressure (r.t.p.).

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Name: \_\_\_\_\_ Index Number: \_\_\_\_\_ Class: \_\_\_\_\_



TEMASEK SECONDARY SCHOOL  
Mid-Year Examination 2018  
Secondary 4 Express

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## CHEMISTRY

6092/02

Paper 2 (Section A)

Total duration for Sections A and B:  
1 hour 45 minutes

Question and Answer Booklet

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### READ THESE INSTRUCTIONS FIRST

**Do not open the booklet until you are told to do so.**

**Hand in this booklet** at the end of the paper.

Write your name, index number and class in all the work you hand in.  
Write in dark blue or black pen.

Answer all questions in the spaces provided on the question paper.

At the end of the examination, submit **Section A and B separately**.

The number of marks is given in brackets [ ] at the end of each question or part question.

A copy of the Periodic Table is printed on **page 12**.

<b>FOR EXAMINER'S USE</b>	
<b>Section A</b>	<b>/50</b>

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## Section A

Answer all the questions in this section in the spaces provided.  
The total mark for this section is 50.

**A1** The table below shows some information about substances **A** to **F**.

substances	melting point/°C	boiling point/°C	conducts electricity when solid	dissolves in water
<b>A</b>	Turns directly from solid to gas		No	slightly
<b>B</b>	1583	2862	Yes	No
<b>C</b>	1873	2230	No	No
<b>D</b>	-114	78	No	Yes
<b>E</b>	0	100	No	-
<b>F</b>	-97	40	No	No

Using the information provided, suggest the best separation technique to separate the following mixture.

- (a) **A and B** .....
- (b) **C and D** .....
- (c) **D and E** .....
- (d) **E and F** .....

[4]

**A2** This question is about ammonia.

- (a) Describe briefly how you would prepare ammonia using an ammonium salt.

.....  
..... [1]

- (b) Explain why it is not advisable to dry ammonia using concentrated sulfuric acid.

.....  
..... [1]

- (c) Suggest a suitable substance to dry ammonia.

..... [1]

- (d) When dry ammonia is passed over heated sodium, hydrogen and solid sodamide ( $\text{NaNH}_2$ ) are formed.

Suggest why ammonia must be dried before reacting with sodium?

.....  
..... [1]

- (e) Explain how hydrogen can be collected from the gaseous mixture from (d).

.....  
.....  
.....  
..... [2]

- (f) Construct the equation for the reaction between sodium and ammonia. Include state symbols.

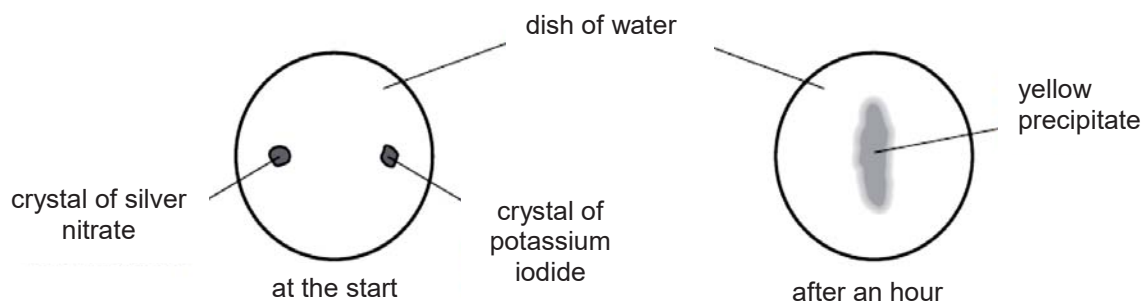
..... [2]

- (g) If  $240 \text{ cm}^3$  of hydrogen were formed at room temperature and pressure, calculate the mass of sodamide obtained.

[2]

- A3** A student placed a crystal of silver nitrate and a crystal of potassium iodide in a dish of water.

After an hour she observed that the crystals had disappeared and a yellow precipitate had appeared near the middle of the dish.

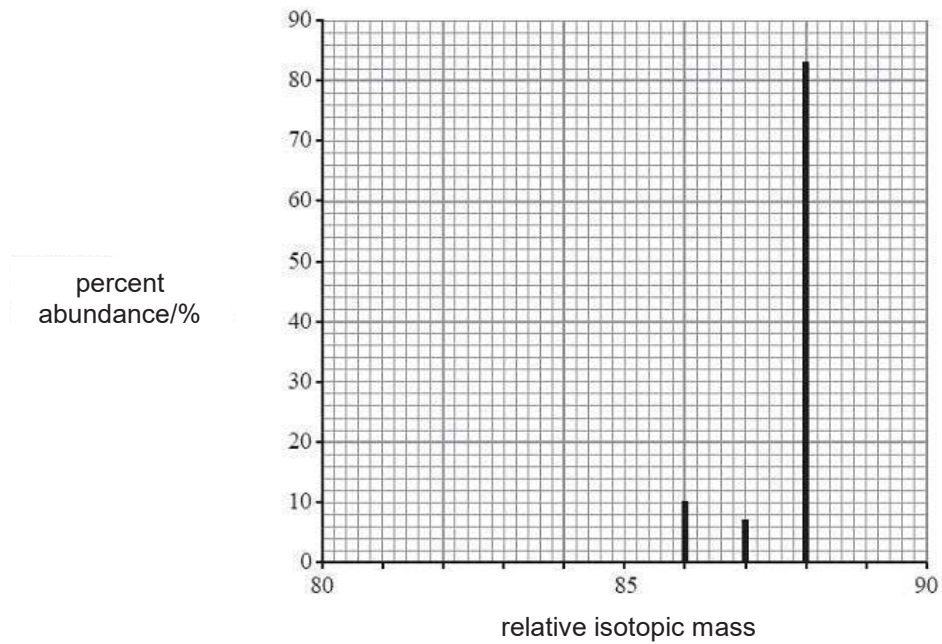


Use your knowledge of the kinetic particle theory and reactions between ions to explain these observations.

[3]

[3]

- A4** The graph below shows the percent abundance (%) and relative masses of three naturally occurring isotopes of element **Z**.



- (a)** Define the term 'isotopes'.

.....  
 ..... [1]

- (b)** Using the graph, calculate the relative atomic mass of element **Z**.

[2]

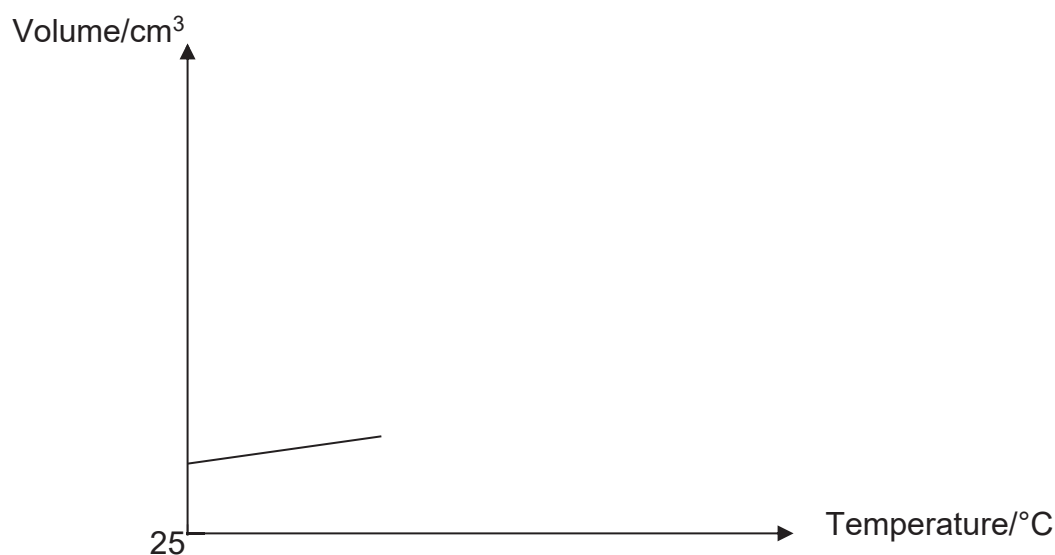
- (c) (i) **Z** has a melting point of  $777^{\circ}\text{C}$  and a boiling point of  $1382^{\circ}\text{C}$ .

A solid sample of **Z** was heated from room temperature to  $1500^{\circ}\text{C}$ . There was a larger increase in volume at the boiling point than at the melting point.

Explain, in terms of arrangement and movement of the particle, why there was a larger increase in volume at the boiling point.

.....  
.....  
..... [2]

- (ii) Complete the graph below to show changes in volume of solid sample **Z** against temperature. Label all temperatures clearly.



[1]

**A5** The labels of eight substances below had fallen off from their containers.

Zn(s)	Na <sub>2</sub> CO <sub>3</sub> (aq)	HCl(aq)	BaCO <sub>3</sub> (s)
CuSO <sub>4</sub> (aq)	NaOH(aq)	H <sub>2</sub> SO <sub>4</sub> (aq)	NH <sub>4</sub> Cl(aq)

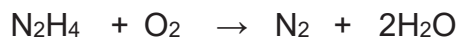
A qualitative analysis was conducted in an attempt to identify the eight substances.

	substance 1	substance 2	substance 3	substance 4
substance 5	Soluble salt formed by titrating substances 1 & 5.	Effervescence seen. Soluble salt formed.	Effervescence seen. Soluble salt formed.	Effervescence seen. Soluble salt formed.
substance 6	Blue precipitate formed.	Green insoluble salt formed.	No visible observation.	Pink solid formed.
substance 7	Soluble salt formed by titrating substances 1 & 7.	Effervescence seen. Soluble salt formed.	Effervescence seen. Insoluble salt formed.	Effervescence seen. Soluble salt formed.
substance 8	Alkaline gas formed.	No visible observation.	No visible observation.	No visible observation.

Identify substances 1 to 8.

Substance 1	.....	[1]
Substance 2	.....	[1]
Substance 3	.....	[1]
Substance 4	.....	[1]
Substance 5	.....	[1]
Substance 6	.....	[1]
Substance 7	.....	[1]
Substance 8	.....	[1]

- A6** Hydrazine,  $\text{N}_2\text{H}_4$ , is commonly used as a liquid rocket fuel. It reacts with oxygen in the equation shown below.



- (a)** Suggest why the combustion of hydrazine has negligible adverse environmental impact.

.....

..... [1]

- (b)** Do the reactants or products have stronger bonds? Explain your answer.

.....

.....

.....

..... [3]

- (c)** Sketch a labeled energy profile diagram for the above reaction.

[2]



(d) 10 g of hydrazine was burnt in 50 dm<sup>3</sup> of air.

(i) Did the hydrazine undergo complete combustion? Show your working.

[3]

(ii) Given that 194 kJ of energy was involved in the burning of 10g of hydrazine, calculate the enthalpy change in kJ/ mol for the reaction of hydrazine with oxygen.

[2]

**A7** The reactivity of some metals can be compared using the data in the table below.

metals	displacement reactions	reaction with water and steam	observations during reaction with steam
mercury	Mercury does not displace any of the metals.	Has no reaction with steam	Silvery metal remains unchanged.
magnesium	$\text{Mg} + \text{Zn}(\text{NO}_3)_2 \rightarrow \text{Mg}(\text{NO}_3)_2 + \text{Zn}$	Reacts slowly with cold water. Burns in steam.	Grey solid turns white.
nickel	$\text{Ni} + \text{Hg}(\text{NO}_3)_2 \rightarrow \text{Ni}(\text{NO}_3)_2 + \text{Hg}$	Has no reaction with water. Reacts slowly with steam.	Silvery solid turns green.
zinc	$\text{Zn} + \text{Ni}(\text{NO}_3)_2 \rightarrow \text{Zn}(\text{NO}_3)_2 + \text{Ni}$	Has no reaction with water. Reacts slowly with steam.	Grey solid turns yellow when hot.

**(a)** Using the data from the table, arrange the metals in increasing order of reducing ability.

..... [1]

**(b) (i)** Solution containing nickel(II) ions are green.

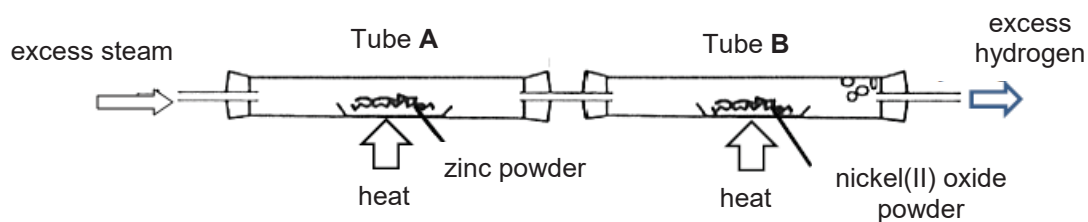
State what you would expect to observe when magnesium is added to nickel(II) nitrate solution.

.....  
..... [2]

**(ii)** Write an ionic equation for the reaction in **(b)(i)**. Include state symbols.

..... [2]

(c) Steam was passed through the apparatus set up below.



(i) Write an equation for the reaction that occurred in Tube A.

..... [1]

(ii) Given that nickel lies between iron and lead in the reactivity series, what would you observe in Tube B?

Explain your answer.

.....  
 .....  
 ..... [2]

**END OF SECTION A**

# The Periodic Table of Elements

Group																	
I	II	1 H hydrogen 1										III	IV	V	VI	VII	0
		Key proton (atomic) number atomic symbol name relative atomic mass															
3 Li lithium 7	4 Be beryllium 9																
11 Na sodium 23	12 Mg magnesium 24	5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20										
		13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40										
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga germanium 73	32 Ge selenium 79	33 As arsenic 75	34 Se tellurium 128	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium -	85 At astatine -	86 Rn radon -
87 Fr francium -	88 Ra radium -	89 – 103 actinoids	104 Rf Rutherfordium -	105 Db dubnium -	106 Sg seaborgium -	107 Bh bohrium -	108 Hs hassium -	109 Mt meitnerium -	110 Ds darmstadtium -	111 Rg roentgenium -	112 Cn copernicium -	114 Fl flerovium -	116 Lv livermorium -	118 Ts tennessine -	119 Nh nihonium -	120 Dl dubnium -	121 Uut ununium -

lanthanoids

57	La	lanthanum	139
58	Ce	cerium	140
59	Pr	praseodymium	141
60	Nd	neodymium	144
61	Pm	promethium	—
62	Sm	samarium	152
63	Eu	euroium	152
64	Gd	gadolinium	157
65	Tb	terbium	159
66	Dy	dysprosium	163
67	Ho	holmium	165
68	Er	erbium	167
69	Tm	thulium	169
70	Yb	ytterbium	173
71	Lu	lutetium	175
72	Hf	hafnium	178
73	Ta	tantalum	181
74	W	tungsten	184
75	Re	rhenium	186
76	Os	osmium	190
77	Ir	iridium	192
78	Pt	platinum	195
79	Au	gold	197
80	Hg	mercury	200
81	Tl	thallium	203
82	Pb	lead	207
83	Bi	bismuth	209
84	Po	polonium	—
85	At	astatine	—
86	Rn	radon	—
87	Fr	francium	—
88	Ra	radium	—
89	Ac	actinium	—
90	Th	thorium	232
91	Pa	protactinium	231
92	U	uranium	238
93	Np	neptunium	—
94	Pu	plutonium	—
95	Am	americium	—
96	Cm	curium	—
97	Bk	berkelium	—
98	Cf	californium	—
99	Es	einsteinium	—
100	Fm	fermium	—
101	Md	mendelevium	—
102	No	nobelium	—
103	Lr	lawrencium	—

actinoids

The volume of one mole of any gas is  $24\text{ dm}^3$  at room temperature and pressure (r.t.p.).

Name: \_\_\_\_\_ Index Number: \_\_\_\_\_ Class: \_\_\_\_\_



TEMASEK SECONDARY SCHOOL  
Mid-Year Examination 2018  
Secondary 4 Express

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**CHEMISTRY**

**6092/02**

**Paper 2 (Section B)**

**Total duration for Sections A and B:  
1 hour 45 minutes**

Question and Answer Booklet

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**READ THESE INSTRUCTIONS FIRST**

**Do not open the booklet until you are told to do so.**

**Hand in this booklet at the end of the paper.**

Write your name, index number and class in all the work you hand in.  
Write in dark blue or black pen.

Answer **three questions** from this section.

Question B10 is in the form of either/or and only one of the alternatives should be attempted.

Write your answers in the spaces provided.

At the end of the examination, submit **Section A and B separately**.

The number of marks is given in brackets [ ] at the end of each question or part question.

A copy of the Periodic Table is printed on **page 12 of Section A**.

<b>FOR EXAMINER'S USE</b>	
<b>Section B</b>	<b>/30</b>

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This document consists of **11** printed pages and **1** blank page.

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## Section B

Answer three questions from this section.

Question B10 is in the form of either/or and only one of the alternatives should be attempted.

Write your answers in the spaces provided.

- B8** The table below shows some physical properties and common oxidation states of the Period 4 metals.

name of element	chemical symbols of element	density (g/cm <sup>3</sup> )	melting point (°C)	common oxidation state(s)
potassium	K	0.9	64	+1
calcium	Ca	1.5	842	+2
scandium	Sc	3.0	1541	+3
titanium	Ti	4.5	1660	+2,+3,+4
vanadium	V	6.1	1917	+2,+3,+4,+5
chromium	Cr	7.9	1857	+2,+3,+4,+5,+6
manganese	Mn	7.2	1244	+2,+3,+4,+5,+6,+7
iron	Fe	7.9	1537	+2,+3,+4,+6
cobalt	Co	8.7	1494	+2,+3,+4
nickel	Ni	8.9	1455	+2,+3,+4
copper	Cu	8.9	1084	+1,+2

- (a) Quoting data from the table above, state two ways the main group metals, potassium and calcium differ in their physical properties from the transition metals, titanium to copper.

.....

.....

.....

.....

.....

..... [2]

- (b) State two differences that can be observed when the metals potassium and iron are added to dilute hydrochloric acid respectively.

.....

.....

.....

.....

..... [2]

- (c) Describe the general pattern for the oxidation states exhibited by the transition metals from titanium to copper.

.....

.....

..... [1]

- (d) Explain why the main group metals, potassium and calcium have only one oxidation state of +1 and +2 respectively.

.....

.....

..... [1]

- (e) Manganese(II) nitrate decomposes upon strong heating to form manganese(IV) oxide and nitrogen dioxide gas.

Explain, with the aid of an equation, whether the decomposition of manganese nitrate is a redox reaction in terms of oxidation state.

.....

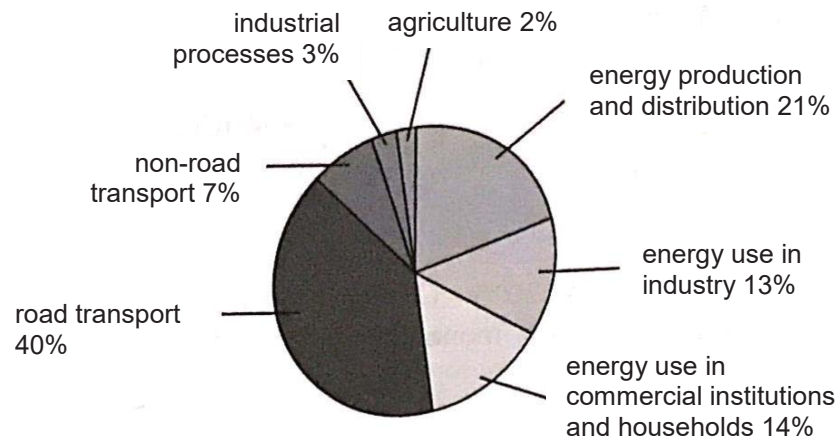
.....

.....

.....

..... [3]

- (f) The pie chart below shows how oxides of nitrogen,  $\text{NO}_x$  production is contributed by the different activities.



- (i) Describe how oxides of nitrogen are formed in car engines.

.....  
 ..... [1]

- (ii) Based on the statistics given in the chart, suggest one way to drastically reduce  $\text{NO}_x$  emissions.

.....  
 .....  
 ..... [1]

- (iii) Describe an impact of  $\text{NO}_x$  emissions on the environment.

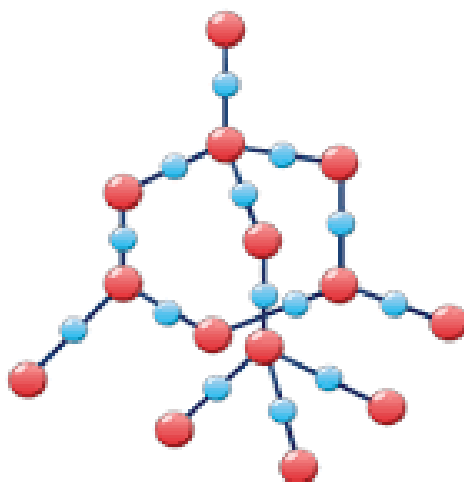
.....  
 ..... [1]

[Total: 12 marks]



- B9** Silicon dioxide, also known as silica, is a chemical compound that is an oxide of silicon. Silica, in the form of sand is used as the main ingredient in sand casting for the manufacture of various metallic components in engineering.

A diagram of a silicon dioxide is shown below.



- (a) State one similarity and one difference between the structure of silicon dioxide and structure of diamond.

.....  
 .....  
 .....  
 ..... [2]

- (b) Both diamond and silicon dioxide are poor electrical conductors.

State the name of another form of carbon which can conduct electricity.

How is this form of carbon different in structure from silicon dioxide which allows it to conduct electricity?

.....  
 .....  
 .....  
 ..... [2]



**B10 Either**

Read the information below about the oxides of elements in Period 3 of the Periodic Table.

**Elements and their oxides**

The table below show the properties of the oxides formed by elements in Period 3.

element	formula of oxide	melting point of oxide/ $^{\circ}\text{C}$	boiling point of oxide/ $^{\circ}\text{C}$
Na	$\text{Na}_2\text{O}$	1132	1950
Mg	$\text{MgO}$	2852	3600
Al	$\text{Al}_2\text{O}_3$	2072	2977
Si	$\text{SiO}_2$	1600	2230
P	$\text{P}_4\text{O}_6$	24	173
	$\text{P}_4\text{O}_{10}$	340	360
S	$\text{SO}_2$	-72	-10
	$\text{SO}_3$	17	45
Cl	$\text{Cl}_2\text{O}$	-121	2
	$\text{Cl}_2\text{O}_7$	-92	82

- (a) Describe the pattern for the ratio of each metallic element to oxygen across period 3. Include ratios in your answer. \_\_\_\_

.....  
 ..... [1]

- (b) Account for the melting and boiling points of the oxides formed by elements in Period 3 in terms of structure and bonding.

.....  
 .....  
 .....  
 .....  
 .....  
 .....  
 .....  
 ..... [3]

- (c) Suggest a reason for the difference in the melting and boiling points between the two oxides of sulfur.

.....  
 .....  
 ..... [2]

- (d) The table below shows the variation of atomic and ionic radius across Period 3.

element	atomic radius/nm	simple ion	ionic radius/nm	number of electron shells in simple ion
Na	0.191	Na <sup>+</sup>	0.102	
Mg	0.160	Mg <sup>2+</sup>	0.072	
Al	0.130	Al <sup>3+</sup>	0.054	
Si	0.118	*	-	-
P	0.110	P <sup>3-</sup>	0.212	
S	0.102	S <sup>2-</sup>	0.184	
Cl	0.099	Cl <sup>-</sup>	0.181	
Ar	0.095	-	-	-

\*Si does not form simple ions and thus the data is omitted from the table

- (i) Complete the table above to show the number of shells of electrons in the ions of period 3 elements. [1]

- (ii) Use the information from the table to explain the difference between the radii of anions and cations in the same period.

.....  
 .....  
 .....  
 ..... [2]

- (iii) Suggest why there is no value stated for the ionic radius of argon.

.....  
 ..... [1]

[Total: 10 marks]

**B10 OR**

Read the information below about the chlorides of elements in Period 3 of the Periodic Table.

**Elements and their chlorides**

The formulae and chemical properties of the chlorides of the elements change across Period 3.

The chlorides behave differently when they are added to water. Some the chlorides dissolve in water to form a solution. Some hydrolyse when they are added to water. This means that they react chemically with water to produce new products.

element	metal / non-metal	formula of main chloride	bonding in chloride	effect of adding chloride to water	products of adding chloride to water
Na	metal	$\text{NaCl}$	ionic	dissolves	$\text{NaCl(aq)}$
Mg	metal	$\text{MgCl}_2$	ionic	dissolves	$\text{MgCl}_2\text{(aq)}$
Al	metal	$\text{AlCl}_3$	covalent	hydrolyses	Complex mixture of products including $\text{HCl(aq)}$
Si	non-metal	$\text{SiCl}_4$	covalent	hydrolyses	$\text{SiO}_2\text{(s)}$ $\text{HCl(aq)}$
P	non-metal	$\text{PCl}_3$	covalent	hydrolyses	$\text{H}_3\text{PO}_3\text{(aq)}$ $\text{HCl(aq)}$
S	non-metal	$\text{S}_2\text{Cl}_2$	covalent	hydrolyses	complex mixture of products including $\text{HCl(aq)}$
Cl	non-metal	$\text{Cl}_2$	covalent	hydrolyses	$\text{HClO(aq)}$ $\text{HCl(aq)}$

The chlorides have a different formulae and the ratio of the element to chlorine changes across Period 3. Some examples are shown in the table below.

formula of chloride	ratio of element to chlorine
$\text{NaCl}$	1:1
$\text{MgCl}_2$	1:2
$\text{AlCl}_3$	1:3

- (a) Describe the pattern for the ratio of each element to chlorine across period 3. Include ratios in your answer.\_\_\_\_\_

.....  
.....  
..... [2]

- (b) (i) Which chloride forms a precipitate when it is added to water?

..... [1]

- (ii) Write a balanced equation for the reaction of phosphorus (III) chloride with water.

..... [1]

- (c) Two students talk about the data.

Student 1: 'I think that whether or not the chloride hydrolyses is linked to the metal or non-metal character of the element.

Student 2: 'I think that whether or not the chloride hydrolyses is linked to the bonding of the chloride.'

Does the information in the table support the ideas of the students?

Explain your reasoning.

.....  
.....  
.....  
.....  
..... [3]

- (d) Another student performs an experiment to test whether some other chlorides dissolve or hydrolyse when they are added to water.

He adds each chloride to water and tests the pH of the mixture.

Explain how the result of a pH test shows whether or not a chloride has hydrolysed.

.....  
.....  
.....  
..... [2]

- (e) Suggest a reason why argon is not included in the table of information about Period 3 chlorides.

.....  
..... [1]

[Total: 10 marks]

**END OF SECTION B**





**Sec 4E Chemistry 6092**  
**Mid Year Examination 2018**  
**Mark Scheme**

**Paper 1**

1	D	11	D	21	B	31	D
2	B	12	D	22	C	32	C
3	A	13	D	23	D	33	C
4	C	14	C	24	A	34	A
5	C	15	C	25	C	35	C
6	C	16	A	26	D	36	A
7	D	17	A	27	A	37	B
8	C	18	A	28	A	38	C
9	D	19	D	29	A	39	D
10	A	20	C	30	C	40	B

**Paper 2 Section A**

- A1** (a) Sublimation [1]  
 (b) Filtration [1]  
 (c) Fractional distillation [1]  
 (d) Using separating funnel [1]
- A2** (a) Heating of ammonium salt with an alkali. [1]  
 (b) Ammonia is an alkaline gas and will react with /be neutralized by concentrated sulfuric acid, forming a salt. [1]  
 (c) Calcium oxide/fused calcium chloride [1]  
 (d) Sodium will react vigorously with water to form sodium hydroxide and hydrogen gas. [1]  
 (e) • Pass the gaseous mixture through water / collect by displacement over water. [1]  
 • As ammonia is very soluble in water, it will be absorbed by the water. Only hydrogen will be collected as it is insoluble in water. [1]  
 (f)  $2\text{NH}_3(\text{g}) + 2\text{Na}(\text{s}) \rightarrow \text{H}_2(\text{g}) + 2\text{NaNH}_2(\text{s})$  [2]  
 [1] for balanced equation  
 [1] for correct state symbols  
 (g) No of moles of hydrogen  
 =  $0.24/24$   
 =  $0.0100$  [1]

$$\begin{array}{l} \text{Mole ratio of } \text{H}_2 : \text{NaNH}_2 \\ 1 : 2 \\ 0.0100 : 0.0200 \end{array}$$

$$\begin{array}{l} \text{Mass of sodamide} \\ = 0.0200 \times (23+14+2) \\ = 0.780 \text{ g [1]} \end{array}$$

[2]

**A3** Crystal of silver nitrate and potassium iodide dissolve in the dish of water [1] and form ions which diffuse from a region of higher concentration at the 2 spots to a region of lower concentration at the middle of the dish [1].  
Silver ions and iodide ions react to form insoluble silver iodide [1] which is yellow in colour

**A4 (a)** Isotopes are atoms of the same element with same number of proton but [1] different number of neutrons.

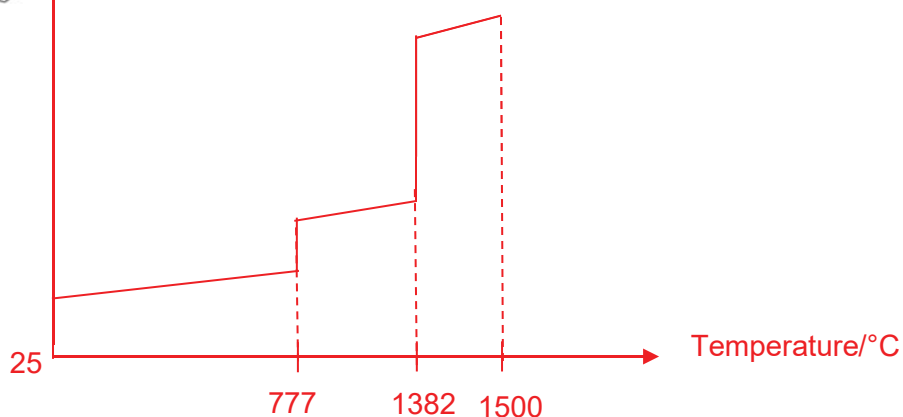
(b)

$$\begin{array}{l} A_r \text{ of Z} = \frac{(10 \times 86) + (7 \times 87) + (83 \times 88)}{100} \quad [1] \\ = 87.7 \text{ (3sf)} \quad [1] \end{array}$$

(c) (i) There was a change in state from liquid to gas.  
 The particles moved faster in all directions / randomly [1]  
 and were spaced further apart / large spaces between particles. [1]

(ii)

Volume/cm<sup>3</sup>



The vertical line at 1382 must be longer than that at 777.  
All the 3 values (777, 1382 and 1500) must be indicated clearly.

<b>A5</b>	Substance 1	NaOH / sodium hydroxide	[1]
	Substance 2	Na <sub>2</sub> CO <sub>3</sub> / sodium carbonate	[1]
	Substance 3	BaCO <sub>3</sub> / barium carbonate	[1]
	Substance 4	Zn / zinc	[1]
	Substance 5	HCl / hydrochloric acid	[1]
	Substance 6	CuSO <sub>4</sub> / copper(II) sulfate	[1]
	Substance 7	H <sub>2</sub> SO <sub>4</sub> / dilute sulfuric acid	[1]
	Substance 8	NH <sub>4</sub> Cl / ammonium chloride	[1]

**A6 (a)** The only products of the combustion are nitrogen and water vapour which are components of clean air. [1]

**(b)** • The products have stronger bonds. [ no marks] [3]

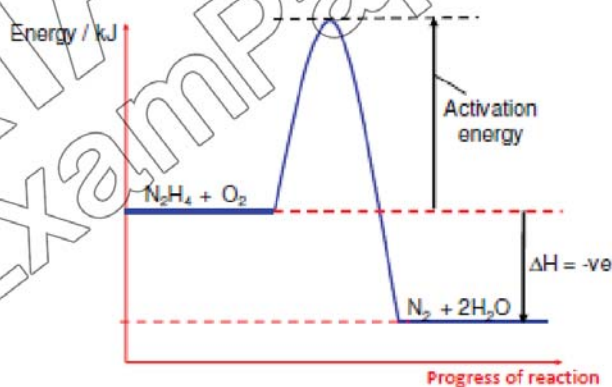
• The total energy absorbed during the breaking of bonds in N<sub>2</sub>H<sub>4</sub> and O<sub>2</sub> is less than the the total energy released during the forming of bonds in N<sub>2</sub> and H<sub>2</sub>O

• as reaction of hydrazine with oxygen is an exothermic reaction. [1]

[1] for idea that energy absorbed during bond breaking is less than energy released released during bond forming

[1] correct relation of substances in bond breaking and bond forming

**(c)** [2]



[1] for correct energy profile

[1] for labeled axes, reactants, products, activation energy &  $\Delta H$

- (d) (i) No of moles of hydrazine  
=  $10 / (14 \times 2 + 4)$   
= 0.313 [1]

Volume of oxygen in air  
=  $21\% \times 50$   
=  $10.5 \text{ dm}^3$

No. of moles of oxygen  
=  $10.5/24$   
= 0.438 [1]

Mole ratio of  $\text{O}_2 : \text{N}_2\text{H}_4$   
1 : 1  
0.438 : 0.438

Since 0.438 moles of  $\text{N}_2\text{H}_4$  is required and only 0.313 moles is available,  $\text{N}_2\text{H}_4$  is the limiting reagent and is completely used up and hence, underwent complete combustion. [1]

[3]

- (ii) 0.313 moles of hydrazine releases 194 kJ of energy  
1 mole of hydrazine releases  $194/0.313$  [1]  
= 621 kJ

Hence,  $\Delta H = -621 \text{ kJ/mol}$  [1]

[2]

A7 (a) Mercury, nickel, zinc, magnesium

[1]

- (b) (i) Solution changes from green to colorless. [1]

[2]

Silvery solid is formed. [1]

- (ii)  $\text{Mg (s)} + \text{Ni}^{2+} (\text{aq}) \rightarrow \text{Mg}^{2+} (\text{aq}) + \text{Ni (s)}$

[2]

[1] for balanced ionic equation

[1] for state symbols

- (c) (i)  $\text{Zn} + \text{H}_2\text{O} \rightarrow \text{ZnO} + \text{H}_2$

[1]

- (ii) Silvery solid is formed. [1]

[2]

Nickel(II) oxide has been reduced to grey solid nickel by hydrogen [1]

## Paper 2 Section B

- B8 (a)** The density of main group metals, potassium and calcium, are lower ( $0.9 \text{ g/cm}^3$  and  $1.5 \text{ g/cm}^3$  respectively) than the transition metals (ranges from  $4.5 \text{ g/cm}^3$  to  $8.9 \text{ g/cm}^3$ ) or vice versa. [1m with quoted data from table]

The melting points of the main group metals, potassium and calcium, ( $64^\circ\text{C}$  and  $842^\circ\text{C}$ ) are lower than that of the transition metals ( $1084^\circ\text{C}$  and above/ranges from  $1084^\circ\text{C}$  to  $1917^\circ\text{C}$ ) [1m with quoted data from table]

- (b)**
- For potassium, the solution remains colourless but for iron, the solution changes from colourless to green.
  - Potassium took a shorter time to disappear than iron.
  - The rate of effervescence for potassium with dilute hydrochloric acid is greater as compared with iron.

Any 2 observations [2m]

- (c)** The oxidation states exhibited by the elements increase from titanium with 3 different oxidation states to manganese with 6 different oxidation states and then decreases from manganese to copper with 2 different oxidation states.

1 mark for correct trend + quoted evidence

- (d)** Potassium and calcium has a fixed number of valence electrons of 1 and 2 respectively and lose their valence electrons

to achieve a stable octet configuration/noble gas configuration [1m].

This explains why they have only one oxidation state at +1 and +2 respectively.

- (e)**  $\text{Mn}(\text{NO}_3)_2 \rightarrow \text{MnO}_2 + 2\text{NO}_2$  [1]

$\text{Mn}(\text{NO}_3)_2$  is oxidised to  $\text{MnO}_2$  as the oxidation state of manganese increases from +2 to +4. [1]

$\text{Mn}(\text{NO}_3)_2$  is reduced to  $\text{NO}_2$  as the oxidation state of nitrogen decreases from +5 to +4. [1]

Since oxidation and reduction occurs simultaneously, this a redox reaction.

(f) (i) Under high temperature, the nitrogen and oxygen in the air of car engine reacts to form oxides of nitrogen.

(ii) The largest contributor of 40% to the production of NO<sub>x</sub> is road transport. Hence we can,

- Fit catalytic converters in the exhaust pipes of cars
- Reduce vehicular activity by encouraging greener transportation activities such as public transport and cycling

Any 1

(iii) NO<sub>x</sub> dissolve in rain water and react with oxygen to form acid rain which leads to:

- weathering of limestone buildings and metal structures.
- causing soil to be acidic and leaches nutrients from soil, resulting in poor plant growth, damaging trees and forests
- water being acidic and destroying aquatic life

Any one impact.

B9 (a) Both has a giant tetrahedral arrangement. OR  
There are strong covalent between atoms in both silicon dioxide and diamond. [1]

Silicon dioxide is made of silicon and oxygen atoms covalently bonded together whereas diamond is made up of only carbon atoms covalently bonded together. [1]

(b) Graphite. [correct but no marks]

Each carbon atom in graphite uses only 3 out of its 4 valence electrons for covalent bonding. There is one delocalized electron form each carbon atom which is free to move to carry electric charges whereas

there are no free electrons in silicon dioxide to carry electric charges. [1]

(c) (i)	silicate	soda-lime glass
	Has regular arrangement of atoms/ arranged in hexagonal rings	Has irregular arrangement of atoms /ions
	Absence of ions	Presence of calcium/ sodium ions
	All the oxygen atoms are each covalently bonded to 2 silicon atoms	Some oxygen atoms are covalently bonded to only one silicon atom



Contains covalent bonds	Contains covalent and ionic bonds
-------------------------	-----------------------------------

Any one difference

- (ii) It is not able to conduct electricity in the solid state but is able to conduct electricity in the molten state. [1] **[Reject aqueous state]**

In the solid state, the calcium and sodium ions are in fixed positions and are not free to move to conduct electricity. [1]

In the molten state, the ions are free to move to conduct electricity. [1]

### B10 Either

- (a) The ratio of each metallic element to oxygen across period 3 decreases from 2:1 to 2:3 from sodium to aluminium.

- (b)  $\text{Na}_2\text{O}$ ,  $\text{MgO}$  and  $\text{Al}_2\text{O}_3$  has a giant ionic lattice structure. Large amount of energy is needed to overcome the strong electrostatic forces of attraction between the oppositely charged ions. [1] Thus they have a high melting and boiling point.

$\text{SiO}_2$  has a giant molecular structure. Large amount of energy is needed to overcome the strong covalent bond between the silicon and oxygen atoms. [1] Thus it has a high melting and boiling point.

Oxides of P, S and Cl have a simple molecular structure. Small amount of energy is needed to overcome the weak intermolecular forces of attraction/weak van der Waals forces between molecules. [1] Thus they have a low melting and boiling point.

if ans does not relates to m.p and b.p minus 1m

- (c)  $\text{SO}_3$  has a higher melting and boiling point compared to  $\text{SO}_2$  because it has a higher relative molecular mass [1]  
Thus the intermolecular forces of attraction is stronger. More energy is needed to overcome it. [1]

- (d) (i) 2;2;2;  
3;3;3

- (ii) The radii of anions are generally larger than that of cations  
+ quoted evidence from table eg average radii of cation vs anions [1]

as anions consist of 1 more electron shells [1] compared to cations.

Thus radii of anions are generally larger.

- (ii) Argon has a stable electronic configuration/stable octet configuration and thus do not gain or lose electrons to form ions/ chemically unreactive/inert [1] and will not affect the radius.

**B10 OR**

- (a) Across period 3, the ratio of each element to chlorine decreased from 1:1 in NaCl to 1:4 in SiCl<sub>4</sub> respectively [1]  
and then increased from 1:3 to 1:1 in PCl<sub>3</sub> to S<sub>2</sub>Cl<sub>2</sub>. [1]

- (b) (i) Silicon tetrachloride or silicon(IV) chloride or SiCl<sub>4</sub>



- (c) The information supports the idea of student 2 but not student 1.

The information supports student's 2 idea as covalent chlorides formed from aluminium to sulfur hydrolyse [1] whereas ionic chlorides like those of sodium and magnesium only dissolve. [1]

The information does not support student 1 as chlorides of both metals like aluminium and non-metals from silicon to sulfur hydrolyse. [1]

- (d) Based on the information in the table, if a chloride has hydrolysed, dilute hydrochloric acid will be produced.

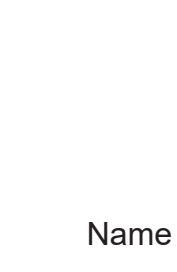
Hence, a pH level lower than 7 will mean that the chloride has hydrolysed. [1]

If the chloride is not hydrolysed, the pH remains at 7. [1]

- (e) Argon has a stable electronic configuration of 8 electrons in the outermost shell/ stable octet configuration.  
Hence, it is chemically unreactive/inert and will not react with chlorine to form a chloride.







Name \_\_\_\_\_

Register No.	Class
	<b>4R1</b>

**BENDEMEER SECONDARY SCHOOL**  
**2018 PRELIMINARY EXAMINATION**  
**SECONDARY 4 EXPRESS**  
**CHEMISTRY PAPER 1**  
**6092/01**

**DATE : 20 August 2018**  
**DURATION : 1 hour**

**READ THESE INSTRUCTIONS FIRST**

Write in 2B pencil.

Do not use paper clips, glue or correction fluid.

Write your name, class and register number on the question paper and OTAS sheet in the spaces provided.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.

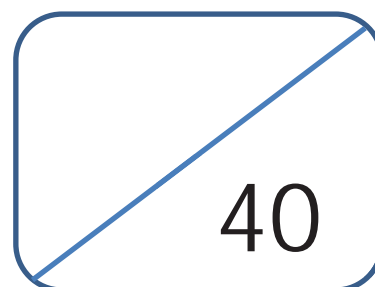
Choose the **one** you consider correct and record your choice in **2B pencil** on the OTAS sheet.

**Read the instructions on the OTAS sheet very carefully.**

Each correct answer will score one mark. A mark will not be deducted for a wrong answer. Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

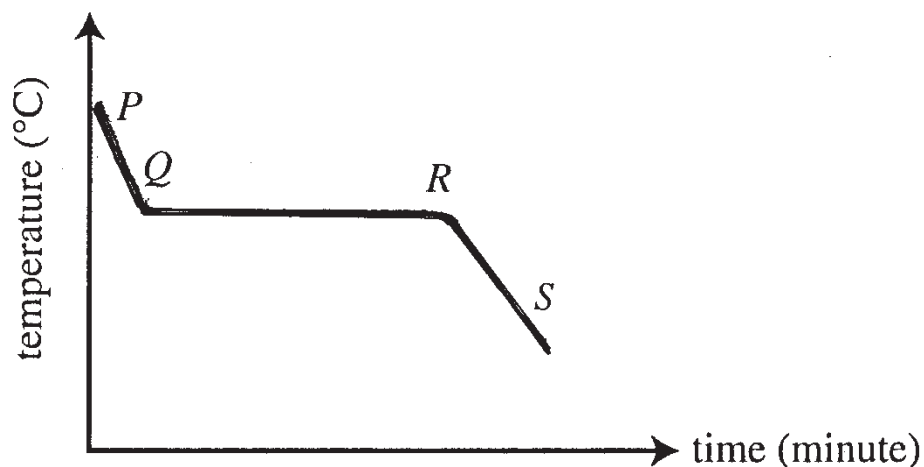
A copy of the Periodic Table can be found on page **18**.



This document consists of **18** printed pages.

**[Turn over**

- 1 A sample of solid X is heated until it is completely melted. The graph shows how its temperature varies with time as molten X is cooled.



Which of the following statements are true about the particles in X?

- I They are closer to each other at stage RS than at stage PQ.
- II The forces of attraction are stronger at stage P than at stage S.
- III The arrangement is more orderly at stage RS than at stage PQ.
- IV Their total energy content at stage QR is lower than at stage RS.

- A I and II are correct
- B I and III are correct
- C II and III are correct
- D II and IV are correct

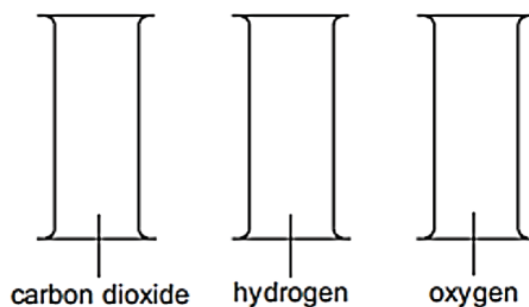
- 2 In a volumetric experiment involving the addition of dilute hydrochloric acid to 25.0 cm<sup>3</sup> of aqueous sodium hydroxide, it is necessary to determine when the reaction has just completed.

Which piece of apparatus could be used to determine the end-point of the reaction?

- A electronic balance
- B gas syringe
- C stop watch
- D thermometer

[Turn over

- 3 The gas jars shown below contain carbon dioxide, hydrogen and oxygen.



Which test could be used to identify the gases in each jar?

- A** a glowing splint  
**B** a lighted splint  
**C** damp blue litmus paper  
**D** limewater
- 4 Which procedure shows the best method to obtain a pure sample of silver nitrate, from a mixture of silver nitrate and silver chloride salts?

	step 1	step 2	step 3	step 4
<b>A</b>	dissolution	filtration	evaporation	crystallisation
<b>B</b>	dissolution	crystallisation	filtration	evaporation
<b>C</b>	dissolution	evaporation	crystallisation	filtration
<b>D</b>	filtration	dissolution	crystallisation	evaporation

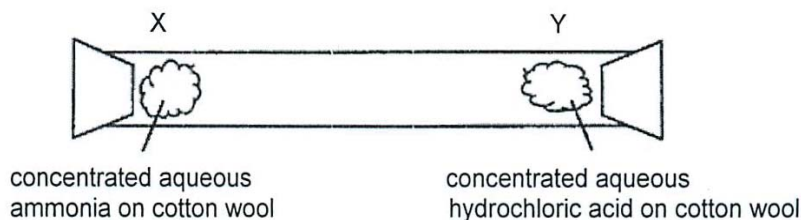
- 5 Argon is used to reduce the evaporation of the metal filament in electric light bulbs. There are three isotopes of argon: argon-36, argon-38 and argon-40.

Which of the following about these three isotopes is correct?

- A** They have different chemical properties.  
**B** They have different rates of diffusion.  
**C** They have different numbers of electrons.  
**D** They have different numbers of protons.

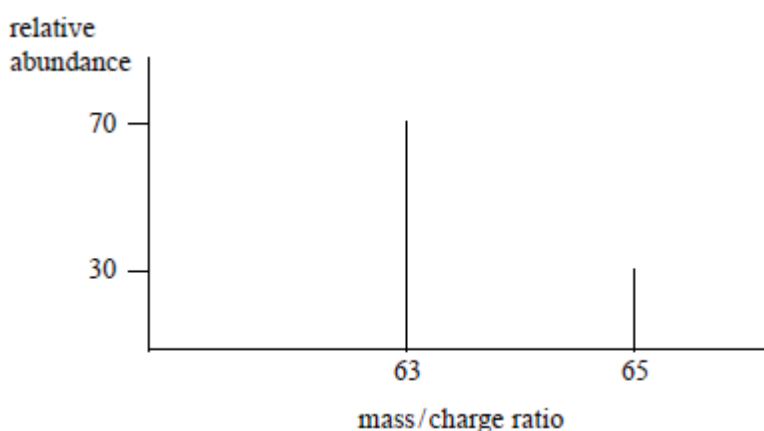
[Turn over

- 6 The apparatus was set up with two cotton wool plugs soaked in concentrated aqueous ammonia and concentrated aqueous hydrochloric acid respectively. These plugs were placed at opposite ends of a long glass tube as shown. After some time, a white solid was formed within the tube. The experiment was then repeated at a higher temperature.



Which was true of the repeated experiment?

- A The white solid was formed even closer to X as compared to the first experiment.  
 B The white solid was formed even closer to Y as compared to the first experiment.  
 C The white solid was formed at a much faster rate as compared to the first experiment.  
 D Yellow solid was formed instead.
- 7 A metal Y was analysed and found to contain only two isotopes, Y-63 and Y-65. The graph below shows the relative abundance of the two isotopes.



What is the relative atomic mass of Y?

- A 63.2                      B 63.4                      C 63.6                      D 64.0

[Turn over

- 8 The table below shows the proton number and nucleon number of elements M and N.

element	proton number	nucleon number
M	13	27
N	8	16

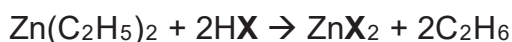
When M and N combine together to form a compound, what will be the mass of one mole of the compound?

- A** 43                      **B** 70                      **C** 102                      **D** 113
- 9 Hexasulfur was prepared by M.R. Engel in 1891 by reacting concentrated hydrochloric acid with thiosulfate,  $\text{HS}_2\text{O}_3^-$ . It is orange-red and forms a rhombohedral crystal. It has a formula of  $\text{S}_6$ .

What can you deduce from the information given above?

- A** Hexasulfur contains only one element.  
**B** Hexasulfur is a compound which contains 6 atoms.  
**C** Hexasulfur is a compound which contains 6 elements.  
**D** Hexasulfur is a mixture which contains 6 elements.
- 10 Since 1850, most books have been printed on acidic paper which eventually becomes brittle and disintegrates. These books can be preserved by treatment with diethylzinc vapour,  $\text{Zn}(\text{C}_2\text{H}_5)_2$ , which reacts with both acid and also with small amounts of water retained in paper.

The reaction below shows the reaction of diethylzinc with an acid.

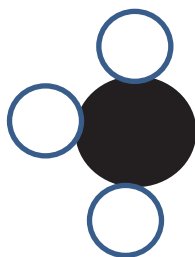


Which products are likely to result from the reaction of diethylzinc with water?



- A**  $\text{ZnH}_2 + \text{C}_2\text{H}_5\text{OH}$   
**B**  $\text{ZnH}_2 + \text{C}_2\text{H}_6$   
**C**  $\text{Zn}(\text{OH})_2 + \text{C}_2\text{H}_5\text{OH}$   
**D**  $\text{Zn}(\text{OH})_2 + \text{C}_2\text{H}_6$

[Turn over

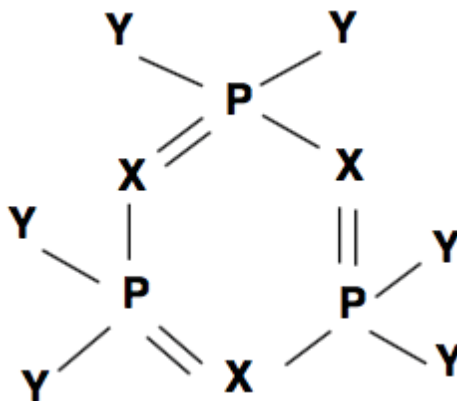
- 11 The following diagram shows the structure of one molecule of a substance.



What are the possible electronic configurations for the elements in the above substance?

		
<b>A</b>	1	2.3
<b>B</b>	2.6	2.5
<b>C</b>	2.7	2.3
<b>D</b>	2.8.7	2.5

- 12 A molecule consists of three types of elements, P, X and Y.



If P is phosphorus, what could X and Y be?

	X	Y
<b>A</b>	Al	H
<b>B</b>	N	Cl
<b>C</b>	O	H
<b>D</b>	Si	Cl

[Turn over

- 13** A student was given four bottles containing different solutions. He mixed pairs of the solutions together and obtained the following results.

solutions	observations
1 and 2	effervescence
2 and 3	white ppt.
2 and 4	no visible reaction
1 and 3	white ppt.
1 and 4	white ppt.

Which of the following correctly identifies each solution?

	solution 1	solution 2	solution 3	solution 4
<b>A</b>	hydrochloric acid	sodium carbonate	barium nitrate	lead(II) nitrate
<b>B</b>	lead(II) nitrate	barium nitrate	sodium carbonate	hydrochloric acid
<b>C</b>	sodium carbonate	hydrochloric acid	lead(II) nitrate	barium nitrate
<b>D</b>	barium nitrate	lead(II) carbonate	hydrochloric acid	sodium carbonate

- 14** Which of the following pairs of solutions will show no visible change when mixed?

- A** barium nitrate and hydrochloric acid
- B** copper(II) sulfate and lead(II) nitrate
- C** magnesium chloride and sodium carbonate
- D** zinc and iron(II) sulfate

- 15** The following results are obtained from an experiment involving the reduction of an oxide of lead to lead metal.

Mass of test tube	= 21.28 g
Mass of test tube + lead oxide	= 27.26 g
Mass of test tube + lead	= 26.46 g

What is the empirical formula of this oxide of lead?

- A** PbO
- B** Pb<sub>2</sub>O<sub>3</sub>
- C** PbO<sub>2</sub>
- D** Pb<sub>3</sub>O<sub>4</sub>

[Turn over



16 Which aqueous acid neutralizes the greatest volume of aqueous sodium hydroxide?

- A 1 dm<sup>3</sup> of H<sub>2</sub>SO<sub>4</sub> of concentration 4 mol/dm<sup>3</sup>
- B 2 dm<sup>3</sup> of H<sub>3</sub>PO<sub>4</sub> of concentration 2 mol/dm<sup>3</sup>
- C 3 dm<sup>3</sup> of HNO<sub>3</sub> of concentration 2 mol/dm<sup>3</sup>
- D 4 dm<sup>3</sup> of CH<sub>3</sub>COOH of concentration 1 mol/dm<sup>3</sup>

17 5 g of barium sulfate is contaminated with barium carbonate. The mixture is added to excess nitric acid and filtered. The mass of the residue and filtrate is found to be 2.8 g and 9 g respectively.

What is the percentage purity of barium sulfate?

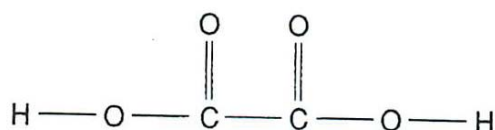
A  $\frac{2.2}{5} \times 100\%$

B  $\frac{2.8}{5} \times 100\%$

C  $\frac{5}{9} \times 100\%$

D  $\frac{9}{5} \times 100\%$

18 The structure of oxalic acid is shown below.



A 25.0 cm<sup>3</sup> solution of oxalic acid reacts completely with 15.0 cm<sup>3</sup> of 2.5 mol/dm<sup>3</sup> sodium hydroxide.

What is the concentration of the oxalic acid solution?

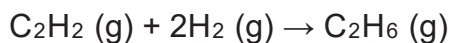
- A 0.667 mol/dm<sup>3</sup>
- B 0.750 mol/dm<sup>3</sup>
- C 1.33 mol/dm<sup>3</sup>
- D 1.50 mol/dm<sup>3</sup>

[Turn over

- 19** Nitrogenous fertilizer such as ammonium nitrate is used to increase crop yield. Which substance can be added to increase pH of the acidic soil without causing a loss of nitrogen?
- A** calcium carbonate
  - B** calcium hydroxide
  - C** magnesium hydroxide
  - D** magnesium sulfate
- 20** Which pair of elements would react together most vigorously?
- A** potassium and bromine
  - B** potassium and iodine
  - C** sodium and chlorine
  - D** sodium and fluorine
- 21** Elements X and Y are in the same Group of the Periodic Table. Which statement must be correct?
- A** Atoms X and Y have similar electronic structure.
  - B** Atoms X and Y have the same physical properties.
  - C** If X has a smaller proton number than Y, it is less metallic.
  - D** The number of electronic shells in atoms X and Y must be the same.
- 22** Which statement about the manufacture of ammonia by the Haber process is correct?
- A** The reactants are both obtained from air.
  - B** The reactants and product are compounds.
  - C** The reactants and product are elements.
  - D** The reactants and product are gases.
- 23** An alloy contains copper and zinc. Some of the zinc has been oxidized to zinc oxide. What is the result of adding an excess of sulfuric acid to the alloy?
- A** A blue solution is formed and a white solid remains.
  - B** A colourless solution is formed and a pink solid remains.
  - C** The alloy dissolves completely to form a blue solution.
  - D** The alloy dissolves completely to form a colourless solution.

[Turn over

- 24 Ethyne ( $\text{H}-\text{C}\equiv\text{C}-\text{H}$ ) undergoes addition of hydrogen to form ethane as shown.



The average bond energies of the bonds in the substances involved are shown in the table below.

bond	C–H	C–C	C=C	C≡C	H–H
bond energy / kJ/mol	413	347	612	839	432

What is the enthalpy change for this reaction?

- A** –296 kJ/mol  
**B** –176 kJ/mol  
**C** +176 kJ/mol  
**D** +296 kJ/mol
- 25 Ammonium chloride dissolves in water according to the equation below.



When 0.2 moles of ammonium chloride dissolves in 50.0 cm<sup>3</sup> of water,

1. the concentration of the solution is 4.0 mol/dm<sup>3</sup>.
2. the energy level of  $\text{NH}_4\text{Cl}$  increases.
3. the heat liberated is 3.0 kJ.
4. the temperature of water falls.

Which of the above statements are correct?

- A** 1, 2 and 3  
**B** 1, 2 and 4  
**C** 1, 3 and 4  
**D** 2, 3 and 4

[Turn over

- 26 The anti-cancer drug, cisplatin, has the formula  $\text{Pt}(\text{NH}_3)_2\text{Cl}_2$ . In the human body, one of the chloride ions of cisplatin is replaced by one water molecule to form an aqua complex.

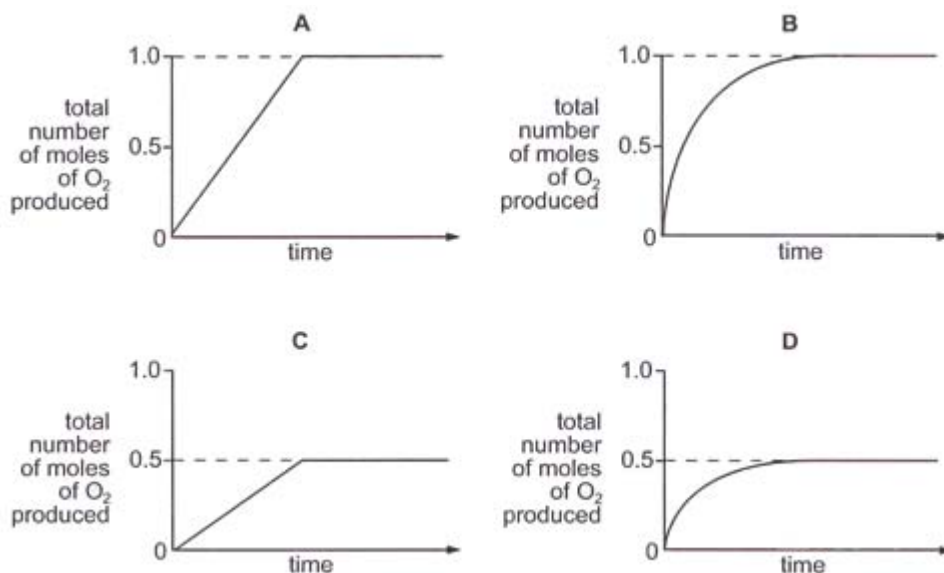


What is the oxidation number of platinum in each of these substances?

	cisplatin	aqua complex
<b>A</b>	+2	+1
<b>B</b>	+2	+2
<b>C</b>	+4	+3
<b>D</b>	+4	+4

- 27 Manganese(IV) oxide catalyses the decomposition of hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) into oxygen and water.

Which curve represents the decomposition of 1.0 mol of hydrogen peroxide?

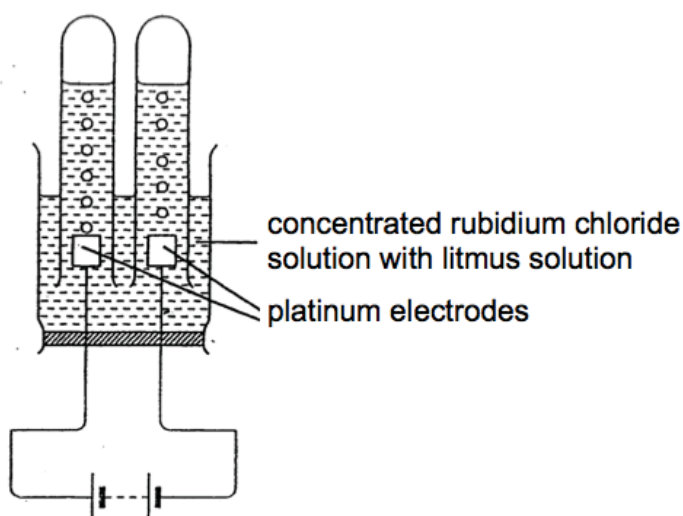


- 28 In which reaction is the underlined substance behaving as an oxidising agent?

- A**  $\underline{\text{BaCl}_2} + \text{Na}_2\text{SO}_4 \rightarrow \text{BaSO}_4 + 2\text{NaCl}$   
**B**  $3\text{CuO} + 2\underline{\text{NH}_3} \rightarrow 3\text{Cu} + \text{N}_2 + 3\text{H}_2\text{O}$   
**C**  $2\underline{\text{FeCl}_2} + \text{Cl}_2 \rightarrow 2\text{FeCl}_3$   
**D**  $2\text{NaI} + \underline{\text{Br}_2} \rightarrow 2\text{NaBr} + \text{I}_2$

[Turn over

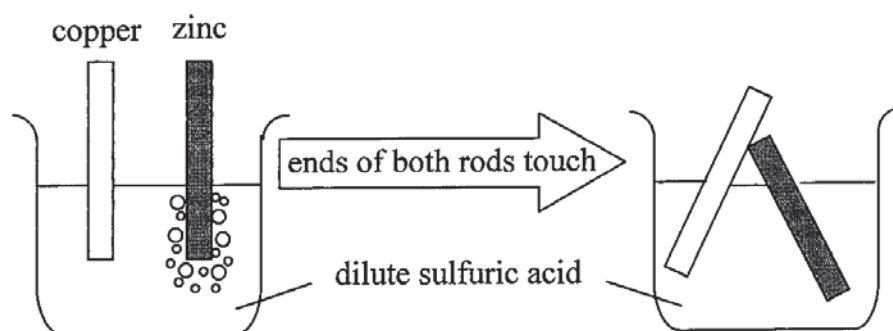
- 29 A few drops of litmus solution were added to concentrated rubidium chloride solution and the resultant solution was electrolysed using platinum electrodes.



Which statement is true?

- A A greenish-yellow gas is formed at the cathode.
  - B The anode decreases in mass.
  - C The pH of the electrolyte decreases.
  - D The solution turns purple around the cathode.
- 30 In an experiment, a copper rod and a zinc rod are placed into a beaker of sulfuric acid as shown below. Bubbles of gas are produced around the zinc rod only.

The experiment is repeated with the ends of both rods touching each other.

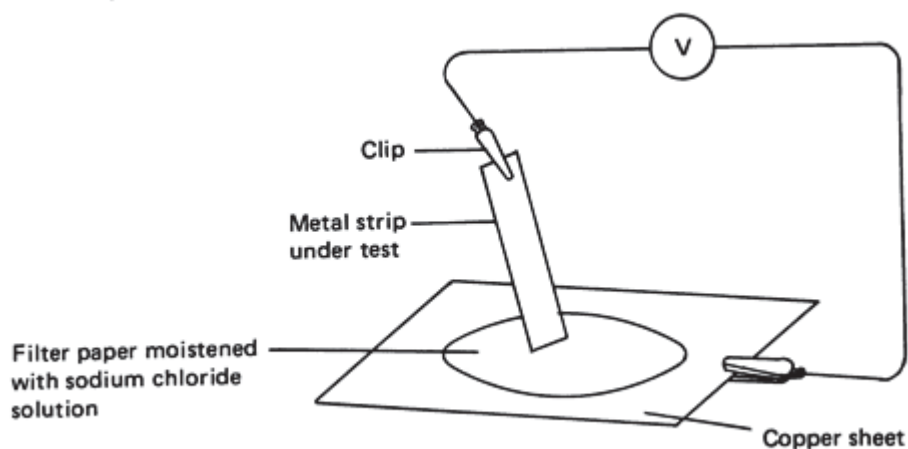


What happens when the ends of both rods touch each other?

- A Bubbles of gas collect around both rods.
- B Bubbles of gas collect around copper rod only.
- C Bubbles of gas collect around zinc rod only.
- D No bubbles of gas collect around both rods.

[Turn over

- 31 The diagram shows the apparatus used to investigate the relative reactivity of four metals. Strips of these metals were connected in turn with the copper sheet and the voltage was recorded in the table below.



Results table:

metal under test	direction of electron flow	voltage recorded (volts)
W	from W to Cu	+ 0.78
X	from Cu to X	- 2.22
Y	from Y to Cu	+ 1.39
Z	from Z to Cu	+ 0.28

What is the order of decreasing reactivity of the four metals?

	most reactive $\longrightarrow$ least reactive			
<b>A</b>	W	Z	X	Y
<b>B</b>	X	Y	W	Z
<b>C</b>	Y	W	Z	X
<b>D</b>	Z	W	Y	X

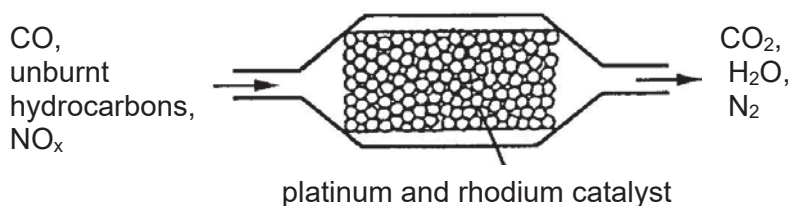
[Turn over

- 32** The table shows the results of adding weighed pieces of zinc metal in salt solutions of metals P, Q and R.

salt solution	initial mass of zinc / g	final mass of zinc after 15 minutes / g
P	6.0	0.0
Q	6.0	6.0
R	6.0	4.5

Which of the following shows the correct arrangement of metals in increasing reactivity?

- A** P, R, zinc, Q  
**B** P, zinc, Q, R  
**C** Q, P, R, zinc  
**D** Q, zinc, R, P
- 33** The diagram below represents a section of a catalytic converter on the exhaust system of a car. Harmful gases are converted into carbon dioxide, nitrogen and water vapour.



Which process(es) take(s) place in this catalytic converter?

- I. Carbon monoxide and unburnt hydrocarbons react together.  
 II. Carbon monoxide and nitrogen oxides react together.  
 III. Platinum and rhodium catalyse redox reactions.

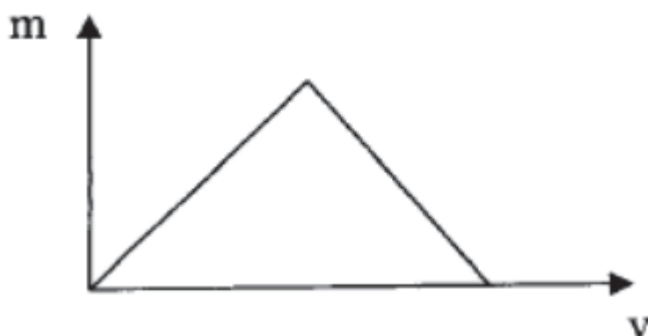
- A** I only  
**B** I and II only  
**C** II and III only  
**D** I, II and III

**[Turn over**

- 34** A salt has the chemical formula  $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$ . Excess aqueous sodium hydroxide was added slowly, with shaking, to a hot solution of the salt in a boiling tube until there were no further reaction. The boiling tube was then left to stand for some time.

Which observation would not be made?

- A** A green precipitate was produced.  
**B** A pungent gas which turned damp red litmus paper blue was produced.  
**C** On standing, the precipitate turned brown.  
**D** The precipitate dissolved in excess aqueous sodium hydroxide.
- 35** In a test for the presence of a cation in an aqueous salt solution, aqueous sodium hydroxide is added slowly until in excess. The diagram shows how the mass ( $m$ ) of the precipitate varies with the volume ( $v$ ) of sodium hydroxide added.



Which could not be the aqueous salt?

- A** aluminium nitrate  
**B** calcium nitrate  
**C** lead(II) nitrate  
**D** zinc nitrate
- 36** 1 mole of a compound X reacts completely with 2 moles of hydrogen gas in the presence of a catalyst to form 1 mole of alkane.

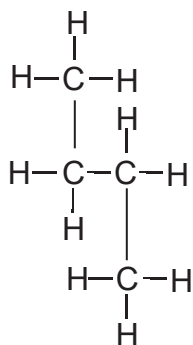
Which compound could X be?

- A**  $\text{CH}_2=\text{CH}-\text{CH}=\text{CH}-\text{CH}=\text{CH}_2$   
**B**  $\text{CH}_2=\text{CH}-\text{CH}_2-\text{CH}_2-\text{CH}=\text{CH}_2$   
**C**  $\text{CH}_2=\text{CH}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_3$   
**D**  $\text{CH}_2=\text{CH}-\text{CH}_2-\text{CH}_2-\text{COH}=\text{CH}_2$

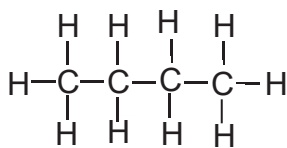
[Turn over



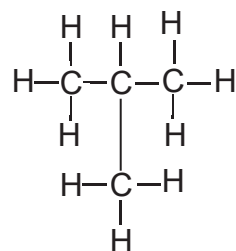
37 Which of these molecules have the same boiling points?



P



Q



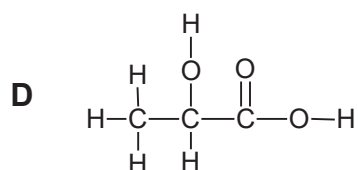
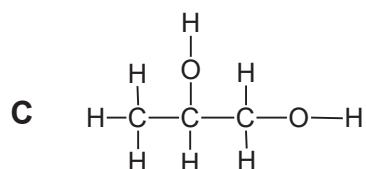
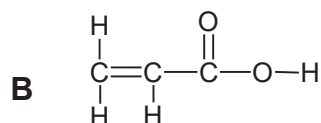
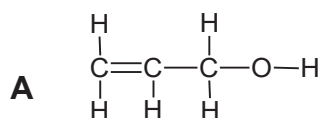
R

- A** P and Q  
**B** P and R  
**C** Q and R  
**D** P, Q and R

38 An organic compound S has the following reactions:

- neutralises sodium hydroxide
- decolourises aqueous bromine

Which structure represents S?

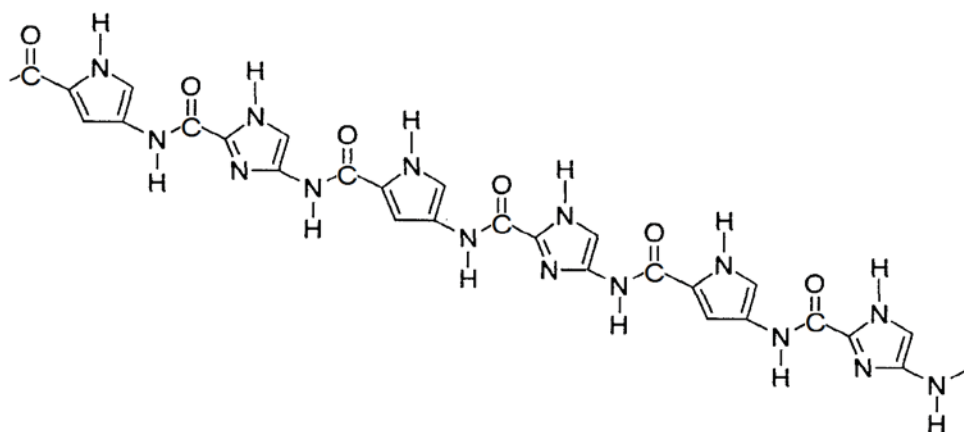


[Turn over

**39** Which statement describes the property of the first fraction obtained from the fractional distillation of crude oil?

- A** It gives the most sooty flame when burnt.
- B** It has the highest boiling point.
- C** It is the most miscible with organic solvent.
- D** It is the most viscous.

**40** The structure below shows part of a polymer.



Which option shows the correct monomers?

	monomer 1	monomer 2
<b>A</b>		
<b>B</b>		
<b>C</b>		
<b>D</b>		

[Turn over

# The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
		<div>1 H hydrogen 1</div>															
		<div>Key</div> <div>proton (atomic) number atomic symbol relative atomic mass</div>															
3 Li lithium 7	4 Be beryllium 9																
11 Na sodium 23	12 Mg magnesium 24	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids		72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium	85 At astatine
87 Fr francium	88 Ra radium	89 – 103 actinoids		104 Rf Rutherfordium	105 Db dubnium	106 Sg seaborgium	107 Bh bohrium	108 Hs hassium	109 Mt meitnerium	110 Ds darmstadtium	111 Rg roentgenium	112 Cn copernicium	114 Fl flerovium	116 Lv livermorium	117 Ts tennessine	118 Og oganesson	119 Nh nihonium

lanthanoids

actinoids

The volume of one mole of any gas is  $24 \text{ dm}^3$  at room temperature and pressure (r.t.p.).



Name \_\_\_\_\_

Register No.	Class
	<b>4R1</b>

**BENDEMEER SECONDARY SCHOOL**  
**2018 PRELIMINARY EXAMINATION**  
**SECONDARY 4 EXPRESS**  
**CHEMISTRY PAPER 2**  
**6092/02**

**DATE : 15 August 2018**  
**DURATION : 1 hour 45 minutes**

**READ THESE INSTRUCTIONS FIRST**

Write your name, class and register number on the work you hand in.  
Write in dark blue or black pen.  
You may use a 2B pencil for any diagrams or graphs.  
Do not use paper clips, glue or correction fluid.

**Section A**

Answer **all** questions.

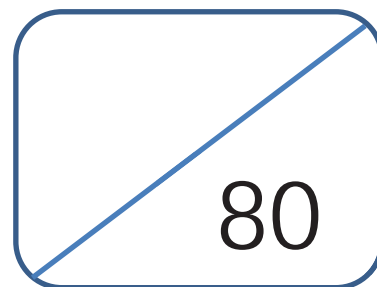
**Section B**

Answer **all** three questions in the spaces provided. The last question is in the form of either/or and only one of the alternatives should be attempted.

Candidates are reminded that **all** quantitative answers should include appropriate units.  
The use of an approved scientific calculator is expected, where appropriate.

At the end of the examination, fasten all your work securely together.  
The number of marks is given in brackets [ ] at the end of each question or part question.

A copy of the Periodic Table can be found on page **22**.



This document consists of **22** printed pages.

**[Turn over**

## Section A

Answer **all** questions in this section in the spaces provided.

The total mark for this section is 50.

**A1** This question refers to the elements shown in the section of the Periodic Table below.

H																He	
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr

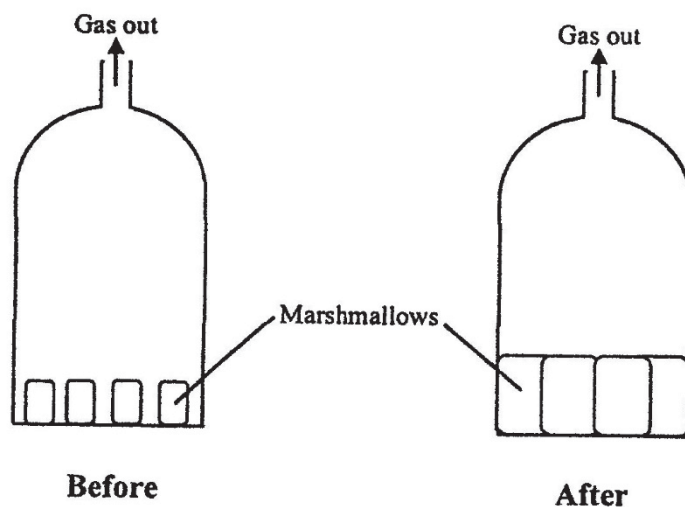
From this list of elements, identify in each case one element that has the property described. Give the symbol of the element.

- (a) An element that sinks in cold water and reacts readily with it.  
..... [1]
- (b) An element that forms an oxide that is a reducing agent.  
..... [1]
- (c) An element in Period 3 that forms the smallest cation.  
..... [1]
- (d) 2 elements that react the most violently together to form a solid.  
..... [1]
- (e) An element that produces a reddish-brown solution with potassium iodide.  
..... [1]

[Total: 5]

**[Turn over**

- A2** A student carried out an experiment where she removed some gas from a gas chamber containing marshmallows.

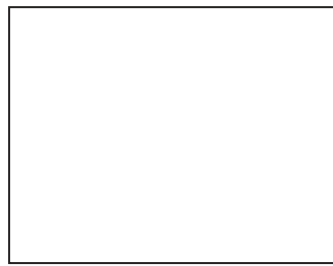


The marshmallows were observed to have increased in size after some gas was removed from the sealed gas chamber.

- (a) In the boxes below, draw the diagram for the gas in the chamber before and after some gas was removed from the chamber.



Before



After

[1]

- (b) Using the kinetic particle theory, provide an explanation for why the marshmallows increased in size.

.....

.....

.....

[2]

[Turn over

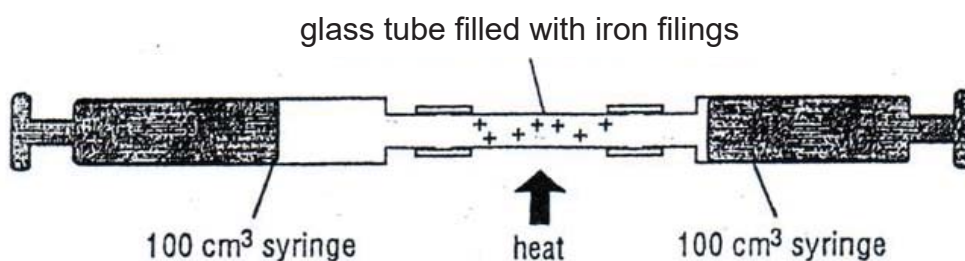
- (c) When heat was applied to the gas chamber before gas was removed, the student theorized immediately that the space between the gas particles will be increased. Do you agree? Explain your answer.

.....

..... [2]

[Total: 5]

- A3 (a)** The percentage of oxygen in air can be determined by using the apparatus shown below. The glass tube was filled with iron filings (in excess) and the total volume of air in the syringes was  $80 \text{ cm}^3$ .



- (i) Calculate the expected total volume of gas left remaining at the end of the experiment.

[1]

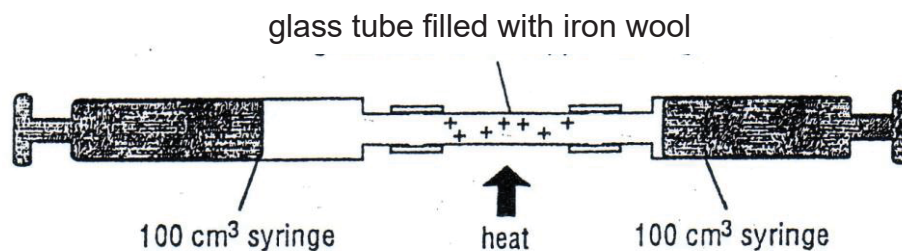
- (ii) A student commented that the glass tube should be fully packed with iron to ensure accurate results. Explain why the results obtained would be less accurate if the glass tube were only partially filled with iron filings.

.....

..... [1]

[Turn over]

- (b) The Haber Process which is used to manufacture ammonia can be demonstrated in the laboratory by the method shown below.



The mixture of nitrogen and hydrogen is passed back and forth over the hot iron wool until there is no further reaction.

- (i) Suggest why it is important to ensure that no air is present in the apparatus shown above.

.....  
 ..... [1]

- (ii) Write a balanced chemical equation for the reaction between nitrogen and hydrogen.

..... [1]

- (c) Aqueous ammonia is formed when ammonia gas is dissolved in water. When aqueous ammonia is added dropwise to a sample of contaminated water, a mixture of white and blue precipitate is formed initially. Upon adding excess aqueous ammonia, a dark blue solution is formed.

- (i) Write the formula(e) of the possible cations present in the water sample.

..... [2]

- (ii) Write the ionic equation with state symbols for the reaction that forms the blue precipitate.

..... [1]

[Total: 7]

[Turn over



- A4** At a children's birthday party, a magician told the children that he can change 'water' to 'milk' and then to a colourless fizzy drink like 7-up.

The magician had three glasses.

He began by holding the glass containing colourless solution **A** which he called 'water'. He then continued:

Step 1: The colourless solution **A** was poured into a seemingly empty glass containing a colourless solution **B** (which appeared to be invisible to the children). The 'water' turned into 'milk' instantly.

Step 2: The 'milk' was poured into another seemingly empty glass containing colourless solution **C** (which appeared to be invisible to the children). The 'milk' turned colourless and fizzing was observed.

The following chemicals were found in the magician's bag:

ammonia solution	calcium carbonate	methyl orange
sodium carbonate	magnesium carbonate	iron(III) chloride
sodium hydroxide	lead(II) nitrate	zinc sulfate
hydrochloric acid	acidified potassium manganate(VII) solution	

- (a) What could be the substances involved in this demonstration?

solution **A**: ..... [1]

solution **B**: ..... [1]

solution **C**: ..... [1]

- (b) What is the chemical name of the 'milk' formed?

..... [1]

- (c) Explain why fizzing was observed in Step 2.

..... [1]

- (d) The magician further demonstrated how he could change 'lemon drink' (yellow solution) to 'rose syrup' (pink solution).

- (i) Which two substances did the magician use to prepare the yellow solution?

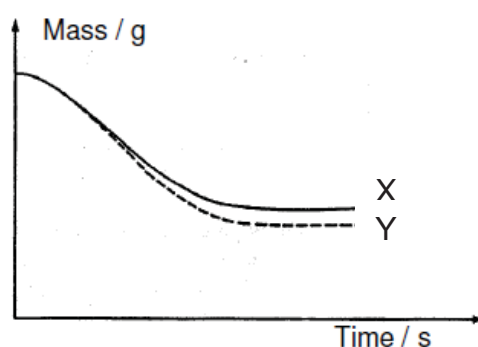
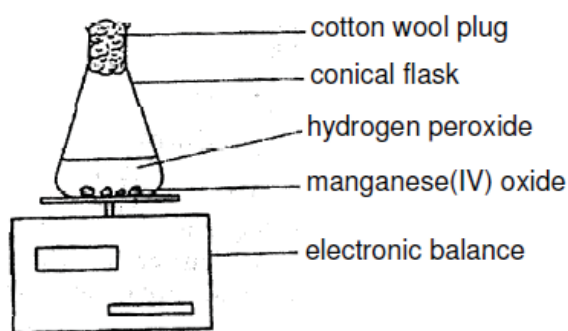
..... [1]

**[Turn over**

- (ii) What is the colourless solution that the magician poured into the yellow solution to get a pink solution?

..... [1]  
[Total: 7]

- A5** The following experiment was carried out to investigate the rate of decomposition of hydrogen peroxide. A catalyst, manganese(IV) oxide, was added to a conical flask containing 50 cm<sup>3</sup> of aqueous solution of hydrogen peroxide. The mass of the flask was measured by an electronic balance as shown. The results were recorded and the graph obtained was labelled X.



- (a) Write the chemical equation for the decomposition of hydrogen peroxide.

..... [1]

- (b) Suggest the use of the cotton wool.

..... [1]

- (c) Curve Y shows the results that is expected to be obtained.  
Explain the difference between the actual curve X and theoretical curve Y.

..... [1]

- (d) State one other way in which the rate of decomposition of aqueous hydrogen peroxide can be increased.

..... [1]

[Turn over

- (e) Describe what you would do to show that manganese(IV) oxide is acting as a catalyst in this decomposition.

.....  
 .....  
 .....  
 .....

[3]

[Total: 7]

- A6** A photographic plate is made up of a plastic base covered with a layer of 0.50 g silver bromide. After a photograph is taken, 35% of the silver bromide is reduced to silver. The image is then fixed by reacting the remaining silver bromide with aqueous sodium thiosulfate as shown in the equation below.



- (a) What is the mass of silver bromide remaining on the plate after a photograph is taken?

mass of silver bromide = .....

[1]

- (b) How many moles of sodium thiosulfate is needed to fix the plate?

moles of sodium thiosulfate = .....

[2]

- (c) A 100 cm<sup>3</sup> sample of 0.200 mol/dm<sup>3</sup> sodium thiosulfate is used in the fixing process. Calculate the number of moles of thiosulfate left after the process.

moles of sodium thiosulfate = .....

[2]

[Turn over]

- (d) Explain using oxidation states, why the silver bromide is said to be reduced to silver.

.....  
 ..... [1]

- (e) Silver bromide is a pale yellow insoluble halide salt. Briefly describe how a pure and dry sample of silver bromide can be prepared starting from silver nitrate.

.....  
 .....  
 .....  
 ..... [2]

[Total: 8]

- A7** On a camping trip, a boy scout can only pack 1 kg of fuel for use. He has to decide which fuel to bring along. The table below shows the energy released by the complete combustion of some compounds used as fuels.

compound	$M_r$	boiling point/ °C	$\Delta H$ in kJ/mol
methane	16	-162	-880
propane	44	-42	-2200
heptane	100	98	-4800

- (a) Explain why the fuels have relatively low boiling point.

.....  
 ..... [1]

- (b) Which fuel produces the most energy when 1 kg of the compound is burnt? Hence, determine the fuel which the boy scout is most likely to bring along.

[2]

[Turn over

- (c) The boy scout finally decided to bring along heptane for his camping trip. Using the data from the table, suggest why his decision differs from your answer in (b).

.....

..... [1]

- (d) Calculate the bond energy of the O=O bond in the combustion of methane given the following bond energies.

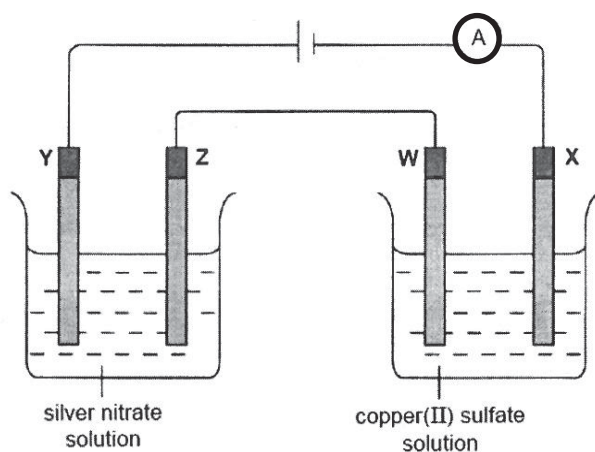
bond	bond energy in kJ/mol
C – H	410
O – H	460
C = O	740

[2]

[Total: 6]

[Turn over

**A8** The diagram below shows the set-up of an electrolysis experiment.



W and X are copper electrodes while Y and Z are silver electrodes.

- (a) Electrodes X and Z will increase in mass after some time.  
Explain why, using half-equations to illustrate your answer.

.....  
 .....  
 ..... [3]

- (b) Electrode Z will increase in mass at a faster rate than electrode X.  
Explain why this is so.

.....  
 .....  
 ..... [2]

[Total: 5]

[Turn over

### Section B

Answer all **three** questions from this section.

The last question is in the form of an either/or and only one of the alternatives should be attempted.

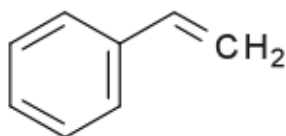
- B9** Styrene, a liquid hydrocarbon that is important chiefly for its marked tendency to undergo polymerisation.

Styrene is employed in the manufacture of polystyrene, an important plastic, as well as a number of specialty plastics and synthetic rubbers.

Pure styrene is a clear, colourless, flammable liquid that boils at 145 °C and freezes at -30.6 °C.

Unless treated with inhibitor chemicals, it has a tendency to polymerise spontaneously during storage. It is slightly toxic to the nervous system if ingested or inhaled, and contact with the skin and eyes can cause irritation. Although it is suspected of being carcinogenic, studies have not proved it to be so.

The chemical formula for styrene is  $C_8H_8$ , but its structural formula,  $C_6H_5CH=CH_2$ , more clearly reveals the sources of its commercially useful properties.



Structural formula of styrene

Styrene is a member of a group of chemical compounds broadly categorised as vinyls—organic compounds whose molecules contain a double bond between two carbon atoms.

Under the action of chemical catalysts or initiators, this link contributes to the formation of polystyrene, in which thousands of styrene units are linked along a carbon backbone. Hanging from this backbone are phenyl groups ( $C_6H_5$ )—large ring-shaped units that interfere with the spontaneous motion of the chainlike polymer and lend polystyrene its well-known rigidity.

The phenyl group is one of the aromatic rings. Styrene, which gives off a penetrating sweetish odour, is therefore one of the aromatic hydrocarbons.

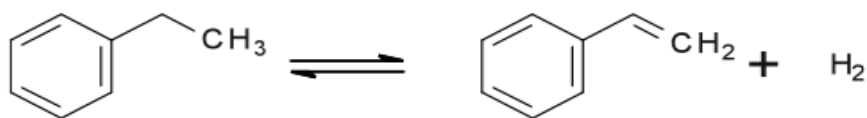
#### Industrial production from ethylbenzene

The modern method for production of styrene by *dehydrogenation* of ethylbenzene was first achieved in the 1930s. The production of styrene increased dramatically during the 1940s, when it was popularised as a feedstock for synthetic rubber.

Because it is produced on such a large scale, ethylbenzene is in turn prepared on a prodigious scale (by alkylation of benzene with ethylene). Ethylbenzene is mixed in the gas phase with 10–15 times its volume in high-temperature steam, and passed over

**[Turn over**

a solid catalyst bed. Most ethylbenzene dehydrogenation catalysts are based on iron(III) oxide, promoted by several percent potassium oxide or potassium carbonate.



Dehydrogenation of ethylbenzene

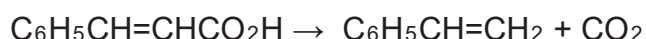
Steam serves several roles in this reaction. It is the source of heat for powering the *endothermic* reaction, and it removes coke that tends to form on the iron(III) oxide catalyst through the water gas shift reaction. The potassium promoter enhances this decoking reaction. The steam also dilutes the reactant and products, shifting the position of chemical equilibrium towards products.

A typical styrene plant consists of two or three reactors in series, which operate under vacuum to enhance the conversion and selectivity. Typical per-pass conversions are 65% for two reactors and 70-75% for three reactors. Selectivity to styrene is 93-97%. The main byproducts are benzene and toluene. Because styrene and ethylbenzene have similar boiling points (145 °C and 136 °C, respectively), their separation requires tall distillation towers and high return/reflux ratios. At its distillation temperatures, styrene tends to polymerise. To minimize this problem, early styrene plants added elemental sulfur to inhibit the polymerisation.

During the 1970s, new free radical inhibitors consisting of nitrated phenol-based retarders were developed. More recently, a number of additives have been developed that exhibit superior inhibition against polymerization. However, the nitrated phenols are still widely used because of their relatively low cost. These reagents are added prior to the distillation.

### Laboratory synthesis

A laboratory synthesis of styrene entails the decarboxylation of *cinnamic acid*.



### Incineration

If polystyrene is properly incinerated at high temperatures (up to 1000 °C) and with plenty of air (14 m<sup>3</sup>/kg), the chemicals generated are water, carbon dioxide, and possibly small amounts of residual halogen-compounds from flame-retardants. If only incomplete incineration is done, there will also be leftover carbon soot and a complex mixture of volatile compounds. According to the American Chemistry Council, when polystyrene is incinerated in modern facilities, the final volume is 1% of the starting volume; most of the polystyrene is converted into carbon dioxide, water vapor, and heat. Because of the amount of heat released, it is sometimes used as a power source for steam or electricity generation.

Adapted from: <https://www.britannica.com/science/styrene>  
<https://en.wikipedia.org/wiki/Styrene>  
<https://en.wikipedia.org/wiki/Polystyrene>

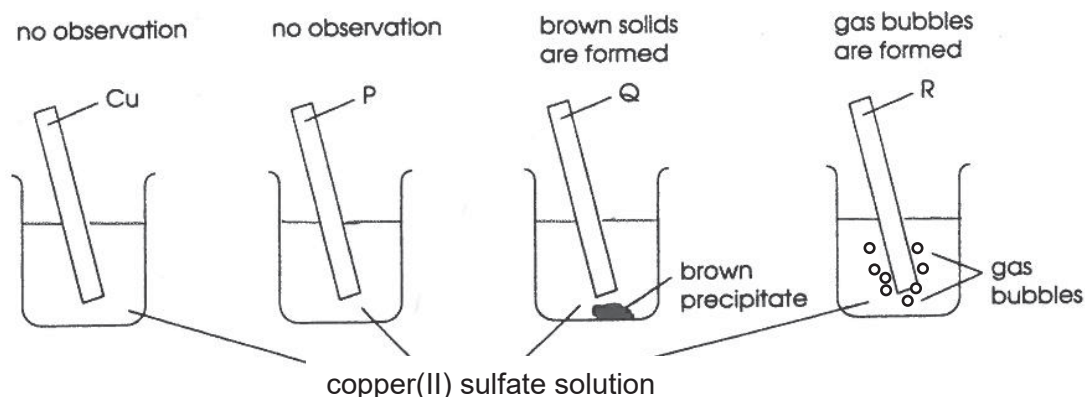
[Turn over



- (a) Draw the 'dot and cross' diagram of styrene, showing only the outermost electrons. [2]
- (b) Explain why styrene has a low melting point of  $-30.6^{\circ}\text{C}$ . [2]
- .....
- .....
- (c) Explain the type of reaction that occurs in the dehydrogenation process. [1]
- .....
- (d) Explain why tall distillation towers are necessary for the separation of styrene and ethylbenzene. [1]
- .....
- .....
- (e) Draw the repeating unit of polystyrene. [1]
- .....
- (f) Write down a balanced chemical equation for the incineration of polystyrene (2 repeat unit) in modern facilities. [1]
- .....
- (g) Describe, with a balanced equation, what would be observed when sodium carbonate is put into cinnamic acid. [2]
- .....
- .....
- [Total: 10]

[Turn over]

- B10** In the following experiment, copper and three other metals, P, Q and R are added separately to copper(II) sulfate solution.



The results for the action of heat on the oxides of copper, P, Q and R are given in the following table:

Metal oxide	CuO	P <sub>2</sub> O	QO	RO
Experiment				
Action of heat on metal oxide	No reaction	Metal P is formed	No reaction	No reaction

- (a) (i) Explain the observations in the reactions of Q and R with copper(II) sulfate solution.

.....  
 .....  
 ..... [2]

- (ii) Write the balanced equations for these reactions.

.....  
 ..... [2]

- (b) Explain why metal P can be formed with direct heating on the oxide of P.

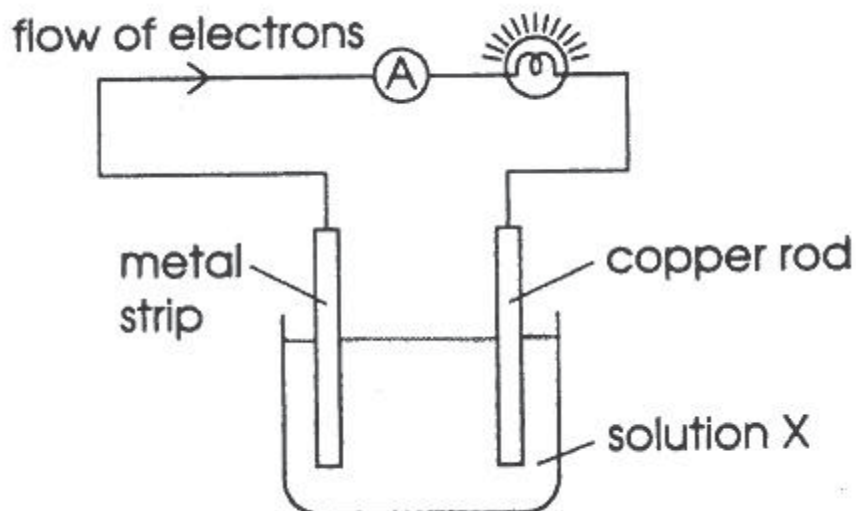
..... [1]

- (c) Arrange the four metals in increasing order of reactivity.

..... [1]

[Turn over

- (d) One of the three metals, P, Q and R, is used to make a chemical cell with a copper rod. The cell is shown in the following diagram:



- (i) Which metal would you choose for the metal strip?  
Give a reason for your choice.

.....  
 ..... [2]

- (ii) If solution X is dilute sulfuric acid, write the ionic equations for the reactions that occur at the two electrodes.

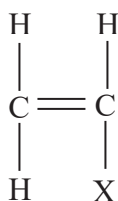
.....  
 ..... [2]

[Total: 10]

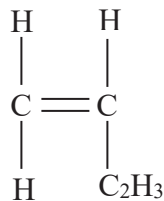
[Turn over

**EITHER**  
**B11 (a)**

Styrene-butadiene rubber is a synthetic rubber. It is made by polymerizing a mixture of the monomers butadiene and styrene.



styrene

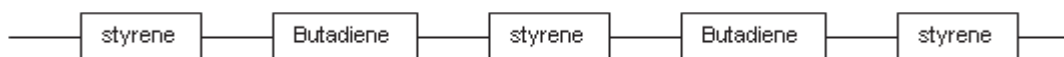


butadiene

- (i) What type of polymerisation will take place when the monomers polymerize?

..... [1]

One possible structure for the polymer is shown below.



- (ii) Give the full structural formula for the repeating unit in this polymer structure.

[1]

- (iii) When the mixture of styrene and butadiene polymerizes, the polymer is unlikely to contain only this regular, repeating pattern. Explain why.

..... [1]  
.....

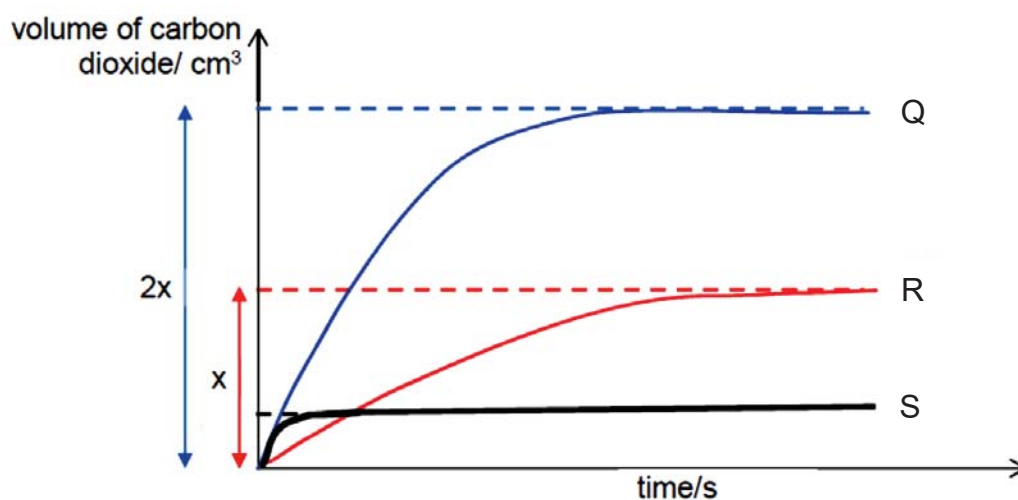
- (iv) Butadiene is obtained from the cracking of butane. 2.90 kg of butane entered the cracking tower. The percentage yield of butadiene is 75%. Calculate the mass of butadiene obtained from the cracking process.

[1]

**[Turn over**

- (b) Three different experiments were carried out using metal carbonates and acids. The table below shows the reactants used in each of the experiment. The graph shows the results of the experiments.

experiment	reactants
Q	150 cm <sup>3</sup> of 2.0 mol/dm <sup>3</sup> H <sub>2</sub> SO <sub>4</sub> (aq) + 26.5g Na <sub>2</sub> CO <sub>3</sub> (s)
R	v cm <sup>3</sup> of 1.0 mol/dm <sup>3</sup> H <sub>2</sub> SO <sub>4</sub> (aq) + excess Na <sub>2</sub> CO <sub>3</sub> (s)
S	150 cm <sup>3</sup> of z mol/dm <sup>3</sup> H <sub>2</sub> SO <sub>4</sub> (aq) + excess CaCO <sub>3</sub> (s)



- (i) Identify the limiting reagent in experiment Q.

[2]

[Turn over]

- (ii) Calculate the volume of carbon dioxide gas produced in experiment R and hence calculate the volume,  $v \text{ cm}^3$ , of sulfuric acid used.

Volume of carbon dioxide = .....

$v = \dots\dots\dots$  [2]

- (iii) From the graph, deduce the concentration of sulfuric acid used in experiment S.

Concentration of sulfuric acid = ..... [1]

- (iv) The mass of the salt formed in experiment S is much lower than expected. Write a balanced chemical equation, including state symbols, to suggest another reaction that can prepare a greater mass of this salt.

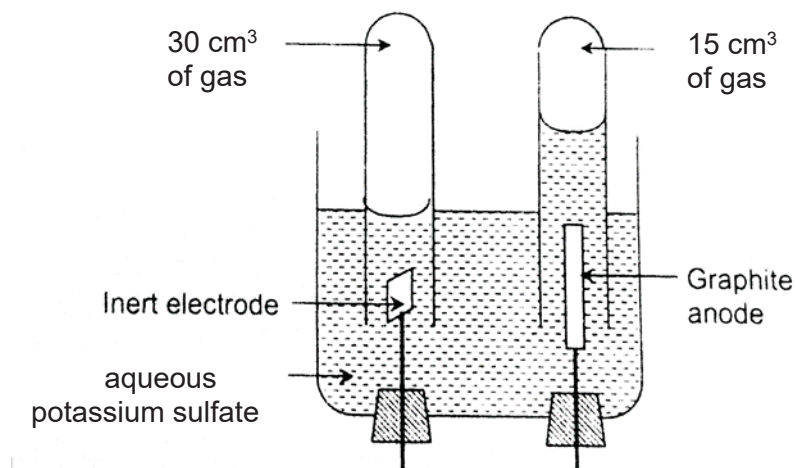
..... [1]  
[Total: 10]

[Turn over

OR

B11 (a)

When graphite anode and a very high current is used in this electrolysis,  $30\text{ cm}^3$  of gas is formed above the cathode and  $15\text{ cm}^3$  of gas is formed above the anode.



- (i) Using a balanced equation, account for the volume of gas collected at both electrodes.

.....  
 .....  
 .....

[2]

- (ii) Explain, with a balanced equation, why the graphite anode has to be replaced periodically.

.....  
 .....  
 .....

[2]

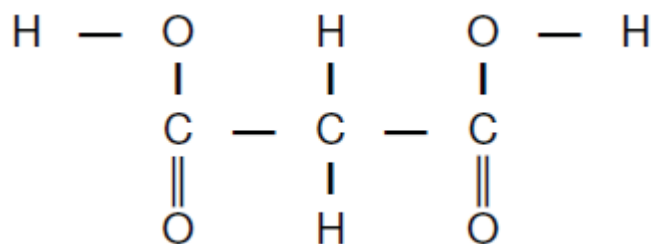
- (b) An organic compound, X, contains carbon, oxygen and hydrogen only. The Percentage by mass of carbon and hydrogen are 47.4% and 10.5% respectively. The relative molecular mass of X is 76.

- (i) Find the empirical formula of X.

[2]

[Turn over]

- (ii) X is a sharp smelling liquid at room temperature. It is soluble in water and can be oxidised to form Y whose structure is shown below.



Under suitable conditions, Y reacts with excess methanol to produce Z.  
State the reagent needed to oxidise X to Y, and the colour change observed.

.....

.....

[2]

- (iii) Draw the full structural formula of X and Z.

[2]

[Total: 10]

**End of Paper**



Group																	
I	II	1 H hydrogen 1					III	IV	V	VI	VII	0					
		<b>Key</b> proton (atomic) number atomic symbol name relative atomic mass															
3 Li lithium 7	4 Be beryllium 9																
11 Na sodium 23	12 Mg magnesium 24																
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium -	85 At astatine -	86 Rn radon -
87 Fr francium -	88 Ra radium -	89 – 103 actinoids	104 Rf Rutherfordium -	105 Db dubnium -	106 Sg seaborgium -	107 Bh bohrium -	108 Hs hassium -	109 Mt meitnerium -	110 Ds darmstadtium -	111 Rg roentgenium -	112 Cn copernicium -	114 Fl flerovium -	116 Lv livermorium -	117 Ts tennessine -	118 Og oganeson -	119 Uue unbinilium -	120 Uuh ununilium -

The volume of one mole of any gas is  $24 \text{ dm}^3$  at room temperature and pressure (r.t.p.).

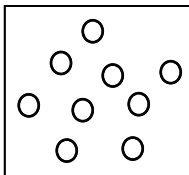
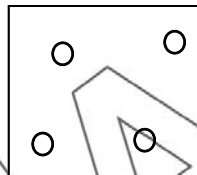


**Chemistry**  
**2018 Preliminary Examination**  
**Answer Scheme**

Qn	Answer
1	B
2	D
3	B
4	A
5	B
6	C
7	C
8	C
9	A
10	D
11	D
12	B
13	C
14	A
15	C
16	B
17	B
18	B
19	A
20	D
21	A
22	D
23	B
24	A
25	B
26	B
27	D
28	D
29	B
30	A
31	C
32	A
33	C
34	D
35	B
36	B
37	A
38	B
39	C
40	A

[Turn over

**Bendemeer Secondary School  
Preliminary Examination 2018  
Chemistry 6092/02  
Answer Scheme**

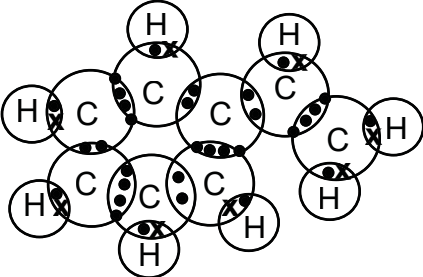
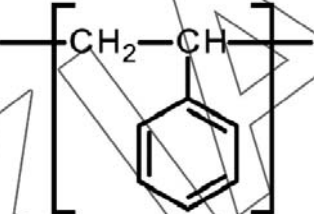
Qn		Answer	Mks	Markers' Report
A1	(a)	Ca	1	For (a), some students either cannot even recall that the only 3 metals that react with water are K, Na and Ca or cannot recall the properties of Group I metals as having low density. For (e), many students wrote Br as the answer. Students failed to realize that after bromine itself is reddish-brown but once it is gone after displacing iodide from KI. They failed to recall the colour of aqueous iodine as reddish-brown.
	(b)	C/ S/ N/ H	1	
	(c)	Na	1	
	(d)	KF	1	
	(e)	Cl/ F	1	
A2	(a)	<div><div></div><div></div></div> <p>Before                      After</p> <p>* Answer to clearly illustrate lesser gas particles (1) AND gas particles are further apart (1) when comparing before and after</p>	1	Badly answered. Basic concepts of the kinetic particle theory is extremely weak.
	(b)	When all the air particles are removed, the <u>vacuum</u> created forces the <u>air particles in the marshmallows to spread further apart</u> . This action <u>pushes</u> against the marshmallows and <u>causes it to swell / increase in size</u> .	1 1	Badly answered. Students went to talk about the increase in pressure in the marshmallows.
	(c)	No, heating the chamber will cause the gas particles to <u>increase in kinetic energy</u> , making them <u>vibrate and move faster</u> OR	2	Almost all students failed to realise that gas particles have already filled up the available spaces in the

		No, the space in the gas chamber is the *same / fixed, so the particles will not move further apart. <i>*only award max. of 1 mark for second answer as students failed to link that an increase a temperature (through heating) lead to an increase in kinetic energy.</i>		container. They managed to note that the gas particles will move faster with greater kinetic energy. Only Joven and Karthik realized that the number of particles is the same and hence the number of particles per unit volume remains the same.
<b>A3</b>	<b>(a)(i)</b>	$80/100 \times 80 = 64 \text{ cm}^3$	1	Some students could not even recall that the percentage of oxygen in air is 20%.
	<b>(ii)</b>	There would be air around the iron fillings if the glass tube is not fully filled. This would result in having more than $80 \text{ cm}^3$ of air present in the gas syringes.	1	Students gave very vague and ambiguous answers such as "iron and oxygen would not fully react"
	<b>(b) (i)</b>	Oxygen in air would react with the iron wool. This would make iron lose its role as the catalyst.	1	None of the students get this question correct. They could not link (a) to (b) that iron is used as a catalyst and if oxidized to iron(III) oxide, would lose its role as a catalyst and would affect the speed of reaction.
	<b>(ii)</b>	$\text{N}_2 (\text{g}) + 3\text{H}_2 (\text{g}) \rightarrow 2\text{NH}_3 (\text{g})$	1	There is still 1 student who wrote the formula of hydrogen gas as H.
	<b>(c) (i)</b>	$\text{Zn}^{2+}, \text{Cu}^{2+}$	2	Generally well answered.
	<b>(ii)</b>	$\text{Cu}^{2+} (\text{aq}) + 2\text{OH}^- (\text{aq}) \rightarrow \text{Cu}(\text{OH})_2 (\text{s})$	1	Weak students could not even recall ionic equation for precipitation.
<b>A4</b>	<b>(a)</b>	A: sodium carbonate B: lead(II) nitrate C: hydrochloric acid	1 1 1	Badly answered. Weak students have no clue at all.
	<b>(b)</b>	Lead(II) carbonate	1	
	<b>(c)</b>	Carbon dioxide produced	1	Students wrote "Gas produced" without specifying the name of gas.
	<b>(d) (i)</b>	Methyl orange and sodium hydroxide/ ammonia solution	1	Some students did not even know the colour change of methyl orange.
	<b>(ii)</b>	Hydrochloric acid (in excess)	1	



A5	(a)	$2\text{H}_2\text{O}_2 (\text{l}) \rightarrow 2\text{H}_2\text{O} (\text{l}) + \text{O}_2 (\text{g})$	1	There are students who do not know the products of the decomposition of hydrogen peroxide. Weak students do not even know the formula of hydrogen peroxide.
	(b)	To prevent acid spray	1	Well-answered.
	(c)	Curve Y shows a slightly lower mass obtained/ greater mass lost. The actual mass lost is smaller due to a small amount of oxygen dissolving in the solution.	1	Many students do not know that oxygen is soluble in water.
	(d)	Heating up hydrogen peroxide solution/ using smaller pieces of manganese(IV) oxide.	1	A small number of very weak students could not even recall the factors that affect the speed of reaction.
	(e)	Weigh a fixed mass of manganese(IV) oxide and add to a solution of hydrogen peroxide. Monitor the mass loss. Once the mass loss reached a constant (the end of reaction), filter and measure the mass of manganese(IV) oxide at the end of the reaction. It would be noted that the mass of manganese(IV) oxide remains the same.	1 1 1	Badly answered. Students did not read the question carefully that it is asking with respect to this decomposition reaction. Hence there is only 1 experiment involved. Many wrote the experiment as conducting 1 without $\text{MnO}_2$ and 1 experiment with $\text{MnO}_2$ .
A6	(a)	$65/100 \times 0.5 = \mathbf{0.325g}$	1	Very well-answered. Only 2 girls could not do this question. The rest of the class obtained full or close to full marks.
	(b)	No. of moles of $\text{AgBr} = 0.325 / (108+80) = 0.001729$ No. of moles of $\text{Na}_2\text{S}_2\text{O}_3 = 2 \times 0.001728 = \mathbf{0.00348}$	1 1	
	(c)	No. of moles of $\text{Na}_2\text{S}_2\text{O}_3$ used = $100/1000 \times 0.2 = 0.02$ No. of moles of $\text{Na}_2\text{S}_2\text{O}_3$ left = $0.02 - 0.00346 = \mathbf{0.0165}$	1 1	
	(d)	Oxidation state of silver decreases from +1 in $\text{AgBr}$ to 0 in $\text{Ag}$ .	1	Well-answered.
	(e)	Add silver nitrate to sodium bromide (any Group I bromide) until no more precipitate forms. Filter to obtain silver bromide as the residue. Wash the residue with a little distilled water and dry it in between 2 pieces of filter papers.	1 1	Many students cannot answer this simple preparation of salts question which is extracted from Sci (Chem). Some could not even differentiate between the filtrate and residue. A small number of students wrote "react silver nitrate with aqueous bromine."

A7	(a) They are covalent compounds with <b>weak intermolecular forces of attraction</b> which require little energy to break.	1	Some students could not even answer this lower sec bonding question.
	(b) No. of moles of methane = $1000/16 = 62.5$ Amount of energy produced by burning 62.5 moles methane = $880 \times 62.5 = 55\,000$ kJ No. of moles of propane = $1000/44 = 22.7$ Amount of energy produced by burning 22.7 moles propane = $2200 \times 22.7 = 49\,940$ kJ No. of moles of heptane = $1000/100 = 10$ Amount of energy produced by burning 10 moles heptane = $4800 \times 10 = 48\,000$ kJ Therefore, <b>methane</b> produces the most energy when burnt. The boy scout is most likely to bring along <b>methane</b> .	1 1	Generally well-answered.
	(c) Heptane is in the liquid state at room temperature. It is easier to be transported than methane which is a gas at room temperature.	1	Generally well-answered.
	(d) $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$ Bond breaking = $4(410) + 2x$ Bond forming = $2(740) + 4(460) = 3320$ kJ $4(410) + 2x - 3320 = -880$ <b><math>x = 400</math> kJ/mol</b>	$\frac{1}{2}$ $\frac{1}{2}$ 1	Many students are still unable to calculate
A8	(a) X: $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}(\text{s})$ Z: $\text{Ag}^+(\text{aq}) + \text{e}^- \rightarrow \text{Ag}(\text{s})$ Copper metal deposited on X and silver metal deposited on Z increases the mass of X and Z.	1 1 1	Generally well- answered
	(b) Silver requires 1 mole of electrons to be discharged whereas copper requires 2 moles of electrons to be discharged. Hence Z will increase at a rate double that of X.	1 1	Generally well-answered. Students who got it wrong mentioned that silver is less reactive than copper hence it will be discharged faster. This concept is wrong.

B9	(a)		2	Dot-and-cross diagram of this compound was shown in class but students failed to register.
	(b)	It is a covalent compound with <b>weak intermolecular forces</b> of attraction which <b>requires little energy to break</b> .	2	Some students could not answer this basic question.
	(c)	Endothermic reaction	1	Badly done. Answer is in the data given.
	(d)	They are miscible liquids with very similar boiling points.	1	Most students were able to identify that styrene and ethylbenzene have similar boiling points but they failed to mention that they are miscible.
	(e)		1	Many students gave the drawing of the polymer rather than the repeating unit.
	(f)	$(C_8H_8)_2 + 20O_2 \rightarrow 8H_2O + 16CO_2$	1	Many students wrote the formula of 2 repeating units as $2C_8H_8$ which is wrong. Some even wrote the formula as $C_{16}H_{16}$ .
	(g)	Effervescence seen. Gas produced forms white precipitate in limewater. $2C_6H_5CH=CHCO_2H + Na_2CO_3 \rightarrow 2C_6H_5CH=CHCO_2Na + CO_2 + H_2O$	1 1	Most students were able to state the observation but few got the equation correct.

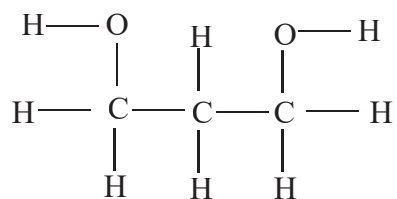


<b>B10</b>	<b>(a)(i)</b>	In the reaction of Q with copper(II) sulfate, displacement reaction takes place. Copper, the reddish-brown solid, is displaced by Q, which is more reactive. In the reaction of R, the metal R is a very reactive metal. It reacts with water in copper(II) sulfate solution to form an alkali and hydrogen gas, which is observed as gas bubbles.	1 1	Most students were able to identify the displacement reaction in Q but were unable to identify the reaction of metal R with water in.
	<b>(ii)</b>	Q: $Q + CuSO_4 \rightarrow Cu + QSO_4$ R: $2R + 2H_2O \rightarrow 2R(OH)_2 + H_2$	1 1	Most students were able to write the equation at Q but not at R.
	<b>(b)</b>	P oxide decomposes upon heating.	1	Some students wrote "metal P is weak and decomposes on heating." This concept is wrong as metal P is an element.
	<b>(c)</b>	P, Cu, Q, R	1	Most students mixed up Q and R
	<b>(d)(i)</b>	Q. Q, being more reactive than Cu, will allow the flow of electrons from Q to Cu.	1 1	Generally well-answered
	<b>(ii)</b>	Q: $Q(s) \rightarrow Q^{2+}(aq) + 2e^-$ Cu: $2H^+(aq) + 2e^- \rightarrow H_2(g)$	1 1	Some students missed out the state symbols and were not given credit.
<b>B11</b>	<b>(a)(i)</b>	Addition Polymerisation	1	Not many students attempted this question. Some students wrote "polymerization" as the answer.

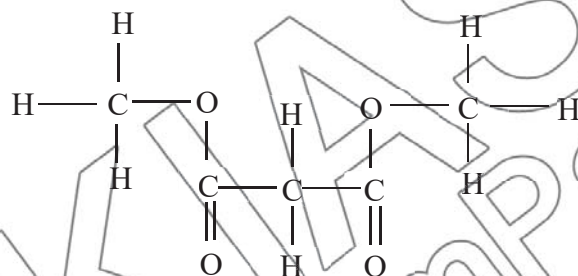
Either	(ii)		1	Many students drew the structure of the polymer instead of the repeating unit.
	(iii)	Poly(styrene) and Poly(butadiene) will be formed as well.	1	Many students gave vague answers like “styrene and butadiene will also combine with itself.”
	(iv)	$0.75 \times 2.9 = 2.175 \text{ kg} = 2.18 \text{ kg}$	1	Some students were unable to calculate this straight forward question.
	(b)(i)	$\text{H}_2\text{SO}_4 + \text{Na}_2\text{CO}_3 \rightarrow \text{Na}_2\text{SO}_4 + \text{CO}_2 + \text{H}_2\text{O}$ No. of moles of $\text{H}_2\text{SO}_4 = 150/1000 \times 2 = 0.3$ No. of moles of $\text{Na}_2\text{CO}_3 = 26.5 / 2(23)+12+3(16) = 0.25$ Limiting reagent = sodium carbonate	$\frac{1}{2}$ $\frac{1}{2}$ 1	Generally well-answered
	(ii)	No. of moles of carbon dioxide used in experiment Q = 0.25 Volume of carbon dioxide used in experiment Q $= 0.25 \times 24 = 6 \text{ dm}^3$ Volume of carbon dioxide produced in experiment R $= 6/2 = 3 \text{ dm}^3$ No. of moles of sulfuric acid in experiment R = 0.25. Volume of sulfuric acid, $v = 0.25/1.0 = 0.25 \text{ dm}^3 = 250 \text{ cm}^3$	$\frac{1}{2}$ $\frac{1}{2}$ 1	Many students were able to calculate the volume of carbon dioxide produced but were unable to calculate the volume of sulfuric acid.
	(iii)	$2.0 \text{ mol/dm}^3$	1	
	(iv)	$\text{Ca}(\text{NO}_3)_2 (\text{aq}) + \text{Na}_2\text{SO}_4 (\text{aq}) \rightarrow \text{CaSO}_4 (\text{s}) + 2\text{NaNO}_3 (\text{aq})$	1	

B11	(a)(i)	$4\text{OH}^- (\text{aq}) + 4\text{H}^+ (\text{aq}) \rightarrow 2\text{H}_2\text{O} (\text{l}) + \text{O}_2 (\text{g}) + 2\text{H}_2 (\text{g})$ From the equation, the ratio of oxygen to hydrogen is 1 : 2. Hence the volume of hydrogen formed at the cathode is double the volume of oxygen formed at the anode.	1 1	Many students only gave half equations instead of the overall equation.																								
OR	(ii)	Under the high temperature, oxygen produced burns the graphite anode off. $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$	1 1	Students who answered this wrote “carbon <u>reacts</u> with oxygen.” There was no mention of the heat involved. These students were given BOD.																								
	(b)(i)	<table border="1"><thead><tr><th></th><th>C</th><th>O</th><th>H</th></tr></thead><tbody><tr><td>% by mass</td><td>47.4</td><td>42.1</td><td>10.5</td></tr><tr><td>Ar</td><td>12</td><td>16</td><td>1</td></tr><tr><td>No. of moles</td><td><math>47.4/12 = 3.95</math></td><td><math>42.1/16 = 2.63</math></td><td><math>10.5/1 = 10.5</math></td></tr><tr><td>÷ by smallest no.</td><td><math>3.95/2.63 = 1.5</math></td><td><math>2.63/2.63 = 1</math></td><td><math>10.5/2.63 = 4</math></td></tr><tr><td>ratio</td><td><math>1.5 \times 2 = 3</math></td><td><math>1 \times 2 = 2</math></td><td><math>4 \times 2 = 8</math></td></tr></tbody></table> Empirical Formula = <b>C<sub>3</sub>O<sub>2</sub>H<sub>8</sub></b>		C	O	H	% by mass	47.4	42.1	10.5	Ar	12	16	1	No. of moles	$47.4/12 = 3.95$	$42.1/16 = 2.63$	$10.5/1 = 10.5$	÷ by smallest no.	$3.95/2.63 = 1.5$	$2.63/2.63 = 1$	$10.5/2.63 = 4$	ratio	$1.5 \times 2 = 3$	$1 \times 2 = 2$	$4 \times 2 = 8$	1       1	Many students have forgotten how to calculate empirical formula.
	C	O	H																									
% by mass	47.4	42.1	10.5																									
Ar	12	16	1																									
No. of moles	$47.4/12 = 3.95$	$42.1/16 = 2.63$	$10.5/1 = 10.5$																									
÷ by smallest no.	$3.95/2.63 = 1.5$	$2.63/2.63 = 1$	$10.5/2.63 = 4$																									
ratio	$1.5 \times 2 = 3$	$1 \times 2 = 2$	$4 \times 2 = 8$																									
	(ii)	Add acidified potassium dichromate (VI). Colour change from orange to green. Add acidified potassium manganate (VII) Colour change from purple to colourless	1 1	Well-answered.																								

(iii)



**X**



**Z**

1

1

Many students were able to draw the structure of X but not Z.





**Bukit Batok Secondary School**  
**PRELIMINARY EXAMINATION 2018**  
**SEC 4 EXPRESS**

**CHEMISTRY**

Paper 1 Multiple Choice

**6092/01**  
**24 August 2018**  
**0745 - 0845**  
**1 hour**

Additional Materials: Multiple Choice Answer Sheet

**READ THESE INSTRUCTIONS FIRST**

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, index number and class on the Answer Sheet in the spaces provided.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

**Read the instructions on the Answer Sheet very carefully.**

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

A copy of the Periodic Table is printed at the end of the question paper.

The use of an approved scientific calculator is expected, where appropriate.

---

This document consists of 15 printed pages.

- 1 The reaction scheme shows how hydrated copper(II) sulfate,  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ , changes when heated.



A little water was accidentally spilled into a dish containing hydrated copper(II) sulfate. What could be done to remove the water, leaving pure, dry  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ ?

- A** Heat the dish over a boiling water-bath.  
**B** Heat the dish to a constant mass.  
**C** Heat the dish with a Bunsen burner.  
**D** Let the dish stand in direct sunlight.
- 2 Aluminium sulfate is sometimes used in water treatment to remove impurities. Aqueous aluminium sulfate is acidic. The table shows the results of tests on four different samples of treated water.  
 To which sample had an excess of aluminium sulfate been added?

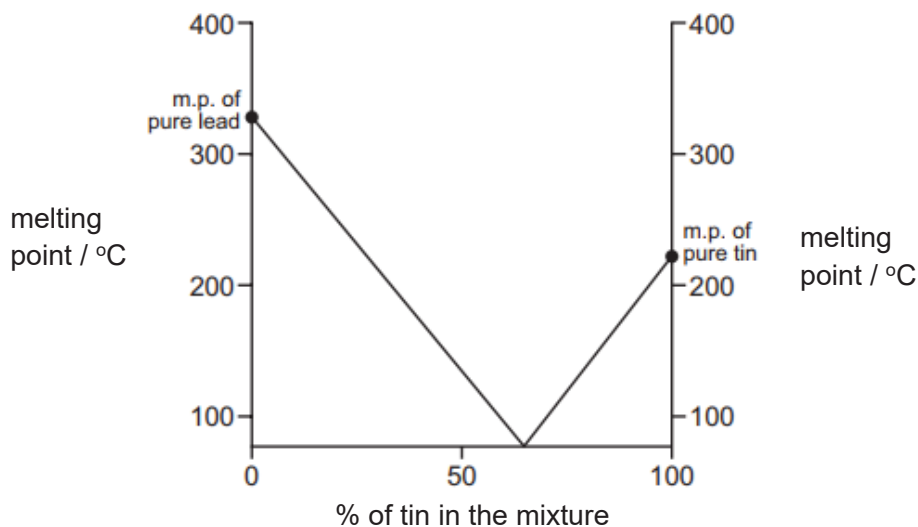
sample	pH of sample	reaction with an excess of aqueous ammonia
<b>A</b>	3	white precipitate
<b>B</b>	3	no reaction
<b>C</b>	7	no reaction
<b>D</b>	11	white precipitate

- 3 An acid, X, was added to a solution of the nitrate of a metal, Y. A dense white precipitate was formed.  
 What are X and Y?

	acid X	metal Y
<b>A</b>	hydrochloric	calcium
<b>B</b>	nitric	zinc
<b>C</b>	sulfuric	aluminium
<b>D</b>	sulfuric	barium

- 4 A student tested a solution by adding aqueous sodium hydroxide. A precipitate was not seen because the reagent was added too quickly.  
 What could **not** have been present in the solution?
- A**  $\text{Al}^{3+}$                       **B**  $\text{Ca}^{2+}$                       **C**  $\text{NH}_4^+$                       **D**  $\text{Zn}^{2+}$

- 5 The graph gives the melting points (m.p.) of mixtures of lead and tin.



The graph shows that any mixture of lead and tin must have a melting point that is

- A above that of tin.  
 B below that of lead.  
 C below that of both tin and lead.  
 D between that of tin and lead.
- 6 The isotopes of carbon and oxygen are given in the table.

Isotopes of carbon	$^{12}\text{C}$	$^{13}\text{C}$	$^{14}\text{C}$
Isotopes of oxygen	$^{16}\text{O}$	$^{17}\text{O}$	$^{18}\text{O}$

A molecule of carbon dioxide with molecular mass 46 could contain

- A one  $^{12}\text{C}$  atom and two  $^{16}\text{O}$  atoms.  
 B one  $^{14}\text{C}$  atom and two  $^{18}\text{O}$  atoms.  
 C one  $^{12}\text{C}$  atom, one  $^{16}\text{O}$  atom and one  $^{18}\text{O}$  atom.  
 D one  $^{14}\text{C}$  atom, one  $^{16}\text{O}$  atom and one  $^{18}\text{O}$  atom.
- 7 Particles with the same electron arrangement are said to be isoelectronic. Which of the following compounds contains ions which are isoelectronic?
- A  $\text{CaCl}_2$   
 B  $\text{KBr}$   
 C  $\text{MgCl}_2$   
 D  $\text{Na}_2\text{S}$

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3



- 8 The table shows information about particles X and Y.

	number of protons	number of neutrons	electronic structure
X	9	10	2, 8
Y	17	20	2, 8, 8

Which statement is correct for both X and Y?

- A They are atoms of metals.  
 B They are atoms of noble gases.  
 C They are isotopes of the same element.  
 D They are negative ions.
- 9 The table shows some properties of four substances.  
 Which substance is an ionic compound?

	melting point /°C	conducts electricity when solid	dissolves in water	conducts electricity in aqueous solution
A	-102	no	yes	yes
B	801	no	yes	yes
C	842	yes	yes	yes
D	3000	yes	no	no

- 10 The shapes and names of some molecules are shown below.

tetrahedral	pyramidal	bent	linear

Phosphine is a compound of phosphorus, an element in Group V, and hydrogen. The shape of a molecule of phosphine is likely to be

- A bent.  
 B linear.  
 C pyramidal.  
 D tetrahedral.

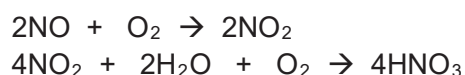
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4

- 11 Which sulfide contains the greatest mass of sulfur in a 10 g sample?

sulfide	formula	mass of one mole /g
<b>A</b>	NiS	91
<b>B</b>	FeS <sub>2</sub>	120
<b>C</b>	MoS <sub>2</sub>	160
<b>D</b>	PbS	239

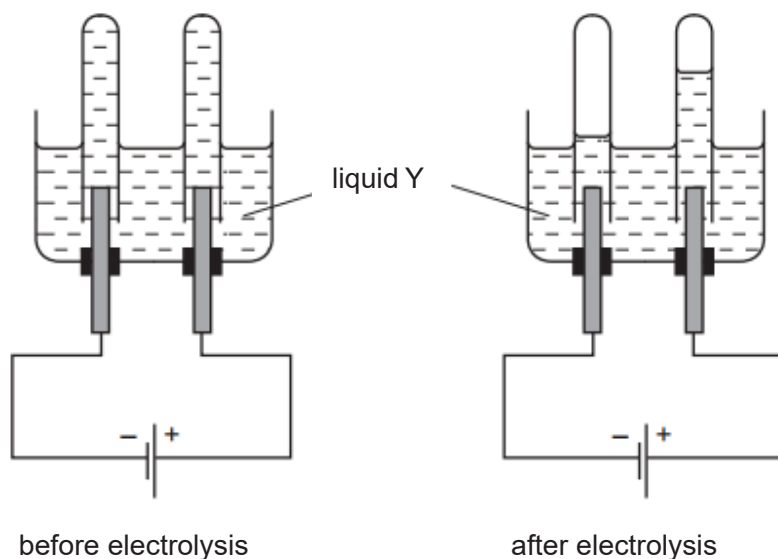
- 12 Two of the reactions used in the manufacture of nitric acid, HNO<sub>3</sub>, are shown.



What is the maximum number of moles of nitric acid which could be formed from one mole of nitrogen monoxide, NO?

- A** 0.5                      **B** 1.0                      **C** 2.0                      **D** 4.0
- 13 A piece of chalk has a mass of 23.0 g. Chalk is impure calcium carbonate. When analysed, the chalk is found to contain 0.226 moles of calcium carbonate. What is the percentage purity of the piece of chalk?
- A** 0.983%              **B** 1.02%              **C** 77.0%              **D** 98.3%
- 14 Which element requires the smallest number of electrons for one mole of atoms to be liberated during electrolysis?
- A** aluminium  
**B** calcium  
**C** copper  
**D** sodium

- 15 The diagrams show an electrolysis experiment using inert electrodes.

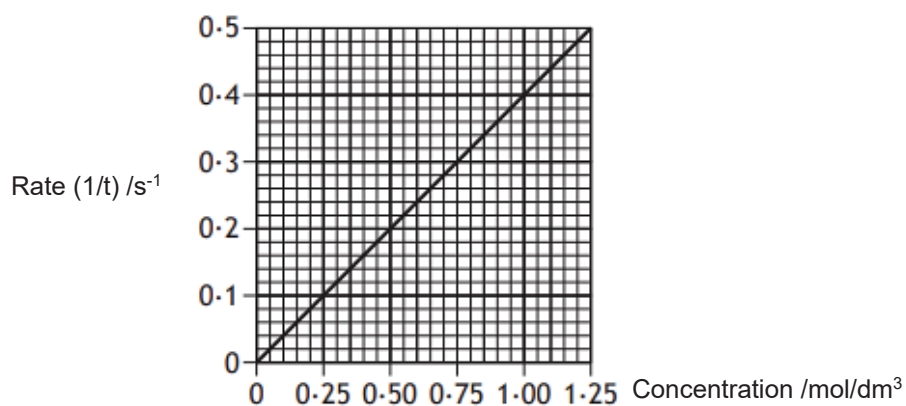


Which could be liquid Y?

- 1 aqueous copper(II) sulfate
- 2 aqueous sodium nitrate
- 3 concentrated aqueous sodium chloride
- 4 dilute sulfuric acid

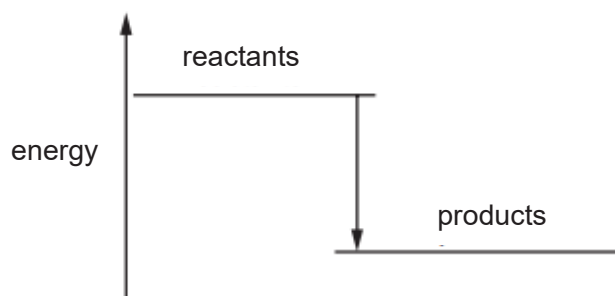
- A** 4 only  
**B** 1 and 4 only  
**C** 2 and 4 only  
**D** 2, 3 and 4 only
- 16 A student carries out a single experiment to determine the speed of reaction between calcium carbonate and an excess of hydrochloric acid.  
 Which of the following does **not** change during the course of the reaction?
- A** concentration of the hydrochloric acid solution  
**B** mass of the calcium carbonate  
**C** volume of carbon dioxide evolved  
**D** volume of hydrochloric acid solution

- 17 The graph shows how the rate of a reaction varies with the concentration of one of the reactants.



What is the reaction time, in seconds, when the concentration of the reactant was 0.50 mol/dm³?

- A** 0.2                      **B** 0.5                      **C** 2.0                      **D** 5.0
- 18 A diagram for the energy change during a chemical reaction is shown.



For which reaction(s) would this be an appropriate diagram?

- 1  $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$
- 2  $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$
- 3  $2\text{C} + \text{O}_2 \rightarrow 2\text{CO}$

- A** 1 only  
**B** 1 and 2 only  
**C** 1 and 3 only  
**D** 1, 2 and 3

- 19** The oxide of titanium,  $\text{TiO}_2$ , is used as a 'whitener' in toothpaste. It is obtained from the ore iron(II) titanate,  $\text{FeTiO}_3$ . What is the change, if any, in the oxidation number of titanium in the reaction  $\text{FeTiO}_3 \rightarrow \text{TiO}_2$ ?

**A** It is oxidized from +3 to +4.  
**B** It is reduced from +3 to +2.  
**C** It is reduced from +6 to +4.  
**D** There is no change in the oxidation number.

- 20** The pH of an aqueous solution of hydrochloric acid is 2. What will be the pH of the acid after the addition of 10.0 g of sodium chloride?

**A** 2                                      **B** 5                                      **C** 7                                      **D** 9

- 21** Which row in the table correctly shows the properties of 0.100 mol/dm<sup>3</sup> hydrochloric acid when compared with 0.100 mol/dm<sup>3</sup> ethanoic acid?

	pH	conductivity	Rate of reaction with magnesium
<b>A</b>	lower	lower	slower
<b>B</b>	higher	higher	faster
<b>C</b>	lower	higher	faster
<b>D</b>	higher	lower	slower

- 22** Consider the three reactions below.

- reaction between nitric acid and calcium hydroxide
- ethane burning in air
- reaction between ethanoic acid and ethanol

A student made three statements about the three reactions above.

- 1 carbon dioxide is produced in all reactions
- 2 water is produced in all reactions
- 3 a salt is produced in all reactions

Which statement(s) is/are true?

**A** 2 only  
**B** 1 and 2 only  
**C** 2 and 3 only  
**D** 1, 2 and 3

- 23** Methylamine,  $\text{CH}_3\text{NH}_2$ , has very similar chemical properties to ammonia,  $\text{NH}_3$ . Methylamine reacts with hydrogen chloride to form a white crystalline salt, methylammonium chloride.



A sample of methylammonium chloride is heated with aqueous sodium hydroxide. What are the products?

- A** ammonia, sodium chloride and water  
**B** ammonia, sodium hydrogencarbonate and sodium chloride  
**C** methylamine, hydrogen chloride and water  
**D** methylamine, sodium chloride and water

- 24** A student has five reagents.

- dilute hydrochloric acid
- dilute sulfuric acid
- dilute nitric acid
- solid calcium carbonate
- solid copper(II) carbonate

How many soluble salts can be prepared?

- A** 3                      **B** 4                      **C** 5                      **D** 6
- 25** How can a pure sample of barium sulfate be obtained from barium carbonate?
- A** Dissolve it in dilute hydrochloric acid, add dilute sulfuric acid, filter and crystallise.  
**B** Dissolve it in dilute hydrochloric acid, add dilute sulfuric acid, filter and wash.  
**C** Dissolve it in water, add dilute sulfuric acid, filter and crystallise.  
**D** Dissolve it in water, add dilute sulfuric acid, filter and wash.

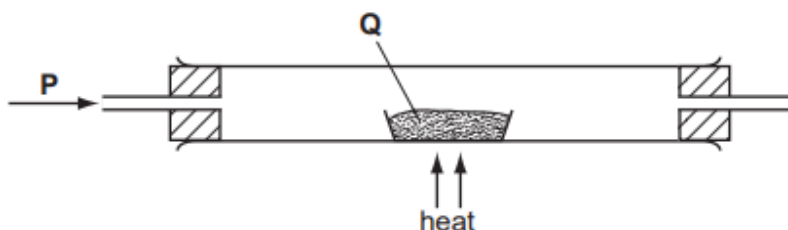
- 26** An alloy of copper and zinc is added to an excess of dilute hydrochloric acid. The resulting mixture is then filtered. Which observations are correct?

	filtrate	residue
<b>A</b>	colourless solution	none
<b>B</b>	colourless solution	pinkish brown
<b>C</b>	blue solution	grey
<b>D</b>	blue solution	none

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- 27 In the apparatus shown, gas P is passed over solid Q.



No reaction occurs if P and Q are

	P	Q
A	hydrogen	lead(II) oxide
B	hydrogen	magnesium oxide
C	oxygen	carbon
D	oxygen	sulfur

- 28 The period 4 elements gallium (Ga), germanium (Ge), arsenic (As) and selenium (Se) are elements below aluminium, silicon, phosphorus and sulfur in the Periodic Table, a portion of which is shown below.

period 3 elements	Al	Si	P	S
period 4 elements	Ga	Ge	As	Se

The properties of each period 4 element resemble those of the period 3 element directly above it.

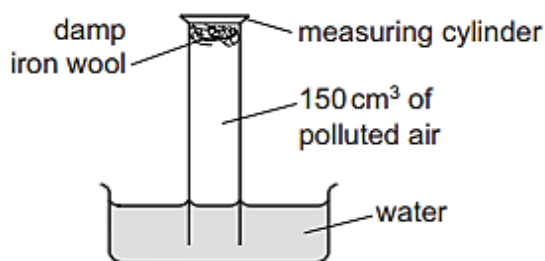
Which period 4 elements form oxides that dissolve in water to give an acid solution?

- A As and Se  
 B Ga and Ge  
 C Ga and Se  
 D Se only
- 29 When a mineral was heated in a Bunsen flame to a constant mass, a colourless gas that produced a white precipitate in limewater, was given off. The remaining solid was cooled and then added to aqueous hydrochloric acid. Vigorous effervescence was seen. What was the mineral?
- A aragonite,  $\text{CaCO}_3$   
 B artinite,  $\text{MgCO}_3 \cdot \text{Mg}(\text{OH})_2 \cdot 3\text{H}_2\text{O}$   
 C barytocalcite,  $\text{BaCO}_3 \cdot \text{CaCO}_3$   
 D dolomite,  $\text{CaCO}_3 \cdot \text{MgCO}_3$

- 30** Listed below are four solutions.
- 1 aqueous sodium hydroxide
  - 2 aqueous silver nitrate
  - 3 aqueous potassium sulfate
  - 4 dilute hydrochloric acid

Which of the following solution(s) will react with magnesium metal?

- A** 4 only  
**B** 1 and 4  
**C** 2 and 4 only  
**D** 2, 3 and 4 only
- 31** Attaching pieces of magnesium to underground iron pipes can protect the iron from corrosion.  
 Which reaction protects the iron from corrosion?
- A**  $\text{Fe}^{2+}(\text{aq}) \rightarrow \text{Fe}^{3+}(\text{aq}) + \text{e}$   
**B**  $\text{Fe}(\text{s}) \rightarrow \text{Fe}^{2+}(\text{aq}) + 2\text{e}$   
**C**  $\text{Mg}^{2+}(\text{aq}) + 2\text{e} \rightarrow \text{Mg}(\text{s})$   
**D**  $\text{Mg}(\text{s}) \rightarrow \text{Mg}^{2+}(\text{aq}) + 2\text{e}$
- 32** An experiment to find the percentage of oxygen in  $150 \text{ cm}^3$  of polluted air is shown.



The apparatus is left for one week.

After this time, the volume of gas in the measuring cylinder is  $122 \text{ cm}^3$ .

What is the percentage of oxygen, to the nearest whole number, in the polluted air?

- A** 19 %                      **B** 21%                      **C** 28 %                      **D** 81%
- 33** The depletion of the ozone layer in the upper atmosphere reduces the Earth's natural protection from harmful ultraviolet radiation.  
 Which compound would cause the most depletion of the ozone layer?
- A**  $\text{CCl}_3\text{F}$                       **B**  $\text{CF}_4$                       **C**  $\text{CHClF}_2$                       **D**  $\text{CH}_2\text{F}_2$

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11



- 34 The compound,  $C_8H_{18}$  undergoes the following process.



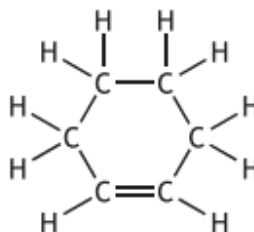
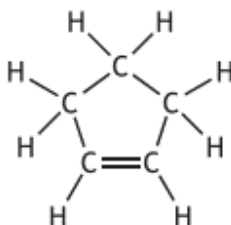
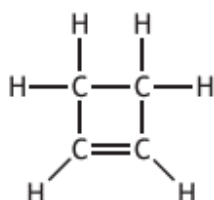
Which row in the table correctly identifies Process X and Compound Y?

	Process X	Compound Y
<b>A</b>	cracking	hexane
<b>B</b>	cracking	hexene
<b>C</b>	distillation	hexane
<b>D</b>	distillation	hexene

- 35 How many moles of hydrogen chloride are formed when one mole of methane is added to a large excess of chlorine in the dark?

**A** 0                      **B** 1                      **C** 2                      **D** 4

- 36 Three members of the cycloalkene homologous series are shown:



Which of the following is the general formula for this homologous series?

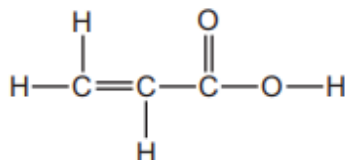
- A**  $C_nH_{2n-4}$   
**B**  $C_nH_{2n-2}$   
**C**  $C_nH_{2n}$   
**D**  $C_nH_{2n+2}$

- 37** Oil contains carbon-carbon double bonds which can undergo addition reactions with iodine. The iodine number of an oil is the mass of iodine in grams that will react with 100 g of oil.

Which row in the table shows the oil that is likely to have the lowest melting point?

	oil	iodine number
<b>A</b>	corn	123
<b>B</b>	linseed	179
<b>C</b>	olive	81
<b>D</b>	soya	130

- 38** A compound has the following structure.



Which reaction(s) will occur with this compound?

- 1 Bromine water will decolourise.
- 2 It will react with an alcohol to form an ester.
- 3 It will react with sodium metal.

- A** 1 only  
**B** 1 and 2 only  
**C** 2 and 3 only  
**D** 1, 2 and 3

- 39** Polyvinyl chloride (PVC) is a man-made polymer used mainly in the manufacture of pipes. PVC pipes are strong, lightweight and does not rot.

Which statements correctly describe the polymer, polyvinyl chloride, PVC?

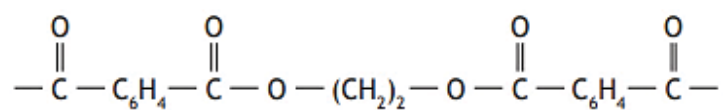
- 1 Combustion of PVC waste produces a highly acidic gas.
- 2 PVC molecules are saturated.
- 3 The empirical formula of PVC is the same as the empirical formula of its monomers.

- A** 1 and 2 only  
**B** 1 and 3 only  
**C** 2 and 3 only  
**D** 1, 2 and 3

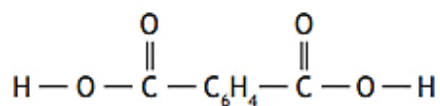
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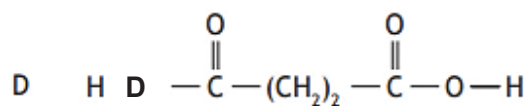
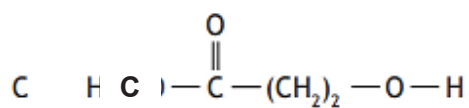
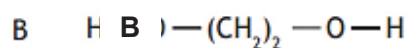
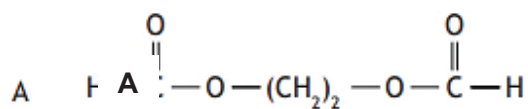
40. A section of a condensation polymer is shown below.



One of the monomers is



The structural formula of the other monomer is



End of paper

# The Periodic Table of Elements

Group																					
I	II	Key																			
		proton (atomic) number					atomic symbol					name					relative atomic mass				
3	4	Li	Be	lithium	beryllium	7	9														
11	12	Na	Mg	sodium	magnesium	23	24														
19	20	K	Ca	potassium	calcium	39	40														
37	38	Rb	Sr	rubidium	strontium	85	88														
55	56	Cs	Ba	caesium	barium	133	137														
87	88	Fr	Ra	francium	radium	-	-														
21	22	Sc	Ti	scandium	titanium	45	48														
39	40	Y	Zr	yttrium	zirconium	89	91														
57 – 71	72	lanthanoids	Hf		hafnium	178	181														
73	74	Ta	W	tantalum	tungsten	181	184														
75	76	Re	Os	rhenium	osmium	186	190														
77	78	Ir	Pt	iridium	platinum	192	195														
79	80	Au	Hg	gold	mercury	197	201														
81	82	Tl	Pb	thallium	lead	204	207														
83	84	Bi	Po	bismuth	polonium	209	-														
85	86	At	Rn	astatine	radon	-	-														
87	88	Fr	Ra	francium	radium	-	-														
89 – 103	104	actinoids	Rf		Rutherfordium	-	-														
105	106	Db	Sg	dubnium	seaborgium	-	-														
107	108	Bh	Hs	bohrium	hassium	-	-														
109	110	Mt	Ds	meitnerium	darmstadtium	-	-														
111	112	Rg	Cn	roentgenium	copernicium	-	-														
113	114	Fl	Mc	flerovium	moscovium	-	-														
115	116	Lv	Uu	livermorium	unbinilium	-	-														
117	118	Ts	Og	tennessine	oganeson	-	-														
119	120	Uut	Uub	ununtrium	unbinilium	-	-														
121	122	Uuh	Uub	ununhexium	unbinilium	-	-														
123	124	Uut	Uub	ununtrium	unbinilium	-	-														
125	126	Uut	Uub	ununtrium	unbinilium	-	-														
127	128	Uut	Uub	ununtrium	unbinilium	-	-														
129	130	Uut	Uub	ununtrium	unbinilium	-	-														
131	132	Uut	Uub	ununtrium	unbinilium	-	-														
133	134	Uut	Uub	ununtrium	unbinilium	-	-														
135	136	Uut	Uub	ununtrium	unbinilium	-	-														
137	138	Uut	Uub	ununtrium	unbinilium	-	-														
139	140	Uut	Uub	ununtrium	unbinilium	-	-														
141	142	Uut	Uub	ununtrium	unbinilium	-	-														
143	144	Uut	Uub	ununtrium	unbinilium	-	-														
145	146	Uut	Uub	ununtrium	unbinilium	-	-														
147	148	Uut	Uub	ununtrium	unbinilium	-	-														
149	150	Uut	Uub	ununtrium	unbinilium	-	-														
151	152	Uut	Uub	ununtrium	unbinilium	-	-														
153	154	Uut	Uub	ununtrium	unbinilium	-	-														
155	156	Uut	Uub	ununtrium	unbinilium	-	-														
157	158	Uut	Uub	ununtrium	unbinilium	-	-														
159	160	Uut	Uub	ununtrium	unbinilium	-	-														
161	162	Uut	Uub	ununtrium	unbinilium	-	-														
163	164	Uut	Uub	ununtrium	unbinilium	-	-														
165	166	Uut	Uub	ununtrium	unbinilium	-	-														
167	168	Uut	Uub	ununtrium	unbinilium	-	-														
169	170	Uut	Uub	ununtrium	unbinilium	-	-														
171	172	Uut	Uub	ununtrium	unbinilium	-	-														
173	174	Uut	Uub	ununtrium	unbinilium	-	-														
175	176	Uut	Uub	ununtrium	unbinilium	-	-														
177	178	Uut	Uub	ununtrium	unbinilium	-	-														
179	180	Uut	Uub	ununtrium	unbinilium	-	-														
181	182	Uut	Uub	ununtrium	unbinilium	-	-														
183	184	Uut	Uub	ununtrium	unbinilium	-	-														
185	186	Uut	Uub	ununtrium	unbinilium	-	-														
187	188	Uut	Uub	ununtrium	unbinilium	-	-														
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191	192	Uut	Uub	ununtrium	unbinilium	-	-														
193	194	Uut	Uub	ununtrium	unbinilium	-	-														
195	196	Uut	Uub	ununtrium	unbinilium	-	-														
197	198	Uut	Uub	ununtrium	unbinilium	-	-														
199	200	Uut	Uub	ununtrium	unbinilium	-	-														
201	202	Uut	Uub	ununtrium	unbinilium	-	-														
203	204	Uut	Uub	ununtrium	unbinilium	-	-														
205	206	Uut	Uub	ununtrium	unbinilium	-	-														
207	208	Uut	Uub	ununtrium	unbinilium	-	-														
209	210	Uut	Uub	ununtrium	unbinilium	-	-														
211	212	Uut	Uub	ununtrium	unbinilium	-	-														
213	214	Uut	Uub	ununtrium	unbinilium	-	-														
215	216	Uut	Uub	ununtrium	unbinilium	-	-														
217	218	Uut	Uub	ununtrium	unbinilium	-	-														
219	220	Uut	Uub	ununtrium	unbinilium	-	-														
221	222	Uut	Uub	ununtrium	unbinilium	-	-														
223	224	Uut	Uub	ununtrium	unbinilium	-	-														
225	226	Uut	Uub	ununtrium	unbinilium	-	-														
227	228	Uut	Uub	ununtrium	unbinilium	-	-														
229	230	Uut	Uub	ununtrium	unbinilium	-	-														
231	232	Uut	Uub	ununtrium	unbinilium	-	-														
233	234	Uut	Uub	ununtrium	unbinilium	-	-														
235	236	Uut	Uub	ununtrium	unbinilium	-	-														
237	238	Uut	Uub	ununtrium	unbinilium	-	-														
239	240	Uut	Uub	ununtrium	unbinilium	-	-														
241	242	Uut	Uub	ununtrium	unbinilium	-	-														
243	244	Uut	Uub	ununtrium	unbinilium	-	-														
245	246	Uut	Uub	ununtrium	unbinilium	-	-														
247	248	Uut	Uub	ununtrium	unbinilium	-	-														
249	250	Uut	Uub	ununtrium	unbinilium	-	-														
251	252	Uut	Uub	ununtrium	unbinilium	-	-														
253	254	Uut	Uub	ununtrium	unbinilium	-	-														
255	256	Uut	Uub	ununtrium	unbinilium	-	-														
257	258	Uut	Uub	ununtrium	unbinilium	-	-														
259	260	Uut	Uub	ununtrium	unbinilium	-	-														
261	262	Uut	Uub	ununtrium	unbinilium	-	-														
263	264	Uut	Uub	ununtrium	unbinilium	-	-														
265	266	Uut	Uub	ununtrium	unbinilium	-	-														
267	268	Uut	Uub	ununtrium	unbinilium	-	-														
269	270	Uut	Uub	ununtrium	unbinilium	-	-														
271	272	Uut	Uub	ununtrium	unbinilium	-	-														
273	274	Uut	Uub	ununtrium	unbinilium	-	-														
275	276	Uut	Uub	ununtrium	unbinilium	-	-														
277	278	Uut	Uub	ununtrium	unbinilium	-	-														
279	280	Uut	Uub	ununtrium	unbinilium	-	-														
281	282	Uut	Uub	ununtrium	unbinilium	-	-														
283	284	Uut	Uub	ununtrium	unbinilium	-	-														
285	286	Uut	Uub	ununtrium	unbinilium	-	-														
287	288	Uut	Uub																		

lanthanoids

57	La lanthanum 139	58	Ce cerium 140	59	Pr praseodymium 141	60	Nd neodymium 144	61	Pm —	62	Sm samarium 150	63	Eu europium 152	64	Gd gadolinium 157	65	Tb terbium 159	66	Dy dysprosium 163	67	Ho holmium 165	68	Er erbium 167	69	Tm thulium 169	70	Yb ytterbium 173	71	Lu lutetium 175
----	------------------------	----	---------------------	----	---------------------------	----	------------------------	----	---------	----	-----------------------	----	-----------------------	----	-------------------------	----	----------------------	----	-------------------------	----	----------------------	----	---------------------	----	----------------------	----	------------------------	----	-----------------------

actinoids

89	Ac actinium	90	Th thorium 232	91	Pa protactinium 231	92	U uranium 238	93	Np neptunium	94	Pu plutonium	95	Am americium	96	Cm curium	97	Bk berkelium	98	Cf californium	99	Es einsteinium	100	Fm fermium	101	Md mendelevium	102	No nobelium	103	Lr lawrencium
----	----------------	----	----------------------	----	---------------------------	----	---------------------	----	-----------------	----	-----------------	----	-----------------	----	--------------	----	-----------------	----	-------------------	----	-------------------	-----	---------------	-----	-------------------	-----	----------------	-----	------------------

The volume of one mole of any gas is  $24 \text{ dm}^3$  at room temperature and pressure (r.t.p.).

Name: ..... Index No. .... Class: .....



**Bukit Batok Secondary School**  
**PRELIMINARY EXAMINATION 2018**  
**Sec 4 EXPRESS**

**CHEMISTRY**

Paper 2

**6092/02**

**15 August 2018**

**1030 - 1215**

**1 hour 45 minutes**

Candidates answer on the Question Paper.  
No Additional Materials are required.

**READ THESE INSTRUCTIONS FIRST**

Write your name, index number and class in the spaces provided at the top of this page.

Write in dark blue or black pen

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, highlighters, glue or correction fluid.

**Section A**

Answer **all** questions in the spaces provided.

**Section B**

Answer all **three** questions, the last question is in the form of either/or.

Answer **all** questions in the spaces provided.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [ ] at the end of each question or part question.

A copy of the Periodic Table is given at the end of the paper.

The use of an approved scientific calculator is expected, where appropriate.

For Examiner's use	
Section A	/50
Section B	
B7	
B8	
B9	
Total	/80

---

This document consists of 23 printed pages.

**Section A**

Answer all the questions in this section in the spaces provided.

The total mark for this section is 50

**A1(a)** The grid below represents part of a blank periodic table, the numbers being the proton number of the elements.

In the grid below, write

- (i) **P** in a space which could be occupied by a noble gas which is used to fill weather balloons. [1]
- (ii) **Q** in a space which the most reactive non-metal would occupy. [1]
- (iii) **R** in a space which could be occupied by a metal with the lowest density. [1]
- (iv) **S** in a space which could be occupied by an element forming an amphoteric hydroxide. [1]
- (v) **T** in a space which could be occupied by an element with an isotope that can be represented by  $^{14}_6X$ . [1]

1							2
3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18

**(b)** (i) Describe how the metallic character of the elements in Period 3 changes across the period from left to right.

.....[1]

(ii) State how the metallic character of an element is related to its electronic structure.

..... [1]

**(c)** Explain what is meant by the term *periodicity*.

.....[1]  
 [Total: 8]

**A2** Carbon atoms can bond to each other to produce a variety of different structures, including diamond, graphite and buckminsterfullerene.

**(a)** There are similarities and differences in the structure and bonding in diamond and graphite.

**(i)** Describe two features of the structure and bonding in diamond that are similar to graphite.

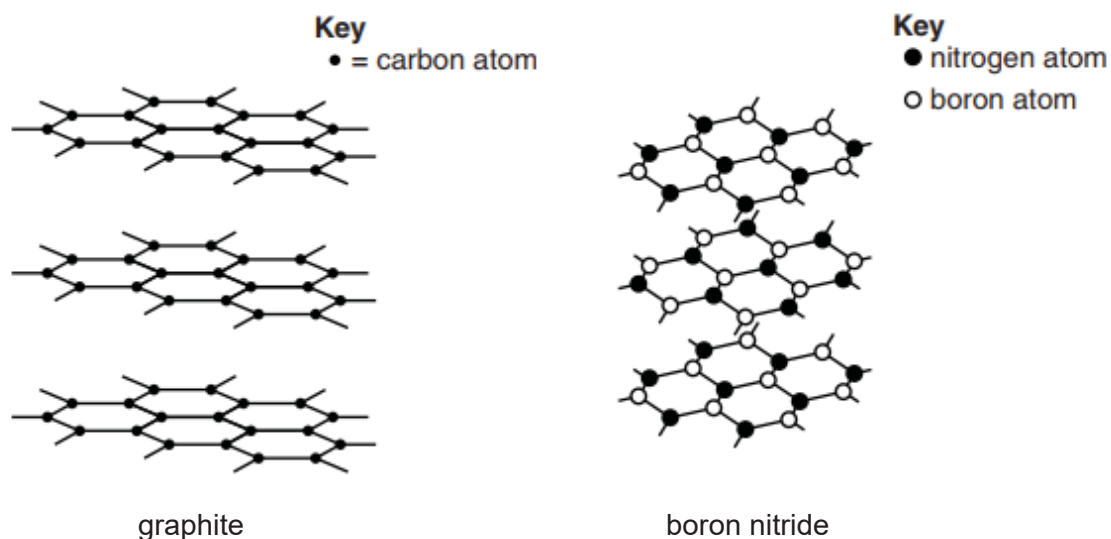
.....  
 .....  
 .....  
 ..... [2]

**(ii)** Describe two features of the structure and bonding in diamond that are different from graphite.

.....  
 .....  
 .....  
 ..... [2]

**(b)** Buckminsterfullerene is a form carbon with the formula  $C_{60}$ . If it is burned completely in oxygen, it forms carbon dioxide as the only product. Calculate the mass of carbon dioxide that is released when 51 g of buckminsterfullerene is completely burned in oxygen. [2]

(c) The structures of graphite and boron nitride are shown below.



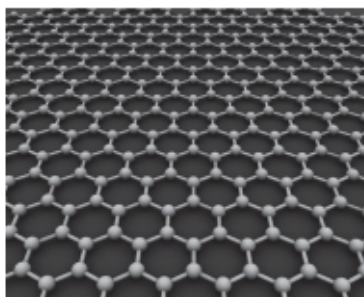
(i) What is the chemical formula for boron nitride? ..... [1]

(ii) Like graphite, boron nitride feels slippery to the touch.  
Explain, in terms of bonding and structure, why boron nitride feels slippery to touch.

.....  
.....  
.....

..... [2]

(iii) The diagram below shows the structure of a solid form of carbon called graphene. Graphene contains **one layer** of carbon atoms.  
Graphene is made from graphite but it is harder than graphite.



Explain, using ideas about structure and bonding, why graphene is hard.

.....  
..... [1]

[Total: 10]

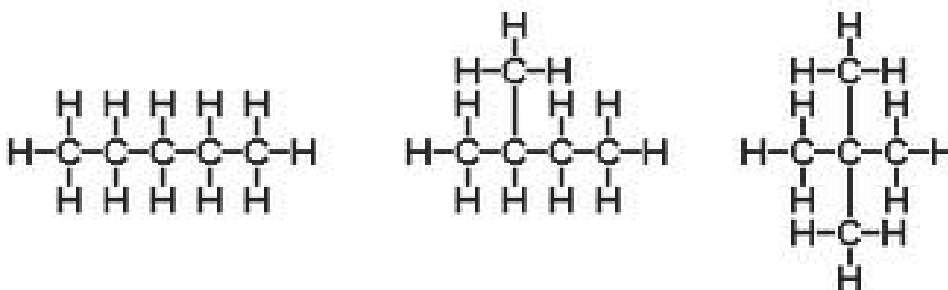


**A3** Alkanes like propane and butane are found in Liquefied Petroleum Gases(LPG).

- (a) An experiment shows that complete combustion of  $1.0 \text{ dm}^3$  (measured at room temperature and pressure) of butane produces 120 kJ of energy.  
Calculate a value for the enthalpy change of complete combustion (kJ/mol) of butane, giving the correct sign.

[1]

- (b)(i) The alkane with 5 carbon atoms, pentane exists as several isomers shown below. One is straight chain pentane while the other two are branched chain pentane.



Will the two isomers which are branched chain pentane have the same enthalpy change on complete combustion as the straight chain pentane?  
Explain your reasoning.

.....  
.....[1]

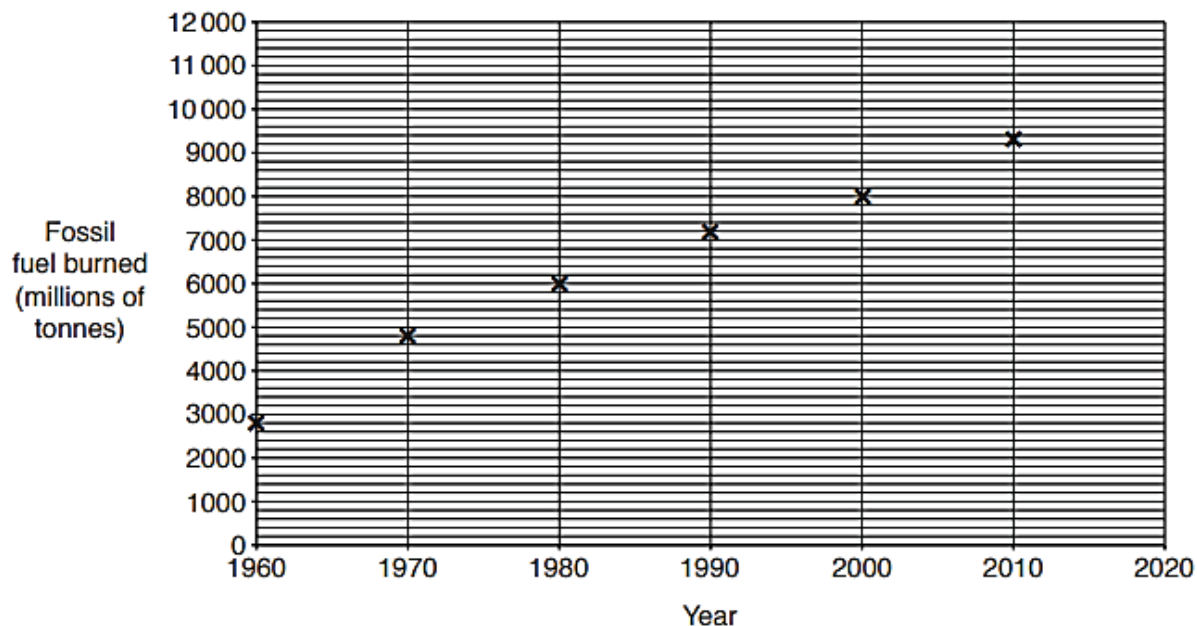
- (ii) The table shows the enthalpy changes of combustion of hexane and heptane.

name	formula	enthalpy change of combustion / kJ/ mol
hexane	$\text{C}_6\text{H}_{14}$	-4163
heptane	$\text{C}_7\text{H}_{16}$	-4817

Using the data given, estimate the enthalpy change of combustion in kJ/mol of octane,  $\text{C}_8\text{H}_{18}$ . Explain the method you use to arrive at your answer.

.....  
.....  
.....[2]

- (c) Some students studied the graph below that shows the amount of fossil fuel burned in the world between 1960 and 2010.



**Fig 3.1**

- (i) One student says that the amount of fossil fuels burned has increased by the same amount every ten years.  
Is the student correct? Use data from the graph to justify your answer.

.....

..... [1]

- (ii) Another student says that it is very difficult to estimate the amount of fossil fuel we will use in 100 years' time. Suggest reasons the student could give to justify this statement.

.....

.....

.....

..... [2]

- (iii) The graph below shows the changes in average global temperature from 1960 to 2010.

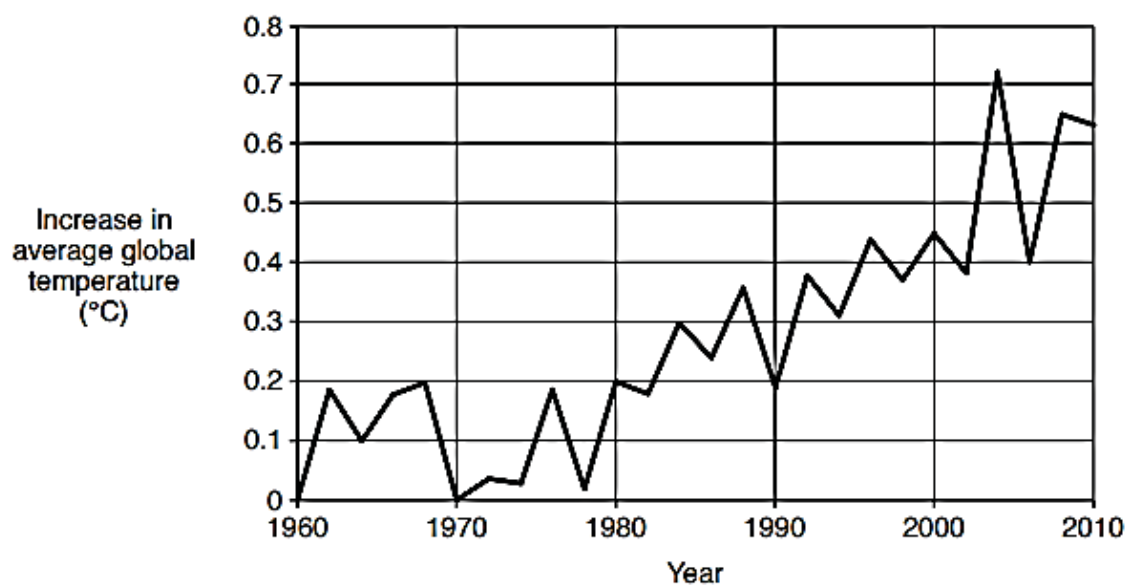


Fig 3.2

Describe the link between the trends shown in the graphs in Fig 3.1 and Fig 3.2.

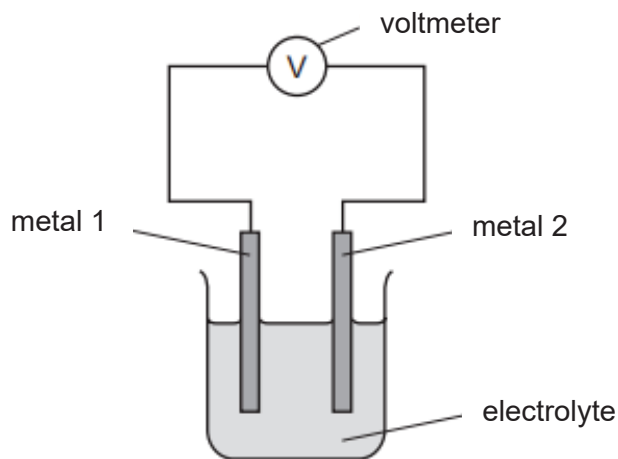
.....

.....[1]  
[Total: 8]

**A4** The diagram shows a simple cell, with two different metals as electrodes dipped in dilute nitric acid. A student did an experiment using the simple cell below.

The voltages were recorded in the table.

- If the voltage measured is positive then metal 2 is more reactive than metal 1.
- If the voltage measured is negative then metal 1 is more reactive than metal 2.



		metal 2				
		beryllium	cobalt	nickel	silver	vanadium
metal 1	beryllium	0.0 V	-1.6 V	-1.6 V	not measured	-0.7 V
	cobalt		0.0 V	0.0 V	-1.1 V	0.9 V
	nickel			0.0 V	-1.1 V	0.9 V
	silver				0.0 V	2.0 V
	vanadium					0.0 V

**(a) (i)** In the simple cell containing nickel and silver, it was observed that the electrolyte slowly turned pale green. Write the ionic equation to explain the colour change.

.....[1]

**(ii)** What happened to the mass of the nickel electrode?

.....[1]

**(b) (i)** Using the data given, state the most reactive metal in the table above. Explain your reasoning.

.....  
 .....  
 ..... [2]

**(ii)** Predict the voltage produced by a simple cell with beryllium as metal 1 and silver as metal 2.

.....[1]

- (c) (i) The student wanted to rank the metals listed in the table according to their reactivity but he was not able to do so. Why?

.....[1]

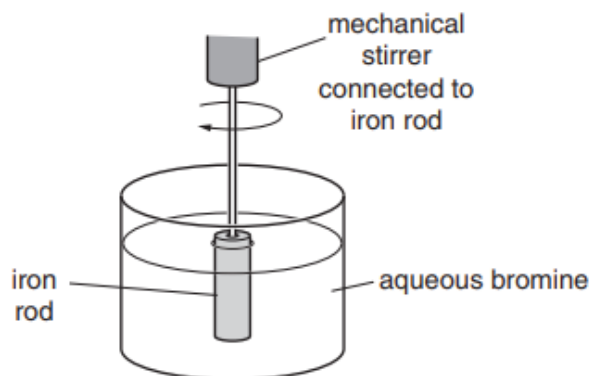
- (ii) Briefly describe one **simple** experiment the student can do which will help him to solve the problem in c(i).

.....

.....[1]

[Total: 7]

- A5** The rate of reaction of iron with aqueous bromine is determined by using the apparatus shown below.



The iron is removed at regular intervals. It is washed, dried and then weighed.

The iron is then replaced in the solution.

The experiment is repeated twice, each time with a different concentration of aqueous bromine at room temperature, 25 °C. The results are shown in the table below.

Experiment	concentration of aqueous bromine mol/dm <sup>3</sup>	speed of reaction mg iron reacted/min
1	0.050	9.2
2	0.10	18.1
3	0.15	27.2

- (a) Describe how and explain why the speed of this reaction changes with concentration of bromine.

.....

.....

.....[2]

- (b) (i) Experiment 1 is repeated after aqueous bromine has been cooled in an ice bath to 15°C.  
Predict the speed of reaction, with appropriate unit.....[1]

- (ii) Using collision theory, explain your answer in (b)(i).

.....  
 .....  
 .....  
 ..... [2]

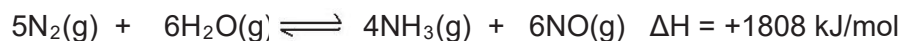
- (c) Suggest another method for measuring the speed of this reaction.

.....[1]  
 [Total: 6]

**A6**

Ammonia, NH<sub>3</sub>, is a colourless, pungent-smelling gas which has been known to man from the beginning of recorded time. Chemists have discovered a novel way of 'fixing' atmospheric nitrogen (converting nitrogen gas into its compounds). Moist nitrogen is passed over a TiO<sub>2</sub> plate which has been coated with other chemicals. The nitrogen is thought to react with moisture in the air at room temperature and pressure to form ammonia.

A possible equation for the reaction is given below.



- (a) (i) Explain why there are only a few reactions that 'fix' nitrogen.

.....  
 .....  
 ..... [2]

- (ii) Suggest and explain one advantage and one disadvantage of the process given in the equation above as a method of making ammonia compared with the Haber process.

.....  
 .....  
 .....  
 ..... [2]

(b) 1.20 dm<sup>3</sup> of ammonia gas was dissolved in water to form 200 cm<sup>3</sup> of aqueous alkali at room temperature and pressure.

(i) Calculate how many moles of NH<sub>3</sub>(g) was dissolved in water.

[1]

(ii) Write the equation for the neutralisation of aqueous ammonia, NH<sub>3</sub>(aq) by dilute sulfuric acid.

..... [1]

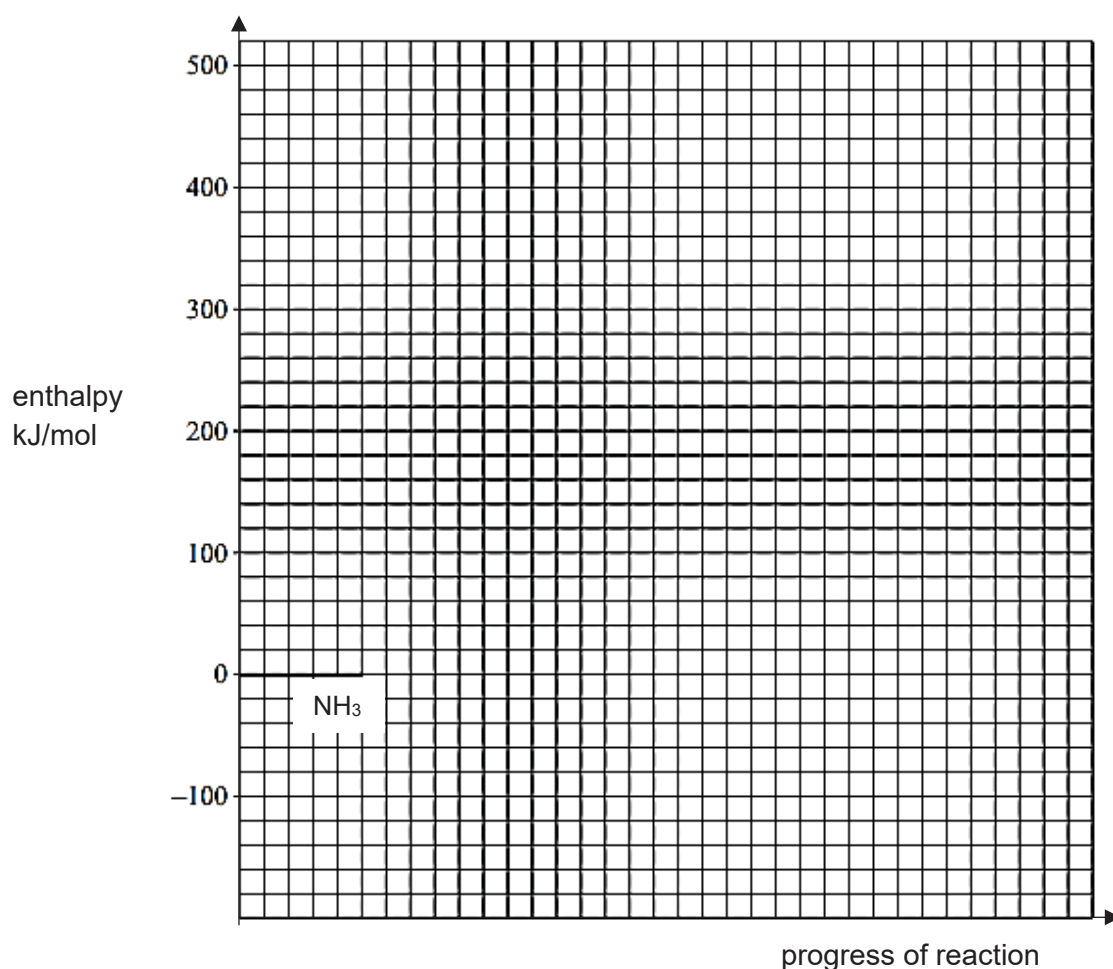
(c) The decomposition of ammonia is represented by the following equation.



The activation energy, **E<sub>a</sub>** for the uncatalysed reaction is 335 kJ/mol.

The activation energy, **E<sub>a</sub>** for the reaction when tungsten is used as a catalyst is 163 kJ/mol.

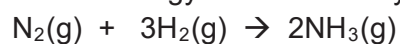
(i) On the grid provided on page 12, draw a **labelled** energy profile diagram for the uncatalysed and catalysed reactions. [3]  
Include the necessary information given.



- (ii) When osmium is used as a catalyst, the activation energy is 197 kJ/mol. Which catalyst, osmium or tungsten, will cause ammonia to decompose at a faster rate? Explain your answer using ideas about particles.

.....  
 .....

- ..... [1]  
 (iii) State the activation energy for the uncatalysed reaction of the following:



..... [1]  
 [Total:11]



**Section B**

Answer **all** three questions in this section.

The last question is in the form of an either/or and only one of the alternatives should be attempted.

**B7 Composition of sea water**

The Earth's ocean holds about  $1.5 \times 10^{18}$  tonnes of water, which in turn contains  $0.05 \times 10^{18}$  tonnes of dissolved salts. The table below shows eight most common ions in the sea.

ion	% by mass of total dissolved solids	concentration in mol/dm <sup>3</sup>
Chloride, Cl <sup>-</sup>	55.04	0.535
Sodium, Na <sup>+</sup>	30.42	0.457
Sulfate, SO <sub>4</sub> <sup>2-</sup>	7.69	0.028
Magnesium, Mg <sup>2+</sup>	3.91	0.056
Calcium, Ca <sup>2+</sup>	1.16	0.010
Potassium, K <sup>+</sup>	1.10	0.0097
Carbonate, CO <sub>3</sub> <sup>2-</sup>	0.41	0.0023
Bromide, Br <sup>-</sup>	0.19	0.00081

The dissolved ions in the sea form an essentially free source of materials to anyone with access to the sea. Evaporation of sea water produces sodium chloride and potassium chloride. The two other elements that can be obtained from sea water are bromine and magnesium.

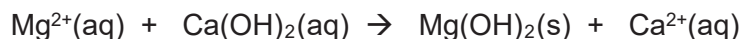
**Uses of Magnesium**

Magnesium is the lightest structural metal used today, some 30% lighter than aluminium. Magnesium is the third most used metal in construction (after iron and aluminium). Nearly 70% of the world production of magnesium is used to make alloys. One example is Magnox which is an alloy of magnesium with small amount of aluminium and other metals.

**Extraction of magnesium**

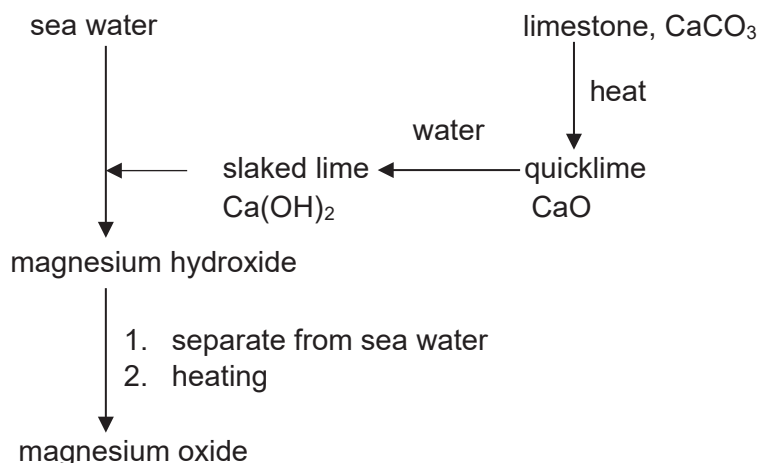
The first stage in the production of magnesium is to mix the sea water with a slurry of calcium hydroxide. This precipitates magnesium hydroxide.

This reaction can be represented as follows.

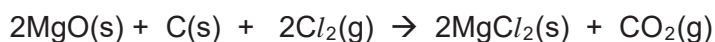


Magnesium hydroxide is then separated and heated to produce magnesium oxide.

The flow chart summarises the process mentioned



Conversion to magnesium chloride is achieved by heating the oxide, mixed with carbon, in a stream of chlorine at a high temperature in the furnace.



The resulting anhydrous magnesium chloride is fed into electrolytic cells. A schematic diagram of the electrolytic cell is shown below in Fig 7.1

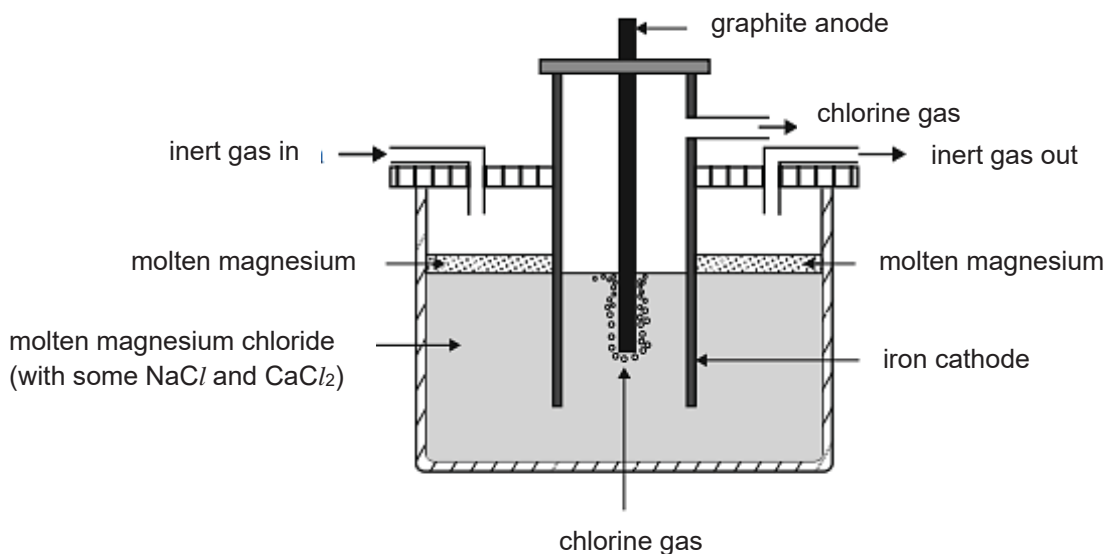


Fig 7.1

The design of this cell considers the following properties of both magnesium metal and magnesium chloride:

- molten magnesium reacts vigorously with oxygen
- at the temperature of molten magnesium chloride, magnesium is a liquid
- molten magnesium has a lower density than molten magnesium chloride and forms a separate layer on the surface.

- (a) Name the most abundant ionic compound in sea water and determine the effective concentration of this compound in  $\text{mol/dm}^3$ .

[1]

- (b) (i) From the information given, deduce the trend in solubility of the Group II metal hydroxide as the proton number increases.

.....

.....[1]

- (ii) Calculate the mass of magnesium hydroxide precipitated when an excess of calcium hydroxide is added to  $1000 \text{ dm}^3$  of sea water.

[2]

- (c) (i) Write an ionic equation for the reaction at the cathode in the electrolytic cell.

.....[1]

- (ii) How does the design of the cell shown in the Fig 7.1, take into consideration the reaction of molten magnesium with oxygen?

.....

.....[1]

- (d) Electrolysis is an expensive process as high consumption of energy is needed. Using the information given, what is being done to lower the cost in industrial process?

.....

.....[1]

- (e) A technician accidentally replaced the graphite electrode with a piece of silver metal.

How would the products of electrolysis be affected? Explain your answer.

Write an ionic equation to support your answer.

.....

.....

.....

.....

.....

.....[3]

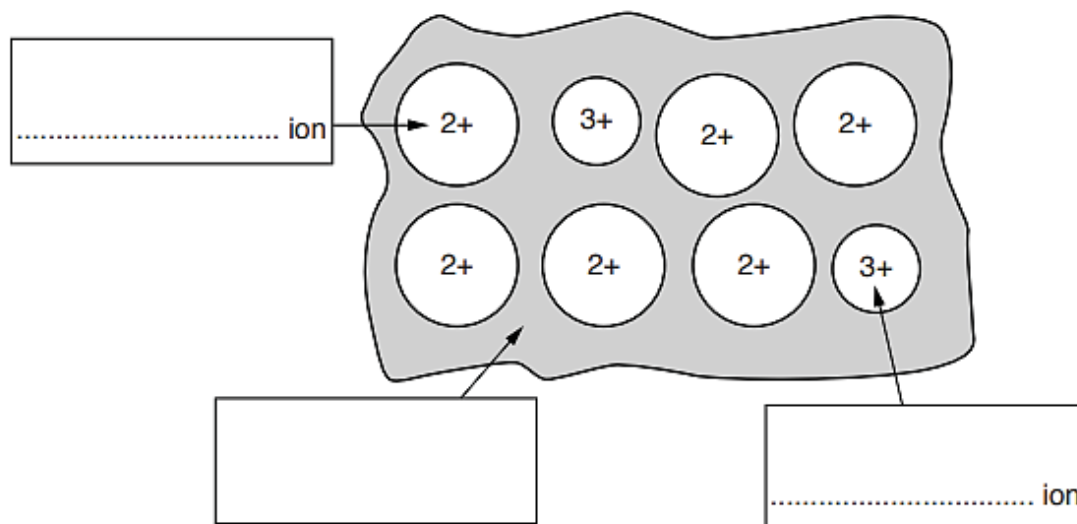
- (f) State an example of recycling that is given in the information.

.....

..... [1]

- (g) The aluminium atoms in Magnox form a metallic structure with magnesium. The figure below represents a simple illustration of the bonding in Magnox. Use your knowledge of atomic structure and metallic bonding to label the boxes.

[1]



[Total: 12]

**B8 (a)** A student reacted together an alcohol and a carboxylic acid under appropriate conditions to produce an ester.  
 A sweet smelling organic liquid, **Q**, with the empirical formula  $C_2H_4O$  was produced.  
 The  $M_r$  of **Q** was found by experiments to be 87.5.

(i) What is the molecular formula of **Q**? Show the necessary calculation. [1]

(ii) In the boxes below, draw the structural formula of **two** isomers with this formula that are **straight chain** esters. [2]

--	--

A sample of **Q** was heated with aqueous sulfuric acid. The product obtained was a mixture of the original alcohol and carboxylic acid. This mixture was heated under reflux with acidified potassium manganate(VII) to give a **single** product, **R**.  
 The product, **R**, was collected and subjected to the following tests:

- A sample of **R** gave no reaction with aqueous bromine.
- A second sample of **R** gave an effervescence with sodium carbonate.
- A third sample of **R** is completely miscible with water.

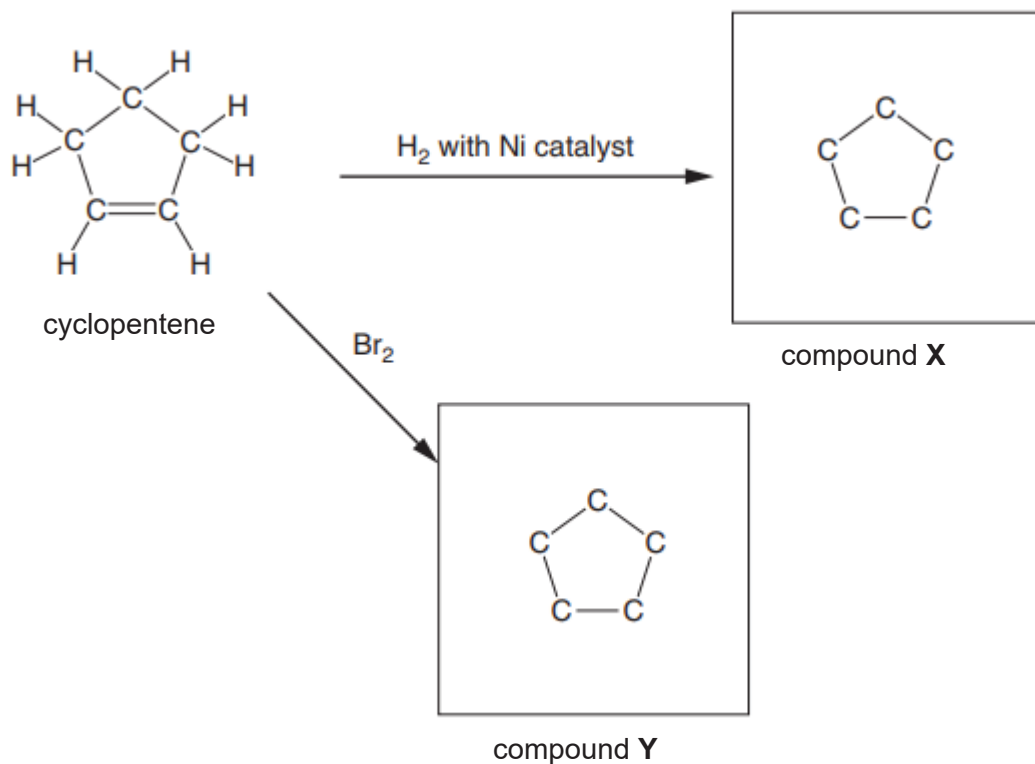
(iii) What is the identity of single organic compound **R**?

..... [1]

- (b) Cyclopentene is a cyclic alkene with the formula  $C_5H_8$ . It is a colourless liquid with a petrol-like odour. It is used as a monomers for synthesis of plastics.

The figure below shows some reactions involving cyclopentene

- (i) Complete the partial structures of compounds **X** and **Y** which are the products of the reactions. [2]



- (ii) Write a balanced chemical equation to show the reaction between cyclopentene and aqueous bromine.

..... [1]

- (iii) Cyclopentene can be polymerised to give poly(cyclopentene). Draw a section of poly(cyclopentene) to show two repeat units. [1]

[Total: 8]

**B9 Either**

Aqueous iron(II) bromide is a pale green solution containing iron(II) ions and bromide ions. When chlorine is passed into aqueous iron(II) bromide, the colour of the solution changes from pale green to orange-red.

When the orange-red solution is heated, it gives off a brown vapour, leaving a yellow solution

**S**. The brown vapour forms a dark orange liquid **T** on cooling. When ethene gas is bubbled into **T**, the dark orange colour disappears. Sodium hydroxide solution is added to solution **S** and a reddish brown precipitate was obtained.

(a) (i) Name liquid **T**. ..... [1]

(ii) Draw 'dot-and-cross' diagram to show the electron arrangement in **T**.  
Show only the outer electrons. [1]

(b) Name the yellow compound present in solution **S**.

..... [1]

(c) (i) Construct a balanced chemical equation for the reaction in which **S** and **T** are formed.

..... [1]

(ii) In this reaction in which **S** and **T** are formed, name the oxidising agent.  
Explain your answer, using **electron transfer**.

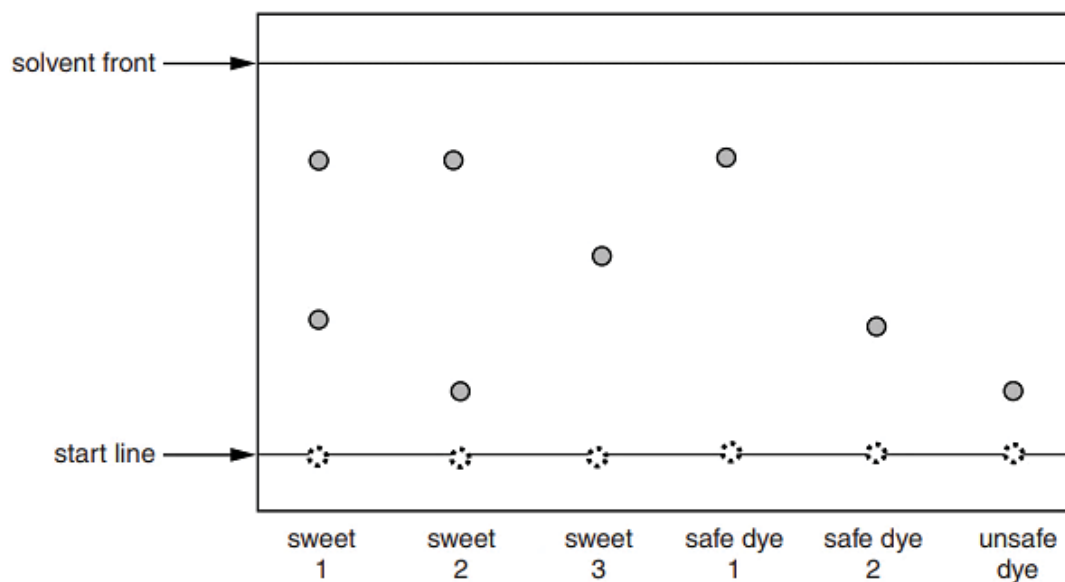
.....

.....

.....[2]

- (d) A student uses chromatography to analyse the food dyes used in a packet of sweets. The packet contains three different coloured sweets. He tests one sweet of each colour. He uses two known safe food dyes and one known unsafe dye as references.

The chromatogram below shows his results.



- (i) The student looks at the results and makes this statement:  
 “The results show that it is possible that two of the sweets contain an unsafe dye.”  
 Explain how the results of the chromatogram support the student’s conclusion.

.....  
 .....  
 .....[2]

- (ii) Calculate the  $R_f$  value of the unsafe dye given in the chromatogram above.

[1]

- (iii) The student also uses chromatography to identify the **flavourings** used in the sweets. He sprays his chromatogram with a locating agent.  
 Why does he need to use a locating agent?

.....[1]



**B9 Or**

Both calcium and barium are elements in Group II of the Periodic Table. The trend of the reactivity of the elements in Group II is similar to that in Group I. Like Group I elements, calcium and barium form salts with the halogens.

The salt, calcium chloride,  $\text{CaCl}_2$ , can be made by different reactions.

A student prepared hydrated calcium chloride by carrying out the following experiment.

- Step 1**            The student added an excess of a solid calcium compound, **X**, to dilute hydrochloric acid. The mixture fizzed as the solid reacted.
- Step 2**            The student filtered the mixture to give an aqueous solution of  $\text{CaCl}_2$ .
- Step 3**            On evaporation, colourless crystals of hydrated calcium chloride were formed.

- (a) Why is calcium chloride an example of 'salt'?

.....

..... [1]

- (b) A friend of the student suggested that solid **X** was calcium oxide. State one reason why the student's friend was **incorrect** and suggest a possible identity of solid **X**.

.....

.....

..... [2]

- (c) Hydrated calcium chloride has a molar mass of 219 g/mol.

Determine the formula of **hydrated** calcium chloride.

You must show your working.

[2]

- (d) Calcium chloride can also be formed by directly reacting calcium with chlorine gas. Explain, using **oxidation states**, why the formation of calcium chloride from its elements, is a redox reaction.

.....  
 .....  
 .....[2]

- (e) The student decided to prepare barium sulfate,  $\text{BaSO}_4$ , by adding barium metal to dilute sulfuric acid. Another student said this method should not be used to prepare the salt, barium sulfate. Give **two** reasons why the other student is correct.

.....  
 .....  
 .....  
 .....[2]

- (f) Barium atom has the electron arrangement 2, 8, 18, 18, 8, 2. Write the electron arrangement of the barium **ion**.

.....[1]

End of paper

Group														
I	II	Key												
		<div>1 H hydrogen 1</div>												
		<div>proton (atomic) number atomic symbol name relative atomic mass</div>												
3 Li lithium 7	4 Be beryllium 9													
11 Na sodium 23	12 Mg magnesium 24													
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65			
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112			
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201			
87 Fr francium -	88 Ra radium -	89 – 103 actinoids	104 Rf Rutherfordium -	105 Db dubnium -	106 Sg seaborgium -	107 Bh bohrium -	108 Hs hassium -	109 Mt meitnerium -	110 Ds darmstadtium -	111 Rg roentgenium -	112 Cn copernicium -			
lanthanoids														
57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium -	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids														
89 Ac actinium -	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium -	94 Pu plutonium -	95 Am americium -	96 Cm curium -	97 Bk berkelium -	98 Cf californium -	99 Es einsteinium -	100 Fm fermium -	101 Md mendelevium -	102 No nobelium -	103 Lr lawrencium -

The volume of one mole of any gas is  $24\text{ dm}^3$  at room temperature and pressure (r.t.p.).



**2018 GCE O Prelim sec 4E Chemistry 6092 Paper 1****Answer & mark scheme**

No.	Ans	Remarks
1	D	(A) A boiling water bath has a temperature of 100°C, so if heat over water bath, $\text{CuSO}_4 \cdot \text{H}_2\text{O}$ obtained (see eqn) (B) This will convert hydrated copper(II) sulfate to the anhydrous form. (C) Same as (B)
2	A	(See QA notes)
3	D	X has sulfate ion reacts with barium ion to form insoluble barium sulfate. This is not the reaction of the hydrogen ion in the acid.
4	B	Both aluminium ion and zinc ion forms white ppt which dissolves in excess aq NaOH giving colourless solution. Calcium ion forms white ppt that does not dissolve in excess aq NaOH.
5	B	
6	C	(add up nucleon no. given in the options and compare to 46)
7	D	(write down electron arrangement of ions given in the option and compare) Electron arrangement for: $\text{Ca}^{2+}$ 2,8,8 $\text{Cl}^-$ 2,8,8
8	D	(compare no. of protons and no. of electrons) X: 9 protons, 10 electrons so X is negative ion Y: 17 protons, 18 electrons, so Y is negative ion
9	B	(see the column for ability to conduct electricity in solid and in aq state)
10	C	(compare with N which is in Group V, compound of N and H is $\text{NH}_3$ , so compound of P and H is $\text{PH}_3$ . Check the no. of white dots which represent hydrogen atoms)
11	B	Mass of S = $\frac{\text{no. of S atom} \times \text{Ar of S}}{\text{Mr}}$ x mass of sample
12	B	
13	D	Mass of calcium carbonate in the chalk = $0.226 \times 100 = 22.6\text{g}$ % purity = $22.6 / 23.0 \times 100 = 98.3\%$
14	D	(compare the charge of the positive ion, eg $\text{Na}^+ + e \rightarrow \text{Na}$ )
15	C	Oxygen and hydrogen gas given off (see volumes of gas produced), so hydroxide ion and hydrogen ion discharged. In (1), copper(II) ion discharged instead of hydrogen ion. In (3), chloride ion discharged instead of hydroxide ion due to higher $[\text{Cl}^-]$
16	D	As reaction progresses: (A) Concentration of acid drops (B) More carbonate used (C) More gas produced
17	D	Reaction time, $t = 1 / \text{rate} = 1 / 0.2 = 5.0 \text{ s}$
18	D	(2) is respiration which is exothermic. (see glucose react with oxygen. Both (1) and (3) are combustion of fuel so exothermic.

Apply past knowledge to past knowledge to new situations

16

No.	Ans	Remarks
19	D	(assign oxidation numbers) In $\text{FeTiO}_3$ , oxidation number of Ti is +4, in $\text{TiO}_2$ , oxidation number is +4
20	A	Sodium chloride is neutral, does not react with hydrogen ions in the acid, so pH unchanged
21	C	Hydrochloric acid is strong acid, total ionization. ethanoic acid is weak acid, partial ionization.
22	A	Carbon dioxide is only produced in 2 <sup>nd</sup> reaction. Salt is produced in 1 <sup>st</sup> reaction.
23	D	(Recall properties of ammonium compound, apply this to methyl ammonium chloride) when ammonium chloride react with aq NaOH, ammonia gas, salt (sodium chloride) and water produced.
24	C	With calcium carbonate, soluble salts will be calcium chloride, calcium nitrate. NOT calcium sulfate as it is insoluble With copper(II) carbonate, soluble salts will be copper(II) chloride, copper(II) sulfate, copper(II) nitrate
25	B	Barium sulfate is insoluble, so need two soluble starting reagents. Barium carbonate is also insoluble. Add barium carbonate to dilute hydrochloric acid to form soluble barium chloride, before reacting with the second soluble reagent.
26	B	Copper will not react, remain as residue. Zinc react with dil hydrochloric acid to form colourless solution zinc chloride.
27	B	(A) Lead(II) oxide will be reduced by hydrogen gas to form lead and water (B) Magnesium is higher up in the reactivity series, so hydrogen is not able to reduce magnesium oxide (C) Carbon react with oxygen to form carbon dioxide (D) Sulfur react with oxygen to form sulfur dioxide
28	A	Both P and S are non-metals, so form acidic oxides which dissolves in water to form an acid.
29	C	Going down group II, the carbonate becomes more difficult to decompose. Both magnesium carbonate and calcium carbonate decomposes, but not barium carbonate.
30	C	(2) magnesium will displace silver from silver nitrate (4) magnesium will react with acid to form salt and hydrogen
31	D	Magnesium is a more reactive metal, so loses electron more easily.
32	A	Rusting uses up oxygen. Volume of oxygen used = $150 - 122 = 28 \text{ cm}^3$ % of oxygen = $28 / 150 \times 100 = 18.7\%$
33	A	Chlorine atom reacts with the ozone molecules, so choose the option with largest no. of chlorine atoms.
34	A	Y is $\text{C}_6\text{H}_{14}$ , so it is hexane
35	A	Absence of uv light, so no substitution occurs
36	B	Cyclobutene – $\text{C}_4\text{H}_6$ , cyclopentane – $\text{C}_5\text{H}_8$ , cyclohexene – $\text{C}_6\text{H}_{10}$
37	B	The oil with the lowest bp will have the largest no. of C=C bonds.

Apply past knowledge to past knowledge to new situations

17

No.	Ans	Remarks
38	D	It has C=C so will react with aq bromine With the -COOH, it is an organic acid, so react with metal and alcohol
39	D	(1) True, Hydrogen chloride gas produced (2) True, no more C=C in addition polymers (3) True, only the polymer is produced
40	B	



**Sec 4E GCE O Prelim Chemistry 6092**  
**Answers & mark scheme**

The paper was

- A1a(i) P – box 2; Q – box 9; R – box 3; S – box 13 T – box 6 [1] each  
 (b) (i) elements becomes less metallic. [1]  
 (ii) metallic elements have fewer outer / valence electrons. [1]  
 (c) periodicity is a repeating pattern (across different periods) [1]

[Total: 8]

- A2a(i) Both consists entirely of **carbon** atoms joined by **covalent** bonds; [1]  
 Both have giant lattice (or giant molecular) [1]  
 ii. In diamond every carbon atom is bonded to four other carbon atoms, but in graphite, each carbon atom is bonded to 3 atoms;  
 diamond has a tetrahedral arrangement of atoms but graphite has a layered arrangement;  
 graphite has delocalised electrons unlike diamond which do not. [any 2]  
 b. No. of mole of  $C_{60} = 51 / 720 = 0.0708$  (eqn – optional)  
 No. of mole of  $CO_2 = 60 \times \text{no. of mole of } C_{60} = 0.0708 \times 60 = 4.24$  [1]  
 Mass of  $C_{60} = 4.24 \times 44 = 187$  g [1]  
 c(i) BN [1]  
 ii. weak Van der Waal (or intermolecular) forces of attraction between layers; [1]  
 layers of **atoms** can slide over each other. [1]  
 iii. graphene has **many** strong covalent bond between carbon atoms. [1]

[Total: 10]

- A3a.  $\Delta H = -24 \times 120 = -2880 \text{ kJ/mol}$  [reject if no unit and sign] [1]  
 b(i) Yes, same(not similar) type bond and same number of bond [1]  
 ii. difference in  $\Delta H = 4817 - 4163 = 654 \text{ kJ}$  [1]  
 from hexane to heptane, increase in one  $CH_2$  group  
 from heptane to octane, same increase of one  $CH_2$  group  
 so  $\Delta H$  for octane =  $-(4187 + 654) = -5471 \text{ kJ/mol}$  [1]  
 c(i) No, quote any two data that shows a difference for every ten years. [1]  
 Egs of data that can be used: 1960 -70, 2000 millions of tons bigger than 1970 to 80 which has increase 1200 millions of tons, or 1990 – 2000, increase of 800 millions of tons smaller than 2000 – 2010 increase of 1300 millions of tons.  
 ii. alternative / renewable forms of energy being used; [1]  
 fossil fuel running out. [1]  
 iii. As the amount of fossil fuel burnt increase, the increase average global temperature is higher. [1]

[Total: 8]

- A4a(i)  $Ni(s) \rightarrow Ni^{2+}(aq) + 2e$  [1]  
 ii. mass decrease [1]

*Apply past knowledge to new situations*

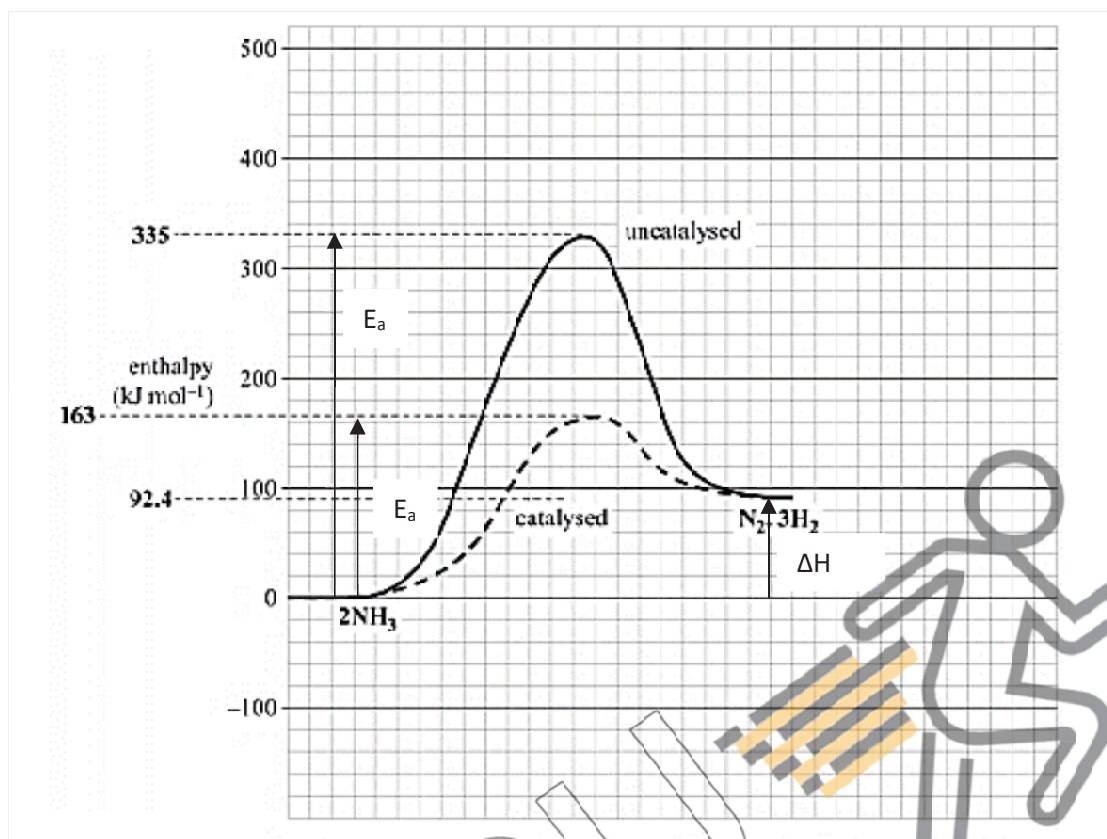
24



- b(i) beryllium; [1]  
It has the largest voltage with cobalt/nickel [1]  
ii.  $-2.7 \text{ V (V + Ag)} + (\text{V + Be})$  [1]  
c(i). both nickel and cobalt has the same reactivity [1]  
ii. Place a piece of nickel in cobalt nitrate solution. If nickel displaces cobalt, nickel is more reactive than cobalt. [1]  
[Total: 7]

- A5a. As concentration increases, the speed of this reaction increases. When concentration increases, there is greater number of particles in the same volume [1]  
Particles are closer to each other so frequency of effective collision increases. [1]  
b(i) 4.5 – 5.0 mg iron reacted/min (units needed)  
ii. As temperature drops, particles loses energy, move slower. [1]  
Number of particles with energy equal to or greater than activation energy drops. [1]  
Frequency of effective collision decreases.  
c. measure the colour intensity of aqueous bromine. [1]  
[Total: 6]

- A6a(i)  $\text{N}\equiv\text{N}$  triple bond; [1]  
A lot of energy is needed to break the (strong covalent) bond [1]  
ii. Advantage: lower temperature / lower pressure so save energy, lesser fossil fuel, or water, instead of hydrogen, water is used, so cheaper [1]  
Disadvantage: nitrogen oxide produced, reacts with oxygen to form nitrogen dioxide which contribute to acid rain / an air pollutant [1]  
b(i) no. of moles of ammonia =  $1.20 / 24 = 0.05$  [1]  
(ii)  $2\text{NH}_3(\text{aq}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow (\text{NH}_4)_2\text{SO}_4(\text{aq})$  (state symbols not needed) [1]  
[1]  
c(i) correct shape and location for both graphs [1m each]  
correct labels of  $E_a$ ,  $E_a''$  and  $\Delta H$  [1]



- b(ii) Tungsten: with it, the reaction has a **lower activation energy**; which means the **higher** proportion of collisions that are successful between ammonia molecules will be higher (not more collisions, both points needed) [1]
- (iii)  $E_a = 243 \text{ kJ/mol}$  (units needed) [1]

[Total: 11]

### Section B

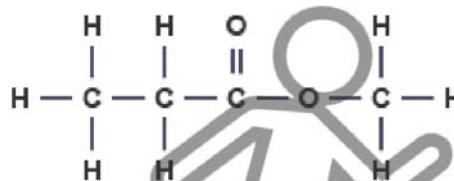
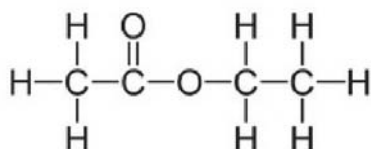
- B7a. sodium chloride,  $\text{Conc}(\text{mol/dm}^3) = 0.457$  (sodium ion is the limiting reactant) [1]
- b(i) as the proton number increases, the group II metal hydroxide becomes more soluble [1]
- ii. no. of mol of  $\text{Mg}^{2+}$  in  $1000 \text{ dm}^3$  sea water =  $0.056 \times 1000 = 56 \text{ mols}$  [1]  
 no. of mol of  $\text{Mg}(\text{OH})_2 = \text{no. of mol of } \text{Mg}^{2+} = 56 \text{ mol}$   
 mass of  $\text{Mg}(\text{OH})_2 = 58 \times 56 = 3248 \text{ g}$  [1]
- c(i)  $\text{Mg}^{2+}(\text{l}) + 2\text{e}^- \rightarrow \text{Mg}(\text{l})$  [1]
- ii an inert gas, instead of air, is blown through the cathode compartment above molten magnesium [1]
- d. sodium chloride and calcium chloride is added to molten magnesium chloride to **lower the melting point**, saving energy. [1]
- e. at the anode, silver will be oxidised instead of chloride ion. Silver ion would be produced rather than chlorine at the anode. [1]  
 $\text{Ag}(\text{s}) \rightarrow \text{Ag}^+(\text{l}) + \text{e}^-$  [1]  
 the silver ion would move to the cathode, get discharged and silver is produced instead at the cathode. [1]

- f. chlorine gas produced during electrolysis is used to convert magnesium oxide to magnesium chloride at the furnace. [1]
- g. magnesium ion, aluminium ion, **delocalised** electron [ all three correct -1]

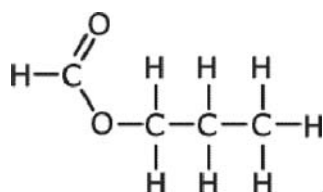
[Total: 12]

B8a(i) relative mass of  $C_2H_4O = 44$  $M_r \sim 88$  $N = 88 / 44 = 2$ Relative molecular formula is  $C_4H_8O_2$  [1]

ii. ethyl ethanoate



Methylpropanoate



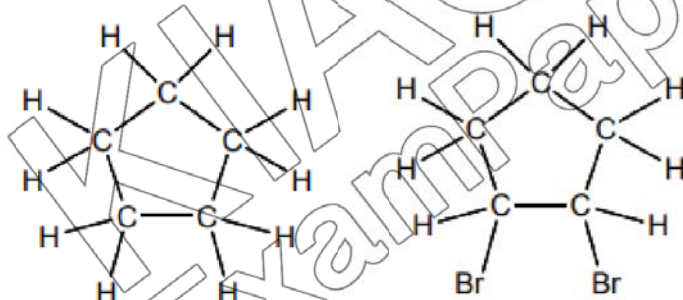
propyl methanoate

[any 2]

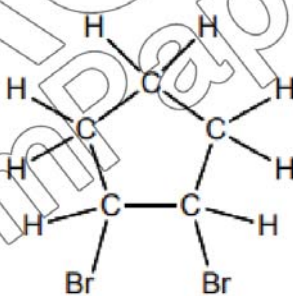
iii. ethanoic acid

b(i)

[1]



Compound X



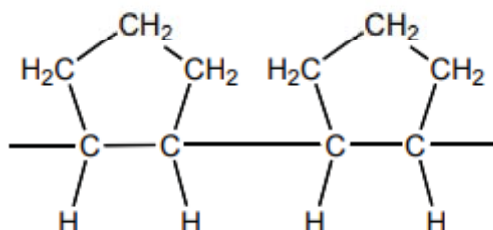
compound Y

[1m for each, all H atoms needed]

ii.  $C_5H_8 + Br_2 \rightarrow C_5H_8Br_2$ 

[1]

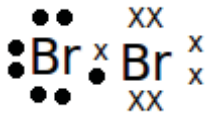
iii.



[Must have at least two repeat units and the free bonds at the end. All carbon-carbon bonds in the polymer chain must be shown.] [1]

[Total: 8]

**B9 Either**

- a(i) bromine [1]  
 ii (dot-cross diagram of bromine molecule,  [1]
- b. iron(III) chloride [1]  
 c(i)  $3\text{Cl}_2 + 2\text{FeBr}_2 \rightarrow 2\text{FeCl}_3 + 2\text{Br}_2$  [1]  
 ii. chlorine [1]  
 chlorine removes electrons from iron(II) ion and bromide ion. [1]  
 d(i) sweet 2 contains an unsafe dye; [1]  
 unknown dye in sweet 3 does not match up with a safe dye [1]  
 ii.  $0.8 / 5.2 = 0.154$  (or 0.15) [1]  
 iii. to see the spots / make the colourless spots visible [1]  
 (ignore 'find / identify the spots')

[Total: 10]

**B9 Or**

- a. Hydrogen ion /  $\text{H}^+$  ion in acid replaced by calcium ion /  $\text{Ca}^{2+}$  ion or metal ion. [1]  
 b. The reaction produced a **gas** / calcium oxide does not produce a **gas** in reaction with acid. [1]  
 calcium carbonate. [1]  
 c. Mr of  $\text{CaCl}_2 = 111$ .  

$$\text{No. of water molecules} = \frac{219 - 111}{18} = 6$$
 [1]  
 Formula:  $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$  [6 and  $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$  score the 2<sup>nd</sup> mark, allow no dot,  $\text{CaCl}_2 6\text{H}_2\text{O}$ ] [1]  
 d. Calcium is oxidised as oxidation state of calcium increases from 0 to +2 [1]  
 Chlorine is reduced as oxidation state of chlorine decreases from 0 to -1 [1]  
 e. barium is very reactive metal, so react violently with the acid, reaction not safe; [1]  
 barium sulfate formed is insoluble, so form a barrier on barium, preventing further reaction. [1]  
 (ii) 2, 8, 18, 18, 8 [1]

[Total:10]





# Geylang Methodist School (Secondary) Preliminary Examination 2018

**CHEMISTRY**

**6092/01**

Paper 1 Multiple Choice

**Sec 4 Express**

Additional materials : OAS

**1 hour**

**Setter** : Mrs Loh Kim Woon

**20 August 2018**

## **READ THESE INSTRUCTIONS FIRST**

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name, class and register number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions.

For each question there are four possible answers **A, B, C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

**Read the instructions on the Answer Sheet very carefully.**

Each correct answer will score one mark.

A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

A copy of the Periodic Table is printed on page 16.

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This document consists of **16** printed pages.

**[Turn over**

1 Which of the following pairs of substances can be separated by heating?

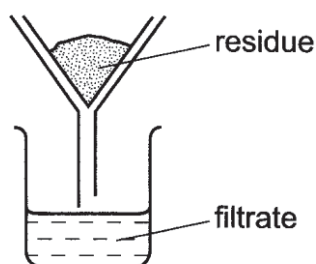
- A ammonium chloride and potassium iodide
- B copper (II) nitrate and potassium iodide
- C ammonium chloride and iodine
- D sodium chloride and copper (II) nitrate

2 The table shows the colours and the solubilities in water of four solids.

solid	colour	solubility in water
W	blue	insoluble
X	blue	soluble
Y	white	insoluble
Z	white	soluble

A mixture containing two of the solids is added to excess water, stirred and filtered.

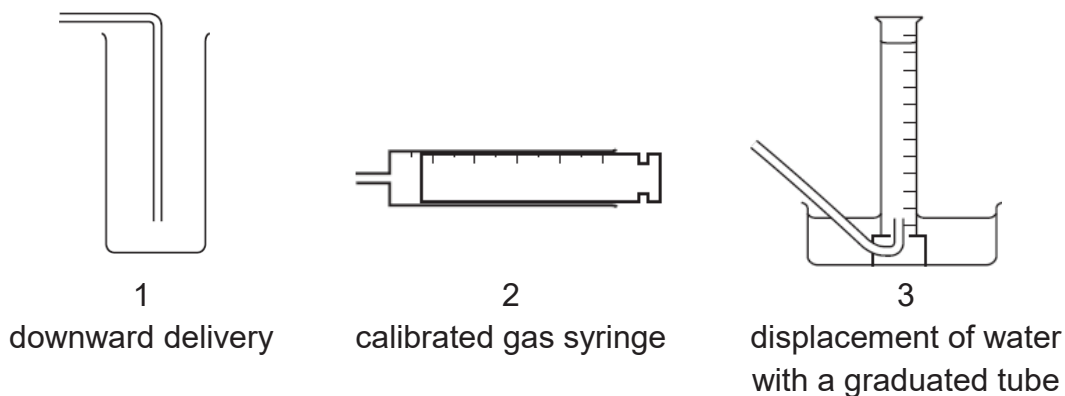
A blue filtrate and a white residue are obtained.



Which two solids are present in the mixture?

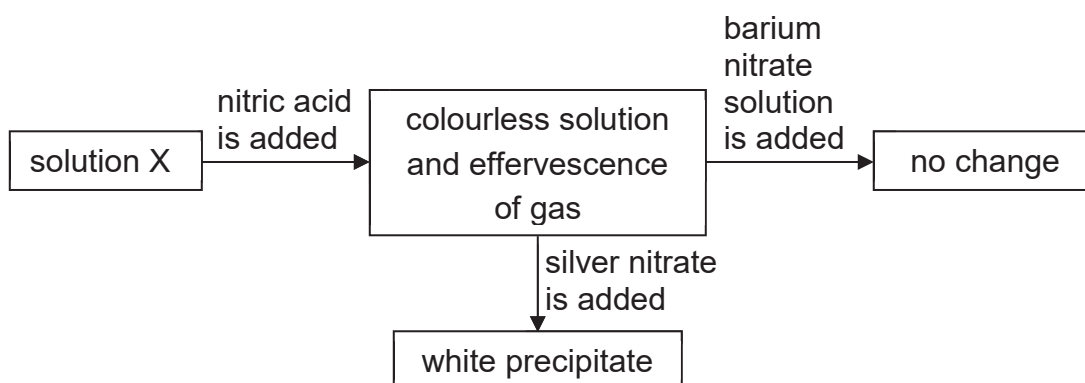
- |          |         |          |         |
|----------|---------|----------|---------|
| <b>A</b> | W and X | <b>B</b> | W and Y |
| <b>C</b> | X and Y | <b>D</b> | X and Z |

- 3** An experiment is carried out to investigate the rate of reaction when calcium carbonate reacts with hydrochloric acid. The volume of carbon dioxide gas given off is measured at different intervals of time. The diagram shows pieces of apparatus used to collect gases.



Which apparatus is suitable to collect and measure the volume of the carbon dioxide?

- A** 1 only      **B** 3 only      **C** 2 and 3      **D** 1, 2 and 3
- 4** Solution X contains two anions. Tests are carried out as shown in the diagram below.



What anions are found in solution X?

- A** sulfate ions and carbonate ions  
**B** carbonate ions and chloride ions  
**C** sulfate ions and chloride ions  
**D** nitrate ions and carbonate ions



- 5 Which statement correctly explains why chlorine,  $\text{Cl}_2$ , at  $40^\circ\text{C}$  diffuses more slowly than neon,  $\text{Ne}$ , at  $20^\circ\text{C}$ ?
- A Chlorine has a relative molecular mass of 71 whilst neon has a relative atomic mass of 20.  
B Chlorine is at a higher temperature than neon.  
C Chlorine is diatomic and neon is monatomic.  
D Chlorine is more reactive than neon.

- 6 Four statements are being made about elements, compounds and mixtures by a student.

Statement 1: Elements and compounds have fixed melting points.

Statement 2: The properties of a compound are similar to that of its elements.

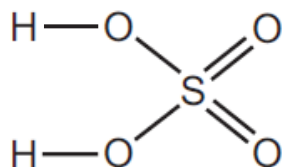
Statement 3: A mixture can be separated into its components by physical means.

Statement 4: Elements can exist either in the form of atoms or molecules.

How many of the above statement(s) is/are **not** correct?

- A one  
B two  
C three  
D four
- 7 Deuterium,  $\text{D}$ , is an isotope of hydrogen.  
Which statement about deuterium is **not** correct?
- A It reacts with ethene,  $\text{C}_2\text{H}_4$ , to form a compound  $\text{CH}_2\text{DCH}_2\text{D}$ .  
B An atom of deuterium contains one proton.  
C It has the same density as hydrogen.  
D It forms the ion  $\text{D}^+$ .

- 8 A molecule of sulfuric acid has the structural formula shown.



How many electrons are involved in forming all the covalent bonds in one molecule of sulfuric acid?

- A 6                      B 8                      C 12                      D 16

- 9 An investigation of the properties of the chlorides of Period III elements shows that the boiling points of sodium chloride and silicon tetrachloride are 1465°C and 57°C respectively. This difference in boiling points is a result of
- A covalent bonds being weaker than ionic bonds.
  - B sodium chloride having strong metallic bonds.
  - C silicon tetrachloride having weak intermolecular forces of attraction.
  - D silicon forming weaker bonds with chlorine than does sodium.

- 10 Compound P is the only substance formed when two volumes of ammonia gas react with one volume of carbon dioxide gas (both volumes being measured at r.t.p.).

What is the formula of P?

- A  $\text{NH}_2\text{CO}_2\text{NH}_4$
  - B  $(\text{NH}_2)_2\text{CO}$
  - C  $\text{NH}_4\text{CO}_2\text{NH}_4$
  - D  $(\text{NH}_4)_2\text{CO}_3$
- 11 When sugar ( $M_r = 342$ ) is fermented using yeast, the following reaction takes place.



What volume of carbon dioxide, at r.t.p., would be produced by the complete fermentation of 1 kg of sugar?

- A  $\frac{342 \times 4 \times 24}{1000} \text{ dm}^3$
  - B  $\frac{1000 \times 24}{342 \times 4} \text{ dm}^3$
  - C  $\frac{342 \times 24}{1000 \times 4} \text{ dm}^3$
  - D  $\frac{1000 \times 4 \times 24}{342} \text{ dm}^3$
- 12 On collision, airbags in cars inflate rapidly due to the production of nitrogen. The nitrogen is formed, in two consecutive steps, according to the following equations.

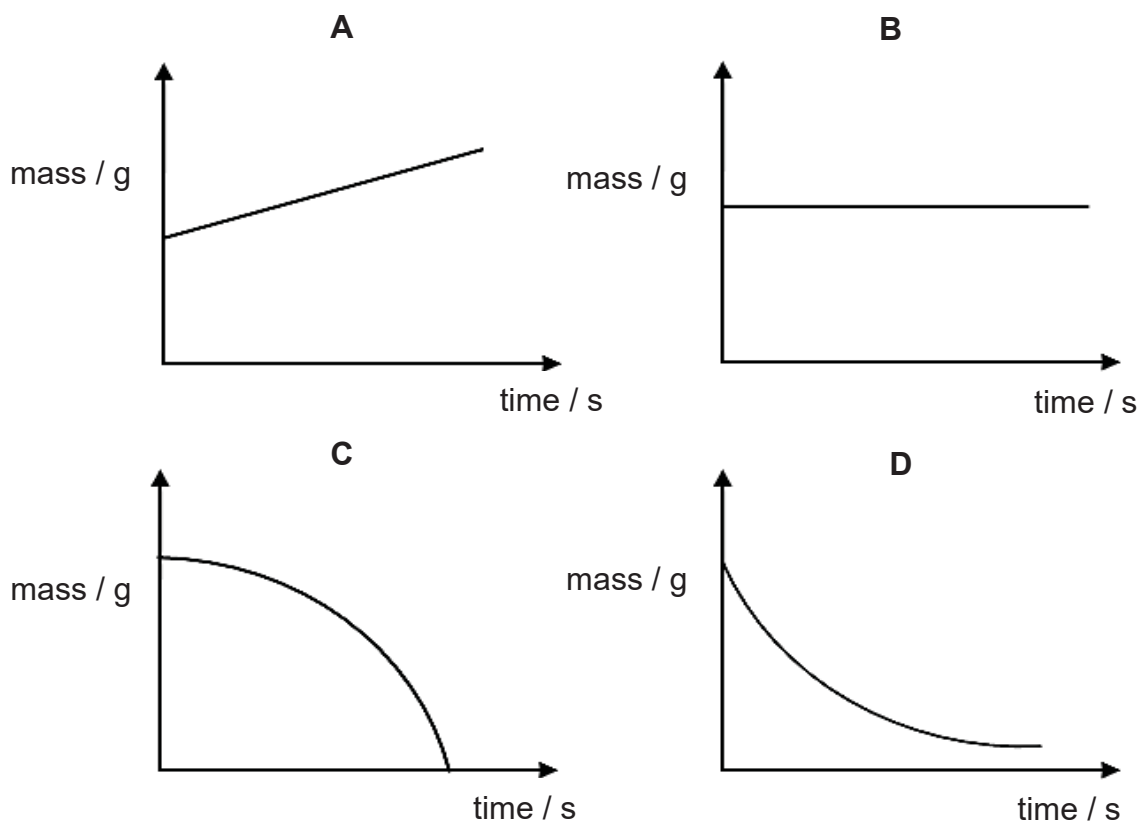


What is the **total** number of moles of nitrogen gas that can be produced from one mole of sodium azide,  $\text{NaN}_3$ ?

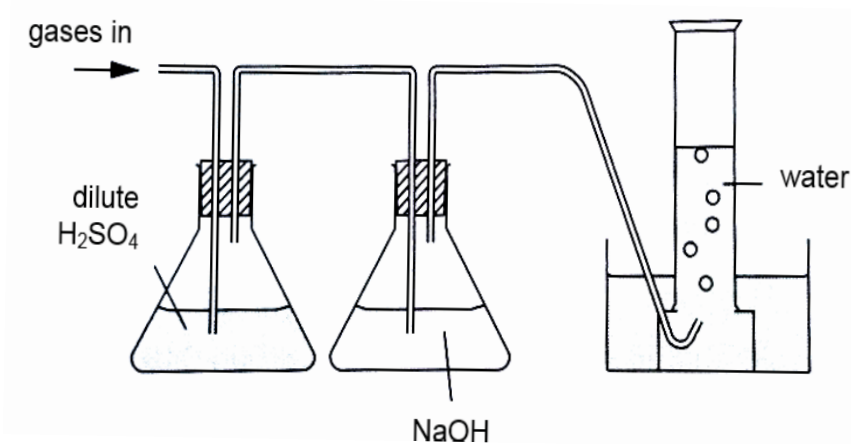
- A 1.5
- B 1.6
- C 3.2
- D 4.0

- 13 Which property would all the hydrogen compounds of the Group VII elements possess?
- A They form covalent compounds.
  - B They are solids at room temperature.
  - C They form alkaline aqueous solutions.
  - D They conduct electricity when molten.
- 14 The properties of the oxides of four elements K, L, M and N in the third period of the Periodic Table are given below.
- The oxide of K is insoluble in water and dilute acid but soluble in concentrated alkali.
  - The oxide of L reacts with both dilute acid and dilute alkali.
  - The oxide of M reacts with dilute alkali at room temperature.
  - The oxide of N dissolves in water to form an alkaline solution.
- If K, L, M and N are placed in order of increasing atomic number, which order is correct?
- A K, L, M, N
  - B N, M, K, L
  - C N, L, K, M
  - D L, K, N, M
- 15 A coil of clean copper wire is suspended in aqueous silver nitrate. Crystals of silver are deposited on the copper wire.
- Which statement is **not** correct?
- A The copper is oxidised.
  - B The total mass of the crystals of silver increases gradually.
  - C The total number of positive ions in the solution is unchanged.
  - D The solution turns blue.
- 16 Which statement about the production of iron from iron oxide in a blast furnace is correct?
- A Limestone is used to remove basic impurities.
  - B The reaction between the iron oxide and carbon monoxide liberates carbon dioxide.
  - C The iron is obtained using carbon monoxide as an oxidising agent.
  - D The iron oxide is reduced by carbon dioxide.

- 17 A known mass of potassium carbonate was placed in an open crucible and heated until there was no further change observed. Which graph shows the change in mass of the crucible and its contents?



- 18 A sample of three gases was passed through the apparatus shown below. It was found that only one gas was collected in the gas jar at the end.



Which of the following could be the mixture of gases in the sample?

- A ammonia, hydrogen, carbon monoxide
- B ammonia, sulfur dioxide, carbon monoxide
- C nitrogen, helium, carbon dioxide
- D oxygen, nitrogen, hydrogen chloride

- 19** Nitrogenous fertiliser such as ammonium nitrate is used to increase crop yield.

Which substance can be added to increase the pH of acidic soil containing ammonium nitrate without causing a loss of nitrogen?

- A** calcium carbonate
- B** calcium hydroxide
- C** magnesium hydroxide
- D** potassium hydroxide

- 20** Which of the following does **not** show the appropriate reagents used for preparation of the named salts?

	salt	reagents
<b>A</b>	barium sulfate	barium nitrate and sulfuric acid
<b>B</b>	lead(II) chloride	lead(II) nitrate and hydrochloric acid
<b>C</b>	lithium nitrate	lithium hydroxide and nitric acid
<b>D</b>	magnesium chloride	magnesium sulfate and hydrochloric acid

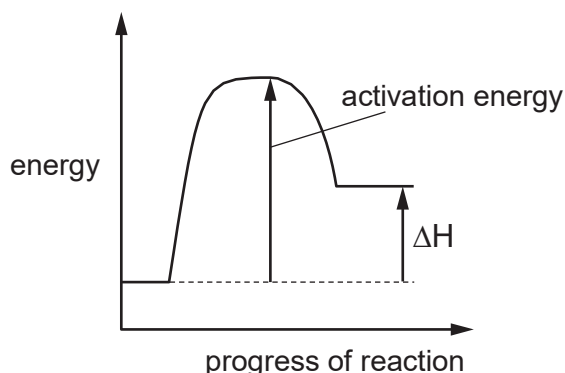
- 21** Which of the following is true about the Haber Process?

- A** The catalyst in the reaction is iron(III) oxide.
- B** The optimum temperature for the reaction is 450°C.
- C** A pressure of above 600 atm will result in lower yields.
- D** 1 mole of nitrogen reacts with 3 moles of hydrogen to form 2 moles of ammonia.

- 22** Which of the following statements best describes the mechanism of a hydrogen-oxygen fuel cell?

- A** Hydrogen and oxygen undergo redox reaction to generate electricity.
- B** Hydrogen ions react with hydroxide ions to generate electricity.
- C** Electricity is used to provide heat energy.
- D** Electricity is used to generate hydrogen and oxygen.

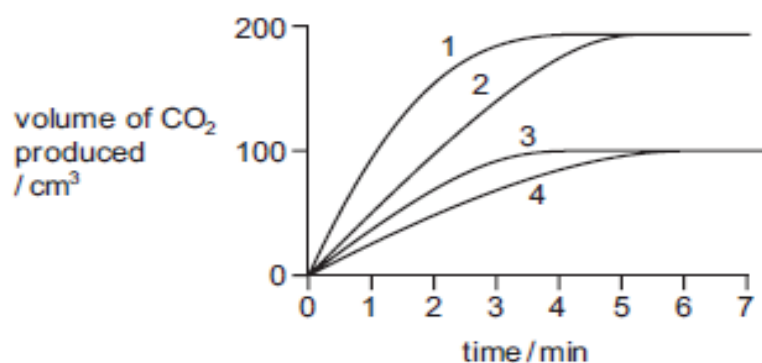
- 23** The energy profile diagram for the forward direction of a reversible reaction is shown.



For the reverse reaction, which row correctly shows the sign of the activation energy and the type of enthalpy change?

	sign of activation energy	type of enthalpy change
<b>A</b>	negative	endothermic
<b>B</b>	negative	exothermic
<b>C</b>	positive	endothermic
<b>D</b>	positive	exothermic

- 24** In four separate experiments, 1, 2, 3 and 4, nitric acid was added to excess marble chips and the volume of carbon dioxide formed was measured. In all four experiments the same volume of nitric acid was used. Its concentration, or temperature, or both concentration and temperature, were changed. The results of the experiments are shown on the graph.



Which statement is correct?

- A** A lower concentration of acid was used in experiment 3 than in experiment 1.
- B** Experiment 4 was faster than experiment 3.
- C** The acid used in experiment 2 was of a lower concentration than in experiment 1.
- D** The temperature of the acid was the same in experiments 1 and 2.

- 25** The following changes could be made to the conditions in the reaction between zinc and hydrochloric acid.

- 1 increase in concentration of the acid
- 2 increase in particle size of the zinc
- 3 increase in pressure on the system
- 4 increase in temperature of the system

Which pair of changes will increase the rate of reaction?

- |          |         |          |         |
|----------|---------|----------|---------|
| <b>A</b> | 1 and 2 | <b>B</b> | 1 and 4 |
| <b>C</b> | 2 and 3 | <b>D</b> | 3 and 4 |

- 26** Disproportionation is a reaction in which the same element is both oxidised and reduced.

Which reaction is an example of disproportionation?

- A**  $3\text{Cu} + 8\text{HNO}_3 \rightarrow 3\text{Cu}(\text{NO}_3)_2 + 2\text{NO} + 4\text{H}_2\text{O}$   
**B**  $2\text{KOH} + \text{H}_2\text{SO}_4 \rightarrow \text{K}_2\text{SO}_4 + 2\text{H}_2\text{O}$   
**C**  $2\text{NO}_2 + \text{H}_2\text{O} \rightarrow \text{HNO}_3 + \text{HNO}_2$   
**D**  $2\text{Pb}(\text{NO}_3)_2 \rightarrow 2\text{PbO} + 4\text{NO}_2 + \text{O}_2$

- 27** Aqueous potassium iodide, KI(aq), can be used as a test reagent in redox reactions.

Iodide ions are readily .....X..... A positive result for the test is when the solution changes colour from .....Y..... to .....Z.....

Which words correctly complete gaps X, Y and Z?

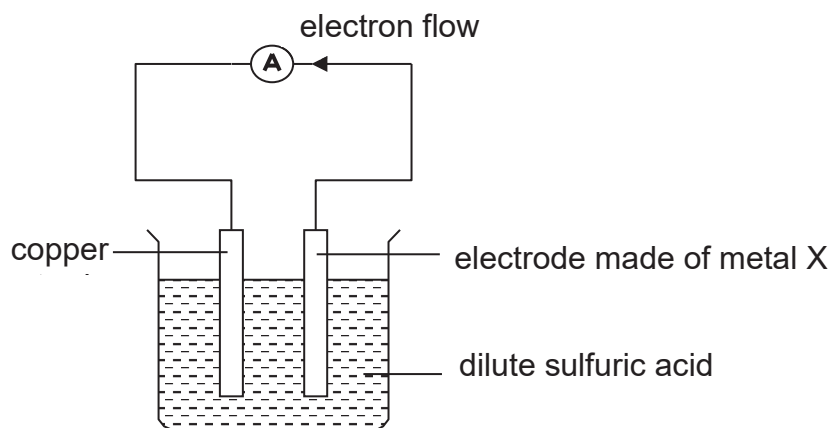
	X	Y	Z
<b>A</b>	oxidised	brown	colourless
<b>B</b>	oxidised	colourless	brown
<b>C</b>	reduced	brown	colourless
<b>D</b>	reduced	colourless	brown

- 28** In an electrolysis experiment, the same amount of charge deposited 54.0 g of silver and 8.5 g of vanadium.

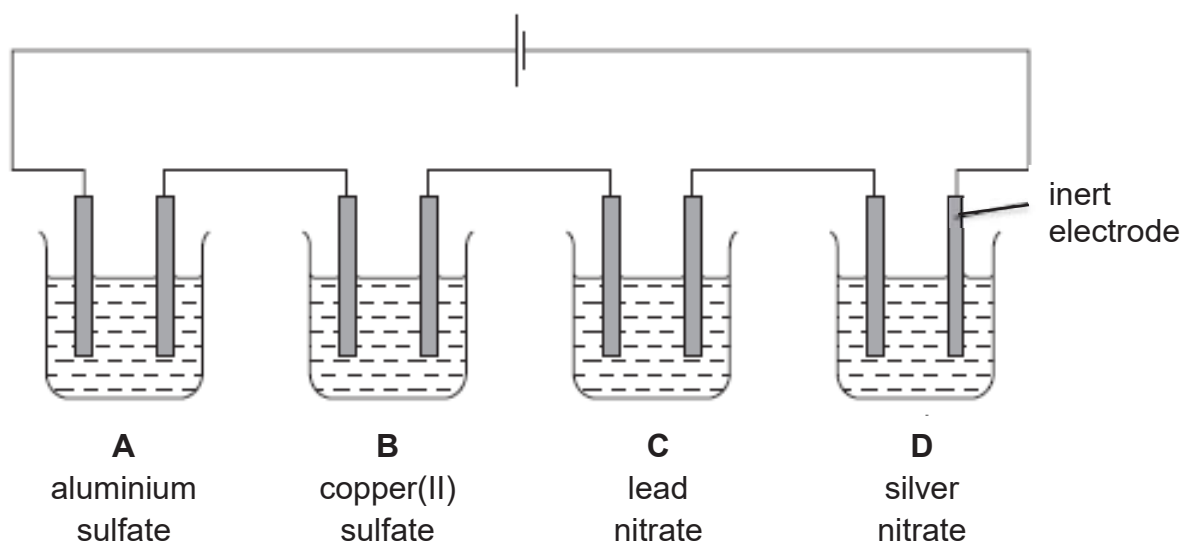
What is the charge on the vanadium ion?

- A** 1+  
**B** 2+  
**C** 3+  
**D** 4+

- 29 With reference to the diagram below, which of the following statements is correct?



- A Copper electrode is the negative electrode.
  - B Metal X is below copper in the reactivity series.
  - C The mass of the copper electrode decreases.
  - D The mass of the metal X electrode decreases.
- 30 When electrolysed using inert electrodes, which dilute solution would produce the greatest increase in mass of the cathode?



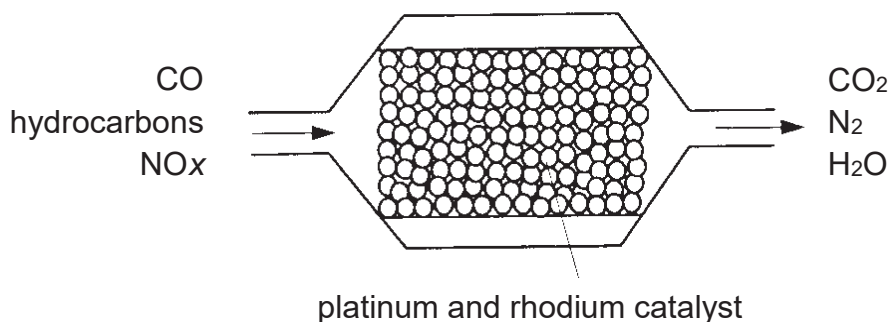


- 31 The table shows some atmospheric pollutants and their possible effects.

Which row is **not** correct?

	pollutant	effect
<b>A</b>	CFCs	cause depletion of the ozone
<b>B</b>	CO <sub>2</sub>	layer forms photochemical smog
<b>C</b>	CO	is poisonous to humans
<b>D</b>	NO <sub>2</sub>	forms acid rain

- 32 The diagram below represents a section of a catalytic converter on the exhaust system of a car. Harmful gases are converted into carbon dioxide, nitrogen and water vapour.



Which processes take place in this catalytic converter?

- I Carbon monoxide and hydrocarbons react together.
- II Carbon monoxide and nitrogen oxides react together.
- III Platinum and rhodium catalyse redox reactions.

- A** I, II and III
- B** I and II only
- C** II and III only
- D** I and III only

**33** Which statement(s) best explains why bitumen has a higher boiling point than paraffin?

- 1 Bitumen is more reactive than paraffin.
- 2 Bitumen is a pure substance whereas paraffin is a mixture.
- 3 Forces of attraction between the molecules of paraffin are weaker than that between the molecules of bitumen.
- 4 There are smaller molecules in bitumen compared to the molecules in paraffin.

- |          |         |          |            |
|----------|---------|----------|------------|
| <b>A</b> | 1 and 2 | <b>B</b> | 1, 2 and 3 |
| <b>C</b> | 3 only  | <b>D</b> | 3 and 4    |

**34** Which compound is the most viscous and the least flammable?

- |          |                |          |                |
|----------|----------------|----------|----------------|
| <b>A</b> | $C_6H_{14}$    | <b>B</b> | $C_8H_{18}$    |
| <b>C</b> | $C_{10}H_{22}$ | <b>D</b> | $C_{12}H_{26}$ |

**35** The second member of a homologous series has the formula  $C_7H_8$ .

What is the formula of the first member?

- |          |          |          |          |
|----------|----------|----------|----------|
| <b>A</b> | $C_6H_6$ | <b>B</b> | $C_6H_8$ |
| <b>C</b> | $C_6H_7$ | <b>D</b> | $C_7H_6$ |

**36** An ester is produced by reacting together the carboxylic acid  $HCO_2H$  and the alcohol  $CH_3CH_2CH_2OH$ .

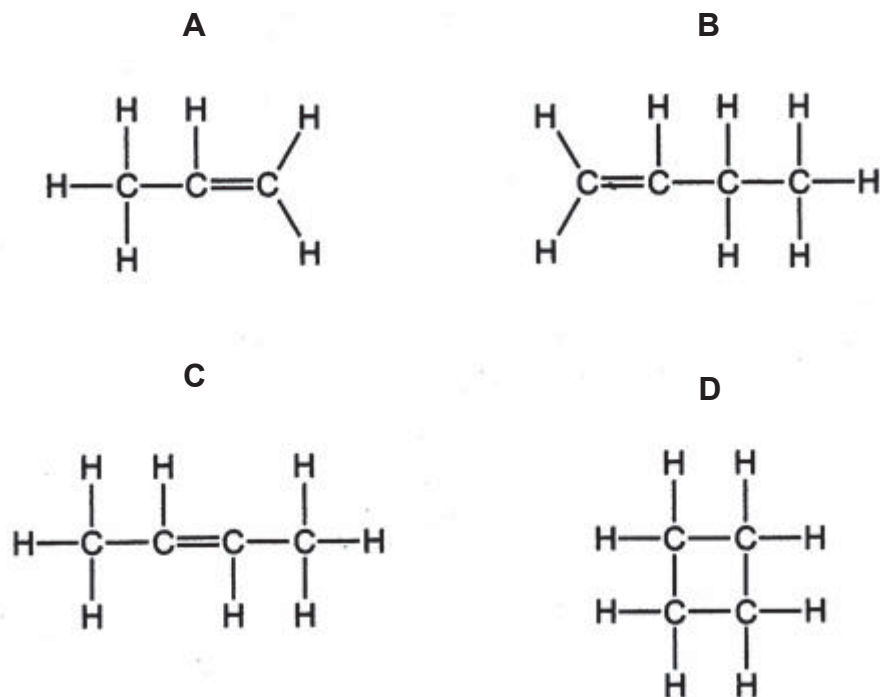
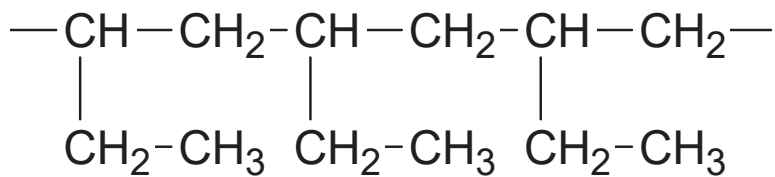
What is the name and structure of this ester?

	name	structure
<b>A</b>	methyl propanoate	$CH_3CH_2CO_2CH_3$
<b>B</b>	methyl propanoate	$HCO_2CH_2CH_2CH_3$
<b>C</b>	propyl methanoate	$CH_3CH_2CO_2CH_3$
<b>D</b>	propyl methanoate	$HCO_2CH_2CH_2CH_3$

**37** Compound Y

- has the empirical formula  $\text{CH}_2$ ,
- has an  $M_r$  of 56,
- forms two alcohols that have different structural formulae when reacted with steam.

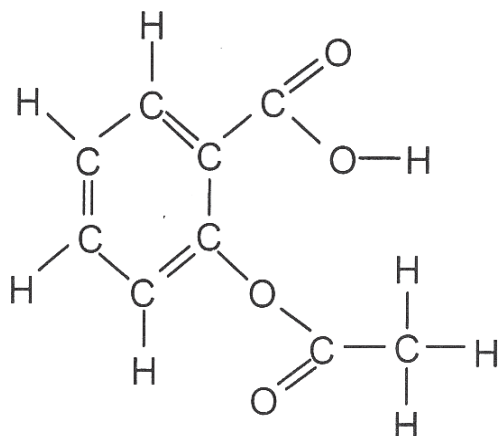
What is compound Y?

**38** The structure of a polymer is shown below.

What is the molecular formula of the monomer?

- A**  $\text{C}_2\text{H}_4$   
**B**  $\text{C}_3\text{H}_8$   
**C**  $\text{C}_4\text{H}_8$   
**D**  $\text{C}_4\text{H}_{10}$

- 39 Aspirin is a drug which is used as a general pain killer. The structural formula of aspirin is shown below.



Which of the following statements about aspirin is **false**?

- A Its aqueous solution reacts with sodium carbonate.
  - B It decolourised aqueous bromine.
  - C It is formed from an alcohol and a carboxylic acid.
  - D It turns purple acidified aqueous potassium manganate (VII) colourless.
- 40 The diagrams show four monomers.



How many of these monomers would react with the molecule below to form a polymer?



- A 1
- B 2
- C 3
- D 4

**End of Paper**



# Geylang Methodist School (Secondary) Preliminary Examination 2018

Candidate  
Name

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Class

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Index Number

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## CHEMISTRY

6092/02

Paper 2

Sec 4 Express

Additional materials : Writing papers

1 hour 45 minutes

Setter : Ms Tan Lay Ming

17 August 2018

### READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.  
Write in dark blue or black pen on both sides of the paper.  
Do not use staples, paper clips, highlighters, glue or correction fluid.

#### Section A

Answer **all** questions in the spaces provided.

#### Section B

Answer **all three** questions, the last question is in the form either/or.  
Write your answers in the writing papers provided.

At the end of the examination, hand in Section A and Section B separately.  
The number of marks is given in brackets [ ] at the end of each question or part question.

A copy of the Periodic Table is printed on page 19.

For Examiner's Use	
Section A	/50
B8	/12
B9	/ 8
B10	/10
Total	80

This document consists of **19** printed pages and **1** blank page.

[Turn over

### Section A

Answer **all** questions in this section in the spaces provided.

The total mark for this section is 50.

**A1** The following table shows some substances and their properties.

substance	melting point (°C)	boiling point (°C)	solubility in water	electrical conductivity	
				when solid	when liquid
<b>A</b>	3550	4830	insoluble	poor	poor
<b>B</b>	-55.6	-78.5	slightly soluble	poor	poor
<b>C</b>	1085	2562	insoluble	good	good
<b>D</b>	801	1413	soluble	poor	good
<b>E</b>	-38.8	357	insoluble	good	good

(a) Using the letters **A**, **B**, **C**, **D** and **E**, which substance(s) is/are likely to have a

(i) simple molecular structure, ..... [1]

(ii) giant covalent structure, ..... [1]

(iii) giant metallic structure. .... [1]

(b) Suggest a possible identity for element **E**.

..... [1]

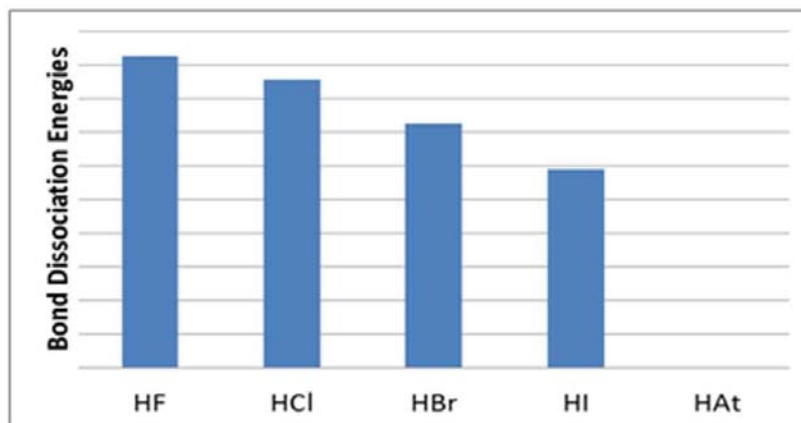
(c) A student passed a current through molten substance **D** and after a while, a gas which rekindled a glowing splint was produced at the anode.

Write an ionic half-equation, including state symbols, for the reaction that happened at the anode.

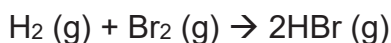
..... [2]

[Total: 6]

- A2** The bond dissociation energies of some hydrogen halides are shown in the chart below. Bond dissociation energy is the energy that must be provided to the molecule in order to break the bond.



- (a) Describe the trend shown in the above chart.  
 ..... [1]
- (b) Predict the bond dissociation energy of hydrogen astatide, HAt, by drawing the rectangular bar in the chart above. [1]
- (c) (i) Suggest which one of the hydrogen halides forms the strongest acid.  
 ..... [1]
- (ii) Explain your answer to (c)(i).  
 .....  
 ..... [2]
- (d) Hydrogen bromide can be produced by reacting hydrogen and bromine according to the following reaction.



The bond energies of some bonds are shown in the table below.

bond	H-H	H-Br	Br-Br
bond energy (kJ/mol)	432	363	193

Calculate the enthalpy change of this reaction and state whether it is exothermic or endothermic.

[2]

[Total: 7]

**A3** This information comes from a textbook about elderberries.

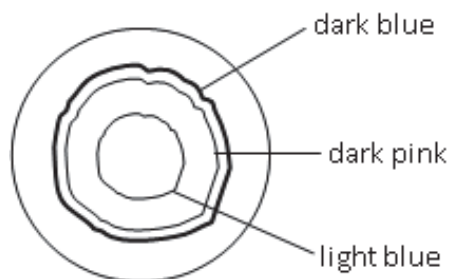
Elderberries are widely used in wine making. Extract of elderberries is a useful pH indicator and it can be separated by chromatography.

As an indicator, the colour of the extract changes to pink at a pH of 2 – 3 and to blue at a pH of 11 – 12.



elderberries

- (a) The chromatogram shown below was obtained when water was added to a drop of elderberries extract at the centre of a filter paper.

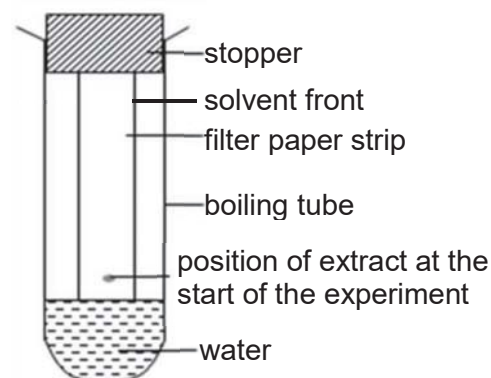


- (i) Predict the colour of the elderberries extract at pH 7.

.....[1]

- (ii) An alternative set-up for the above experiment was shown below.

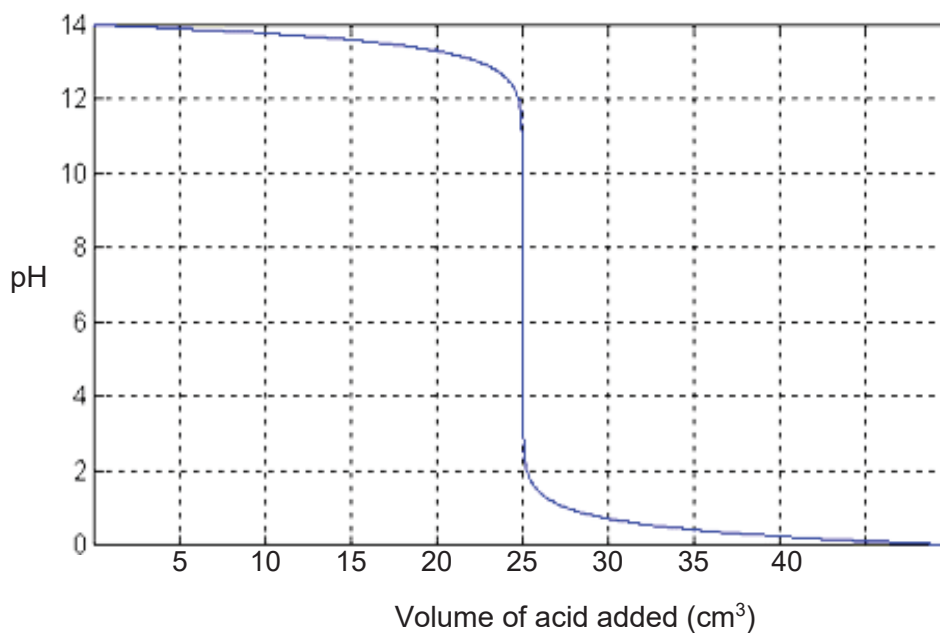
dye	$R_f$ value	distance travelled (cm)
light blue	0.2	
dark pink	0.4	1.00
dark blue	0.5	



Given that the distance travelled by the dark pink dye is 1.00 cm, complete the table above by stating the distance travelled by the light blue and dark blue dyes. [2]



- (b) The diagram below shows how pH values changed during a titration when an acid was added from a burette into a solution of an alkali. Some drops of elderberries extract were added at the start of titration.



- (i) Suggest one possible chemical formula of the alkali.

..... [1]

- (ii) State the colour of the elderberries extract when the volume of acid added was

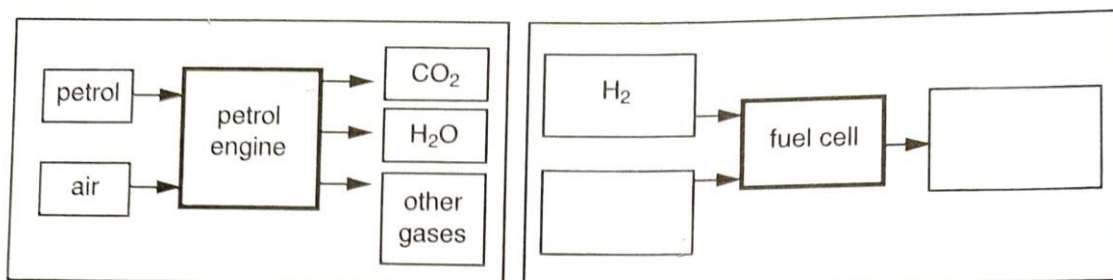
20 cm<sup>3</sup>, ..... [1]

30 cm<sup>3</sup>. ..... [1]

[Total: 6]

- A4** Most vehicles have petrol or diesel engines, but some use fuel cells.

The flow charts show the substances entering and leaving a petrol engine and a fuel cell.



- (a) Complete the flow chart for the fuel cell by filling in the empty boxes. [1]
- (b) The waste products from vehicles with petrol engines cause more harm to human health than those from vehicles with fuel cells.

Explain why this statement is true.

.....

.....

.....

..... [3]

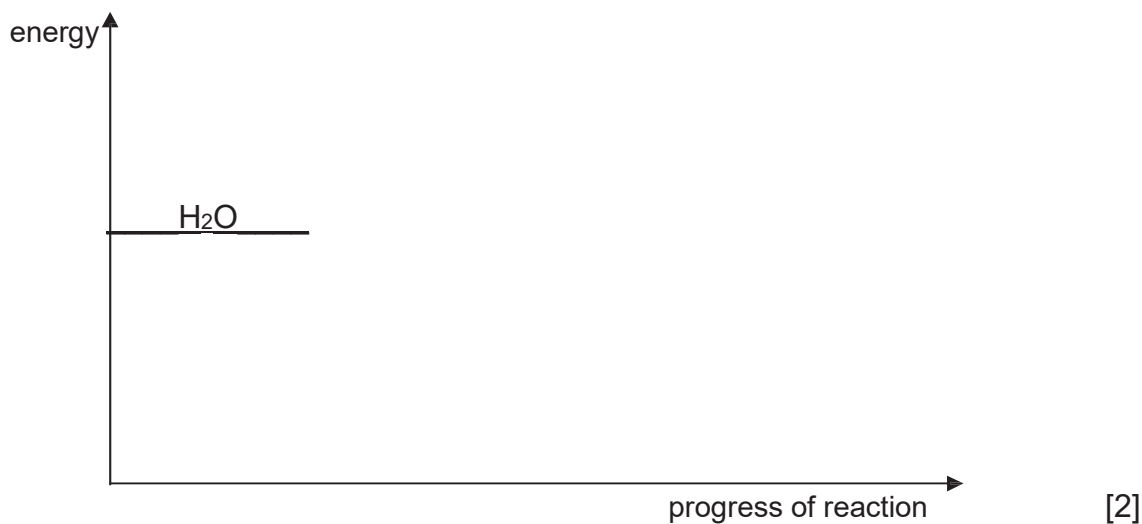
- (c) Hydrogen for fuel cells can be obtained from water by electrolysis.

Electricity is used to provide energy for the electrolysis.

Complete the energy profile diagram for the electrolysis of water.

Your diagram should include

- the **formulae of the products** of the electrolysis,
- a label for the **enthalpy change of reaction**.



[2]

[Total: 6]

**A5** A laboratory assistant has six elements that are **consecutively** arranged in the Periodic Table. He randomly assigns each element a letter, T, V, W, X, Y and Z. The letters do not represent the atomic symbols and the order of the elements.

He carried out some experiments on the elements and found the following properties.

- $V_2$  reacts with  $X_2$  to form a compound  $VX_3$ .
- Y forms a carbonate that decomposes to carbon dioxide and an oxide on heating.
- W reacts with  $T_2$  to form  $W_2T$ .  $W_2T$  dissolves in water to form a solution that turns purple with addition of Universal Indicator.
- Z is a gaseous element. It is used in advertising strip lights.

(a) Identify the following elements

- (i) T, ..... [1]
- (ii) W, ..... [1]
- (iii) Z. .... [1]

(b) Write down the product(s) formed from the reaction between

- (i) Y and  $Cl_2$ , ..... [1]
- (ii)  $X_2$  and  $NaCl$ . .... [1]

(c) State the industrial conditions required to produce  $VH_3$ . (H is hydrogen).

.....

..... [2]

[Total: 7]

- A6** The table below shows some information regarding three materials. They are Kevlar, polyglycine and Teflon.

name of material	structure of polymer
Kevlar	$\left[ \begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{C}_6\text{H}_4-\text{C}-\text{N}-\text{C}_6\text{H}_4-\text{N}- \end{array} \right]_n$
polyglycine	$\left[ \begin{array}{c} \text{H} \quad \text{H} \quad \text{O} \\   \quad   \quad \parallel \\ -\text{N}-\text{C}-\text{C}- \\   \quad   \\ \text{H} \quad \end{array} \right]_n$
Teflon	$\left[ \begin{array}{c} \text{F} \quad \text{F} \\   \quad   \\ -\text{C}-\text{C}- \\   \quad   \\ \text{F} \quad \text{F} \end{array} \right]_n$

- (a) Identify the reaction that formed

- (i) Kevlar, ..... [1]
- (ii) polyglycine, ..... [1]
- (iii) Teflon. .... [1]

- (b) During polymerisation to form Kevlar and polyglycine, hydrogen chloride and water are released respectively.

Draw the structure of the monomer(s) that formed

- (i) Kevlar,

[2]

(ii) polyglycine.

[1]

(c) Suggest the structural formulae of the products formed from a reaction between glycine and ethanol.

[2]

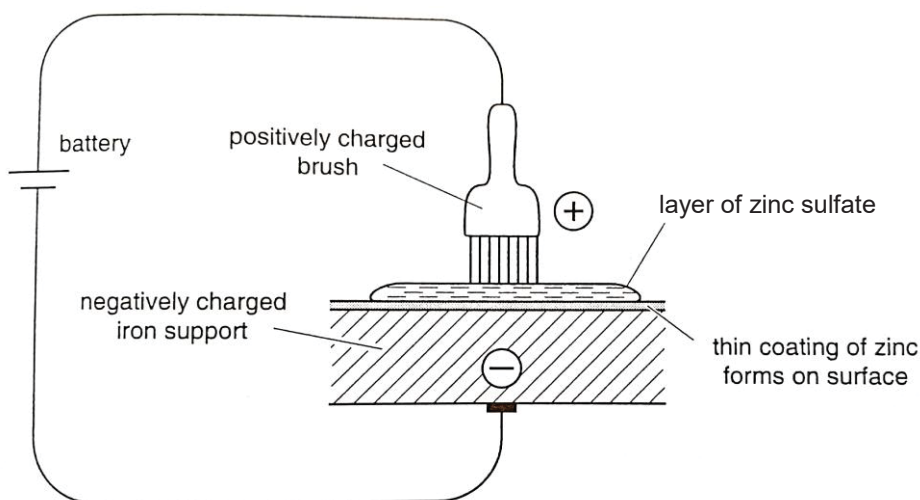
[Total: 8]

- A7** A new type of electroplating is known as 'brush electroplating'. It is used to electroplate zinc onto very large iron supports to be used in buildings. The iron supports are too big to be plated in a normal electrolysis tank.

During the process, a metal brush spreads a layer of aqueous zinc sulfate over the iron surface.

A battery gives the brush a positive charge and gives the iron support a negative charge.

A layer of zinc forms on the surface of the iron support.



- (a) The surface of the iron acts as a cathode.  
Zinc ions from the solution form zinc on the surface of the iron.

Write an ionic half-equation, with state symbols, for this reaction.

..... [2]

- (b) Two different designs of metal brush are available.  
One type of brush is made from zinc, one type is made from platinum.  
As the electrolysis takes place, each brush has a different effect on the concentration of zinc ions in the solution.

- (i) What will happen to the concentration of the zinc ions during the electrolysis if the brush is made from platinum?

..... [1]

- (ii) What will happen to the concentration of the zinc ions during the electrolysis if the brush is made from zinc?

..... [1]

- (iii) Platinum brushes are much more expensive than zinc brushes. However, zinc brushes need replacing regularly but platinum brushes do not. Explain why.

.....  
..... [2]

- (c) During the process, a worker needs to hold the brush.

Which of the following materials would be a good choice for the handle of the brush? Give a reason for your answer.

chromium    copper    graphite    iron    poly(ethene)

material ..... [1]

reason ..... [1]

- (d) Explain why iron supports coated with zinc do not rust, even if the zinc coating is damaged.

.....  
..... [2]

[Total: 10]

**End of Section A**



### Section B

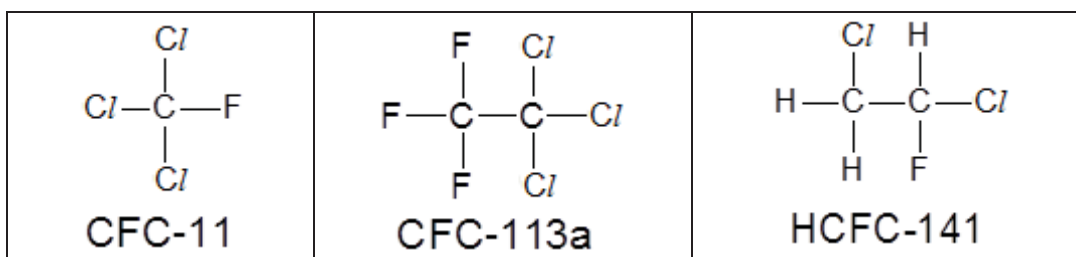
Answer all **three** questions from this section.

The last question is in the form of an either/or and only **one** of the alternatives should be attempted.

The total mark for this section is 30.

Write your answers in the writing papers provided.

- B8** Chlorofluorocarbons (CFCs) are inert on the Earth's surface. However in the stratosphere, they are very reactive. CFCs are part of a group of compounds which can be classified as ozone depleting compounds. Other than CFCs, there are also hydrofluorocarbons (HFCs), hydrochlorofluorocarbons (HCFCs) and perfluorocarbons (PFCs). Some common examples of CFC and HCFC molecules are shown below with their names.



A naming system for these substances was devised several decades ago. The prefixes to the name tell us the elements present in the compound as shown in the table below.

prefix	elements present
PFC	carbon, fluorine
CFC	carbon, fluorine, chlorine
HFC	hydrogen, carbon, fluorine
HCFC	hydrogen, carbon, fluorine, chlorine

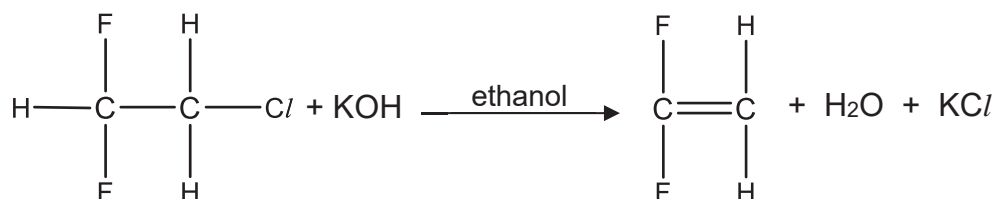
The numbers suffixed to the names of the compounds give us the number of each type of atom present in one molecule of the compound. The key to decoding the number is simply to add 90 to the number suffixed to the name.

For example, to decode the number of atoms in CFC-113a, we add 113 to 90 to obtain 203. The first number, 2, tells us the number of carbon atoms, the second number, 0, tells us the number of hydrogen atoms, and the third number, 3, tells us the number of fluorine atoms. Chlorine atoms make up the remaining bonds since all these compounds are saturated.

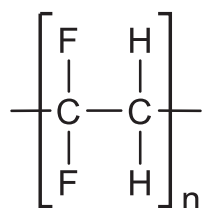
The letter 'a' in CFC-113a tells us about the structural formula of the compound. The arrangement of the type of atoms in the compound that most evenly distributes atomic masses has no letter. The second most even distribution is given the letter 'a', the third most even distribution is given the letter 'b', so on and so forth.

molecule	atomic mass on left carbon	atomic mass on right carbon
$  \begin{array}{c}  \text{F} \quad \text{F} \\    \quad   \\  \text{Cl}-\text{C}-\text{C}-\text{Cl} \\    \quad   \\  \text{F} \quad \text{Cl} \\  \text{CFC-113}  \end{array}  $	73.5	90
$  \begin{array}{c}  \text{F} \quad \text{Cl} \\    \quad   \\  \text{F}-\text{C}-\text{C}-\text{Cl} \\    \quad   \\  \text{F} \quad \text{Cl} \\  \text{CFC-113a}  \end{array}  $	57	106.5

Although most of these substances are harmful to the ozone layer, they can also be used to make polymers by first converting them to alkenes. For example, HCFCs react with potassium hydroxide which is dissolved in ethanol (solvent) to give an alkene, potassium chloride and water. An example of the reaction is shown below.



The alkene produced from the above reaction can be used to make useful polymers such as the one shown below.



(a) Draw the structure of a PFC molecule with two carbon atoms.

[1]

- (b) Copy the table below and draw the other two isomers of HCFC-141 in the correct respective boxes. [2]

HCFC-141a	HCFC-141b

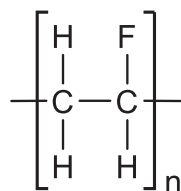
- (c) A student comments that HFCs are safer alternatives to CFCs as HFCs do not harm the environment like CFCs do.

Explain why the student is correct. [1]

- (d) Use the naming system discussed in the passage, write down the names of the following molecules.



- (e) (i) A scientist wants to produce the polymer, polyvinyl fluoride, using HCFCs.



polyvinyl fluoride

Using a suitable HCFC, write down **two** equations showing the reactions he has to carry out to produce polyvinyl fluoride. Show the structures of all the organic compounds in your equations. [3]

- (ii) Samples of the polyvinyl fluoride polymer produced were analysed and found to have a maximum relative molecular mass of 12000.

What is the maximum number of repeating units for this polymer? [2]

[Total: 12]

- B9** Fats and oils such as butter, lard, tallow and coconut are compounds formed by the reaction between fatty acids and an alcohol. Fatty acids may be saturated or unsaturated in nature.

A student collected some data about fatty acids present in some common types of oil or fats, which are shown in the table below.

types of oil or fats \ types of fatty acids	% by mass of fatty acid present in substance				
	lauric acid	palmitic acid	stearic acid	oleic acid	linoleic acid
butter	2-3	23-26	10-13	30-40	4-5
lard	<1	28-30	12-18	41-48	6-7
tallow	<1	24-32	14-32	35-38	2-4
coconut	45-51	4-10	1-5	2-10	0-2

Lauric acid, palmitic acid and linoleic acid are unsaturated fatty acids while stearic acid and oleic acid are saturated fatty acids. Fats and oils containing saturated fatty acids are less healthy than unsaturated ones.

- (a) Linoleic acid,  $C_{17}H_{31}COOH$  is a fatty acid found mainly in sunflower or palm oil. Stearic acid has a molecular formula of  $C_{17}H_{35}COOH$ .
- (i) State the reagent and conditions required to form stearic acid from linoleic acid in the laboratory. [2]
- (ii) Describe an experiment to show that all the linoleic acid had reacted completely to produce stearic acid. You are to include the expected observation. [3]
- (b) Which types of oil or fats is the healthiest? Explain your answer. [1]
- (c) 10 g of oil ( $M_r = 800$ ) completely reacted with  $1.8 \text{ dm}^3$  of hydrogen measured at room temperature and pressure.

Calculate the number of moles of hydrogen that react with one mole of the oil. Hence, deduce how many  $C = C$  bonds there are in one molecule of this oil. [2]

[Total: 8]

**EITHER**

**B10** Sulfur dioxide reacts with chlorine gas in the presence of a catalyst to form a single liquid product, sulfuryl chloride,  $\text{SO}_2\text{Cl}_2$ .

(a) Draw a 'dot-and-cross' diagram for chlorine gas.  
Show the outer shell electrons only. [2]

(b) Student A says, "The sulfur in sulfur dioxide is oxidised."  
Student B says, "Sulfur dioxide is an oxidising agent."

Do you agree with both of them, one of them or neither of them?  
Explain your answer. [2]

(c) Sulfuryl chloride can be heated to produce sulfur dioxide and chlorine.

How can the identities of these two gases be confirmed? [2]

(d) Sulfuryl chloride reacts with water to form two strong acids. One is a dibasic acid while the other is a monobasic acid.

(i) Write down the equation for this reaction. [1]

(ii) Calculate the volume of  $0.5 \text{ mol/dm}^3$  of dilute sodium hydroxide required to completely neutralise the acidic solution produced by reacting one mole of sulfuryl chloride with water. [3]

[Total: 10]

OR

**B10** Calcium carbonate decomposes when it is heated.



In an experiment, 10.5 g of calcium carbonate was heated to a constant temperature.

- (a) Sketch a graph to show how the volume of carbon dioxide collected changes with time.  
Explain your answer. [4]
- (b) Calculate the maximum volume of carbon dioxide, at room temperature and pressure, that can be formed from 10.5 g of calcium carbonate. [2]
- (c) The experiment was repeated under the same conditions using zinc carbonate instead of calcium carbonate.
- (i) Describe how the rates of the reactions would be different.  
Explain your answer. [2]
- (ii) The same mass (10.5 g) of zinc carbonate was used. Would the total volume of carbon dioxide formed be the same?  
Explain your answer. [2]

[Total: 10]

**End of paper**

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# Marking Scheme

## Geylang Methodist School (Secondary) Preliminary Exam 2018 Chemistry 6092

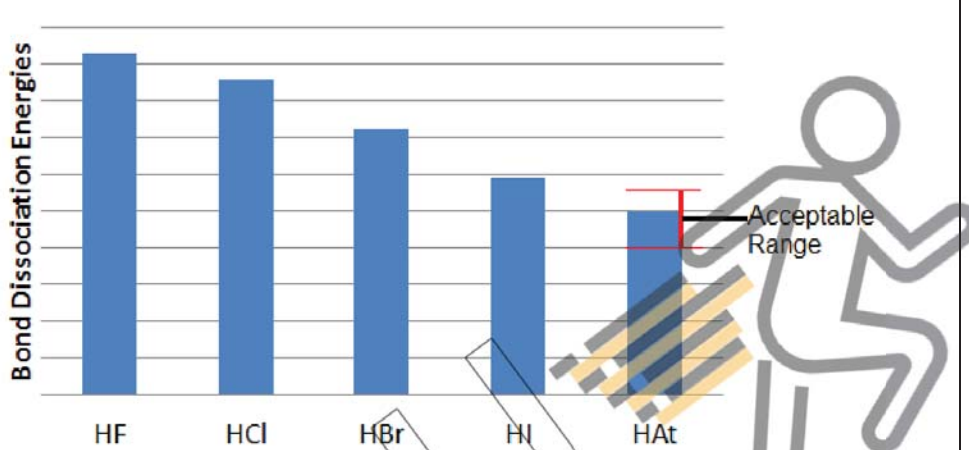
### Paper 1

1	A	11	D	21	B	31	B
2	C	12	B	22	A	32	C
3	C	13	A	23	D	33	C
4	B	14	C	24	A	34	D
5	A	15	C	25	B	35	A
6	A	16	B	26	C	36	D
7	C	17	B	27	B	37	B
8	D	18	B	28	C	38	C
9	C	19	A	29	D	39	D
10	A	20	D	30	D	40	C

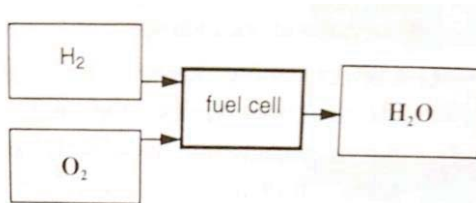
### Paper 2 **Section A**

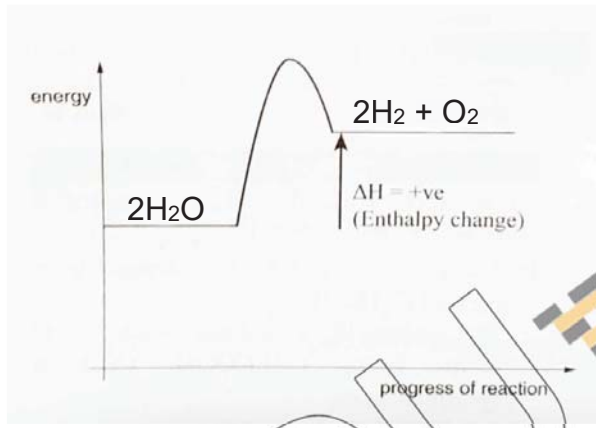
A1	(a)	i. B ii. A iii. C and E <u>Note:</u> both answers must be correct to award 1 mark.	[1] [1] [1]
	(b)	Mercury	[1]
	(c)	$2\text{O}^{2-}(\text{l}) \rightarrow \text{O}_2(\text{g}) + 4\text{e}^-$ <u>Note:</u> [1] for chemically balanced ionic equation without state symbols.	[2]
A2	(a)	The bond dissociation energies of hydrogen halides decreases from HF to HAt.	[1]



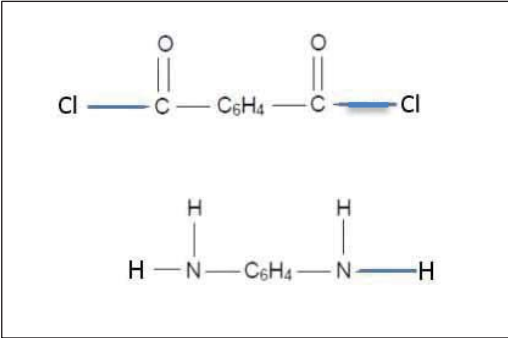
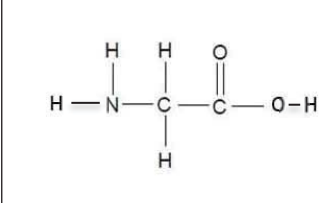
A2	(b)	 <p>Accept if answer is between 200-275kJ/mol</p>	[1]
	(c)	<p>i. HAt <u>Note</u>: chemical name is acceptable.</p> <p>ii. HAt has the lowest bond dissociation energy therefore hydrogen ions will be produced most easily.</p>	<p>[1]</p> <p>[1]</p> <p>[1]</p>
	(d)	<p>Enthalpy change = <math>432 + 193 - 2(363) = -101 \text{ kJ}</math></p> <p>Exothermic reaction</p>	<p>[1]</p> <p>[1]</p>

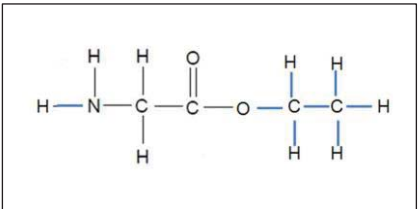
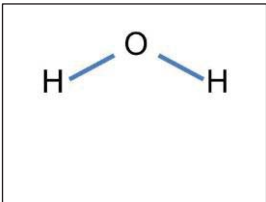
A3	(a) i	<p>Purple / violet</p> <p>Acceptable: bluish-purple or purplish-blue</p>	[1]
	(a) ii	<p>Light blue – 0.500 (3sf)</p> <p>Dark blue – 1.25 (3sf)</p>	<p>[1]</p> <p>[1]</p>
	(b) i	Any strong alkali such as NaOH, KOH	[1]
	(b) ii	<p>20 cm<sup>3</sup> – blue</p> <p>30 cm<sup>3</sup> - pink</p>	<p>[1]</p> <p>[1]</p>

A4	(a)	 <p><u>Note</u>: Both answers must be correct to award 1 mark.</p>	[1]
	(b)	<p>Steam, which is the product of fuel cell, has no adverse effect on human health.</p> <p>Waste product, like <u>carbon monoxide</u>, from <u>incomplete combustion</u> of petrol, can <u>react with haemoglobin in blood to form carboxyhaemoglobin</u>. As a result, <u>haemoglobin cannot transport oxygen to the rest of the body</u>.</p>	<p>[1]</p> <p>[1]</p> <p>[1]</p>

A4	(c)	 <p>[1] – correct graph [1] – for correct labelling</p>	[2]
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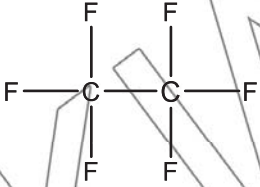
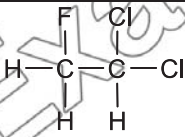
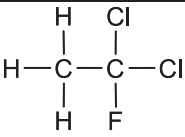
A5	(a)	i. Oxygen ii. Sodium iii. Neon	[1] [1] [1]
	(b)	i. $\text{YCl}_2$ Accept: magnesium chloride ii. $\text{NaX}$ and $\text{Cl}_2$ Accept: sodium fluoride and chlorine	[1] [1]
A5	(c)	200-250atm 400-500°C Iron catalyst <u>Note:</u> 2 marks for 3 correct answers; 1 mark for 2 correct answers.	[2]

A6	(a)	i. condensation polymerisation ii. condensation polymerisation iii. addition polymerisation	[1] [1] [1]
	(b)	i. <div style="text-align: center;">  </div>	[1] [1]
		ii. <div style="text-align: center;">  </div>	[1]

	(c)	 	[1] for each
--	-----	--	--------------

A7 (a)	$\text{Zn}^{2+} (\text{aq}) + 2\text{e}^- \rightarrow \text{Zn} (\text{s})$	[2]
(b)	i. Concentration of zinc ions will decrease over time.	[1]
	ii. Concentration of zinc ions will remain constant throughout electrolysis.	[1]
	iii. Zinc brush will form zinc ions during electrolysis and will be used up whereas platinum is an inert electrode therefore no change in mass.	[1] [1]
(c)	Material – poly(ethene) Reason – It does not conduct electricity.	[1] [1]
A7(d)	Zinc is <u>more reactive</u> than iron and therefore <u>provides sacrificial protection</u> by corroding in place of iron.	[1] [1]

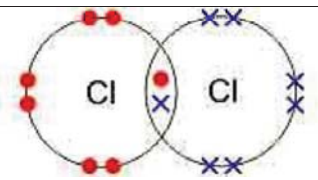
## Section B

B8 (a)		[1]
(b)	<div style="display: flex; justify-content: space-around;"> <div> <p>HCFC-141a</p>  </div> <div> <p>HCFC-141b</p>  </div> </div>	[2]
	[1] for each box.	
(c)	HFCs do not contain <u>chlorine atoms</u> which will <u>deplete the ozone layer</u> .	[1]
(d)	i. CFC-111 ii. HCFC-132a Note: 1 mark for 132, 1 mark for a	[1] [2]

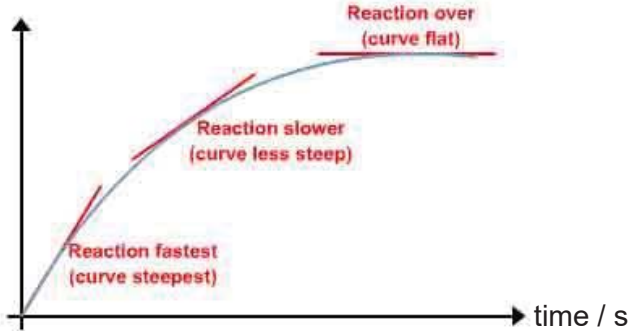
i.

B8(e)	$\text{I: } \begin{array}{c} \text{H} \quad \text{F} \\   \quad   \\ \text{H}-\text{C}-\text{C}-\text{H} \\   \quad   \\ \text{Cl} \quad \text{H} \end{array} + \text{KOH} \xrightarrow{\text{ethanol}} \begin{array}{c} \text{H} \quad \text{F} \\   \quad   \\ \text{C}=\text{C} \\   \quad   \\ \text{H} \quad \text{H} \end{array} + \text{H}_2\text{O} + \text{KCl}$ <p>1 mark for correct HCFC used; 1 mark for equation.</p> $\text{II: } n \left[ \begin{array}{c} \text{H} \quad \text{F} \\   \quad   \\ \text{C}=\text{C} \\   \quad   \\ \text{H} \quad \text{H} \end{array} \right] \longrightarrow \left[ \begin{array}{c} \text{H} \quad \text{F} \\   \quad   \\ -\text{C}-\text{C}- \\   \quad   \\ \text{H} \quad \text{H} \end{array} \right]_n$	<p>[2]</p> <p>[1]</p>
(e)	<p>ii. <math>M_r</math> of repeating unit: <math>12 \times 2 + 19 + 1 \times 3 = 46</math></p> <p>No. of repeating units: <math>12000/46 = 260</math> (round down)</p>	<p>[1]</p> <p>[1]</p>
B9(a)	<p>i. Reagent: hydrogen gas Conditions: Nickel as catalyst, <math>200^\circ\text{C}</math></p> <p>ii. Add aqueous bromine to the reaction mixture. If all the linoleic acid has reacted, the reddish-brown colour of bromine remains. If some linoleic acid is present, the reddish-brown colour of bromine decolourises rapidly.</p>	<p>[1]</p> <p>[1]</p> <p>[1]</p> <p>[1]</p>
B9(b)	<p>Coconut oil is the healthiest. It contains the <u>highest</u> percentage of unsaturated fatty acids/ It contains the <u>lowest</u> percentage of saturated fatty acids.</p> <p><u>Note</u>: Explanation must be correct in order to award mark.</p>	<p>[1]</p>
(c)	<p>No. of moles of hydrogen reacted = <math>1.8/24</math> = 0.075 mol</p> <p>Number of moles of oil = <math>10/800</math> = 0.0125 mol</p> <p>Number of moles of hydrogen : number of moles of oil 0.075 : 0.0125 6 : 1</p> <p>There are 6 double bonds in one molecule of oil.</p>	<p>[2]</p> <p>[1]</p> <p>[1]</p>

**Either**

B10(a)	 <p>1 mark for correct bonding, 1 mark for correct number of electrons for each element.</p>	[2]
(b)	<p>Student A is correct as <u>the oxidation state of sulfur in sulfur dioxide increases from +4 to +6.</u></p> <p>Student B is wrong as <u>sulfur dioxide reduces the oxidation state of chlorine from 0 to -1, hence sulfur dioxide is the reducing agent.</u></p>	[1] [1]
(c)	<p>SO<sub>2</sub>, when bubbled through <u>acidified potassium manganate(VII), will decolourise the purple solution.</u></p> <p>A <u>damp blue litmus paper</u> when placed near the heated liquid will <u>turn red before being bleached</u> by Cl<sub>2</sub>.</p>	[1] [1]
(d) i.	$\text{SO}_2\text{Cl}_2 + 2\text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4 + 2\text{HCl}$	[1]
(d) ii.	<p>No. of moles of H<sub>2</sub>SO<sub>4</sub> = 1 mole          No. of moles of HCl = 2 moles  <math>\text{H}_2\text{SO}_4 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}</math> (equation not needed)          No. of moles of NaOH needed to neutralise 1 mole of H<sub>2</sub>SO<sub>4</sub> = 2 moles [1]  <math>\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}</math> (equation not needed)          No. of moles of NaOH needed to neutralise 2 moles of HCl = 2 moles [1]          Total moles of NaOH needed = 4 moles          Volume of NaOH needed = <math>4 \div 0.5 = 8 \text{ dm}^3</math> [1]</p>	[3]  Refer to marks allocation on the left.

OR

B10(a)	<p>volume of CO<sub>2</sub> / cm<sup>3</sup></p>  <p>time / s</p> <p><b>Note:</b> There isn't a need to indicate the reaction rate on the graph.</p> <p>The <u>initial rate of decomposition is the fastest</u> therefore <u>the gradient is the steepest</u>. As the <u>rate of decomposition slows down</u>, the <u>gradient becomes less steep</u>. Finally reaction stops when <u>all calcium carbonate is used up and gradient is zero</u>.</p>	<p>[1] – graph</p> <p>[1] - correct labels and units</p> <p>[1]</p> <p>[1]</p>
(b)	<p>No. of moles of CaCO<sub>3</sub> = 10.5 / 100 = 0.105 mol Volume of CO<sub>2</sub> = 0.105 x 24 = 2.52 dm<sup>3</sup></p>	<p>[1]</p> <p>[1]</p>
(c)	<p>i. The rate of decomposition of zinc carbonate will be faster than the rate of decomposition of calcium carbonate.</p> <p>Zinc carbonate is <u>less thermally stable</u> than calcium carbonate therefore it decomposes more readily than calcium carbonate.</p> <p><b>Note:</b> Ignore reference to metal reactivity, no mark will be awarded.</p>	<p>[1]</p> <p>[1]</p>
	<p>ii. No.</p> <p>Possible explanation:</p> <p>No. of moles of ZnCO<sub>3</sub> = 10.5 / 125 = 0.084 mol Volume of CO<sub>2</sub> = 0.084 x 24 = 2.02 dm<sup>3</sup></p> <p><b>OR</b></p> <p>Since there are <u>fewer moles of zinc carbonate</u> therefore the <u>volume of carbon dioxide</u> collected will be <u>lesser</u>.</p>	<p>no mark</p> <p>[1]</p> <p>[1]</p> <p>[1]</p> <p>[1]</p>

END OF PAPER

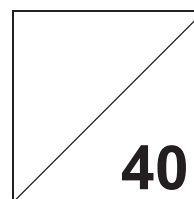
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Class

Index Number



***Jurong West Secondary School***  
**Preliminary Examinations 2018**



**CHEMISTRY**

**6092/01**

Secondary Four Express

**17 August 2018**

Paper 1

**1130 - 1230**

**1 hour**

Candidates answer on the Multiple Choice Answer Sheet.

Additional Materials: Multiple Choice Answer Sheet

**READ THESE INSTRUCTIONS FIRST**

Write your name, class and index number on all the work you hand in.

Write in soft pencil.

You may use an HB pencil for any diagrams, graphs, tables or rough working.

Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.

You may lose marks if you do not show your working or if you do not use appropriate units.

There are **forty** questions. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**. Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet. **Read the instructions on the Answer Sheet very carefully.** Each correct answer will score one mark. A mark will not be deducted for a wrong answer. Any rough working should be done in this question paper.

A copy of the Periodic Table is printed on page 15.

After checking of answer script		
Checked by Student	Signature	Date

This document consists of **15** printed pages.

**Setter: Mr Edwin Kwek**

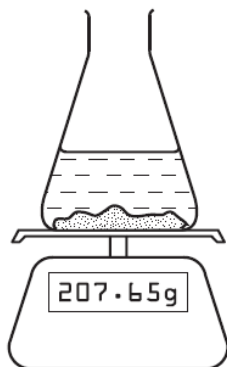
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- 1 Calcium carbonate reacts with hydrochloric acid, producing carbon dioxide gas.



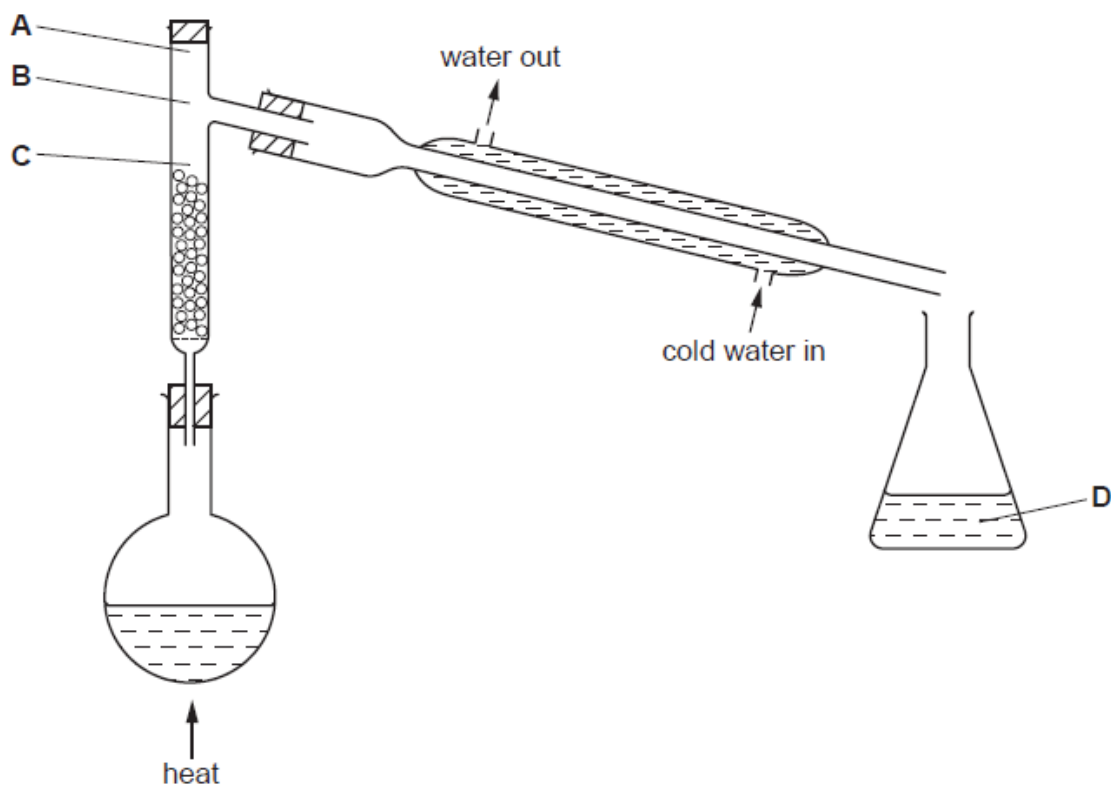
The rate of this reaction can be measured using the apparatus shown.



Which additional piece of apparatus is also required?

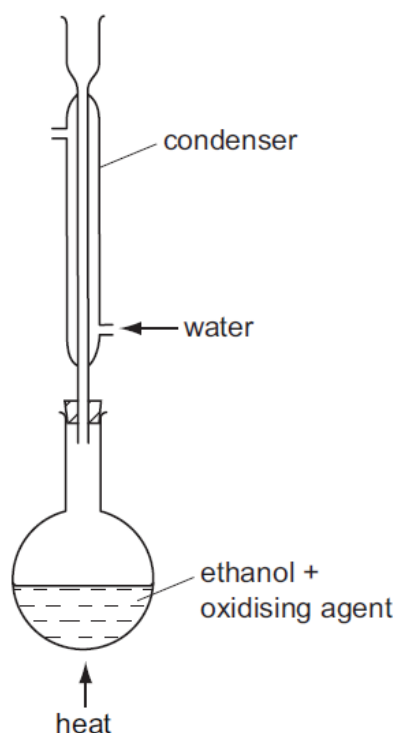
- A a burette
  - B a clock
  - C a gas syringe
  - D a thermometer
- 2 The fractional distillation apparatus shown is being used to separate a mixture of two liquids. A thermometer is missing from the apparatus.

Where should the bulb of the thermometer be placed?





- 3 The oxidation of ethanol to ethanoic acid is often carried out in the apparatus shown.



What is the purpose of the condenser?

- A to prevent any ethanol from escaping
  - B to prevent air from reacting with the ethanoic acid
  - C to prevent the ethanoic acid from reacting with the ethanol
  - D to prevent the ethanoic acid from changing back to ethanol
- 4 The table shows the results of two reactions of an aqueous solution of a salt.

reagents	final observation
excess aqueous sodium hydroxide	white precipitate
dilute nitric acid and aqueous silver nitrate	yellow precipitate

What is the name of the salt?

- A calcium chloride
- B calcium iodide
- C zinc nitrate
- D zinc sulfate

5 Which property or properties will affect the rate of diffusion of gases?

- 1 Temperature
- 2 Solubility
- 3 Molecular mass

- A 1 only  
 B 1 and 2  
 C 1 and 3  
 D All of the above

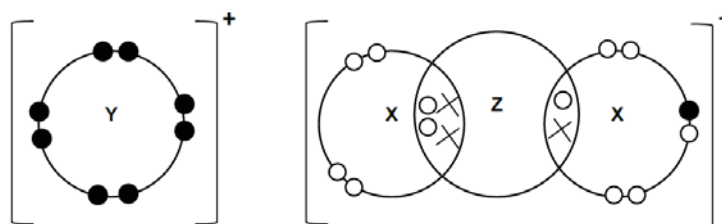
6 Alpha particles consist of two protons and two neutrons bound together into a particle identical to a helium-4 nucleus.

In the Rutherford gold foil experiment, a thin piece of pure gold foil was used. After alpha particles were shot at gold foil, scientists noticed only a tiny fraction of the alpha particles were deflected by a large angle. Most flew straight through the foil.

Suggest a reason for this phenomenon.

- A The gold atoms consist of a small positively charged nucleus with large, empty spaces between the nucleus.  
 B The gold atoms consist of a small negatively charged nucleus with large, empty spaces between the nucleus.  
 C The gold atoms are surrounded by small positively charged electrons with large, empty spaces between the electrons.  
 D The gold atoms are surrounded by small negatively charged electrons with large, empty spaces between the electrons.

7 X, Y and Z are 3 different elements in the Periodic Table. The 'dot-and-cross' diagram of the compound formed from X, Y and Z is shown below. Only the valence electrons are shown.



Which statements are correct?

- 1 Element Y could be lithium.
- 2 Element X belongs to Group VI of the Periodic Table.
- 3 Elements X and Z are bonded together by covalent bonds.
- 4 There are more electrons than protons in  $ZX_2^-$ .

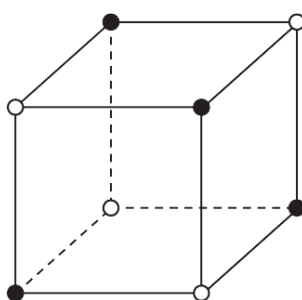
- A 1 and 3 only  
 B 2 and 4 only  
 C 1, 2 and 3 only  
 D 2, 3 and 4 only

- 8 The table below shows the number of neutrons and electrons in the following four particles.

Particle	Number of neutrons	Number of electrons
W	18	8
X <sup>+</sup>	12	10
Y <sup>2-</sup>	16	10
Z	13	11

Which of the following atoms is an isotope of W?

- A X  
B Y  
C Z  
D None of the above
- 9 The diagram shows the arrangement of the ions in an ionic crystal.



Key

○ = positive ion

● = negative ion

Which substance **cannot** have this arrangement of its ions?

- A CuSO<sub>4</sub>  
B KCl  
C MgO  
D Na<sub>2</sub>S
- 10 Which of the following correctly describes the particles in a **very dilute** sodium chloride solution at room temperature?

	ions of sodium chloride	water molecules
A	widely separated, moving at random	close together, moving at random
B	widely separated, vibrating about fixed positions	close together, moving at random
C	close together, moving at random	widely separated, moving at random
D	close together, vibrating about fixed positions	widely separated, moving at random

- 11 The table gives the properties of four substances.  
Which substance is a solid metal at room temperature?

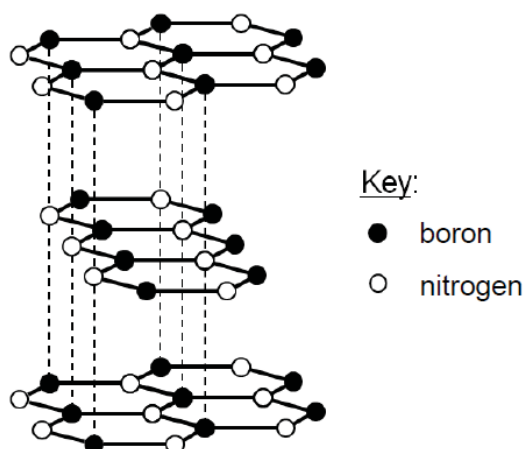
	melting point / °C	boiling point / °C	electrical conductivity when solid	electrical conductivity when molten
A	808	1465	x	✓
B	98	890	✓	✓
C	119	445	x	x
D	-39	357	✓	✓

key

✓ = conducts

x = does not conduct

- 12 The diagram shows the structure of hexagonal boron nitride.



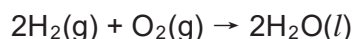
Which property is hexagonal boron nitride most likely to have?

- A It is soluble in water.  
B It has a low melting point.  
C It is soft and acts as a lubricant.  
D It does not conduct electricity in solid state but conducts electricity in liquid state.
- 13 Which statement is **not** true for all metals when they are in solid state?
- A They conduct heat.  
B They are malleable.  
C They conduct electricity.  
D They form coloured compounds.
- 14 All of the following substances can conduct electricity.  
Which substance's conductivity is not due to the movement of electrons?
- A aluminium  
B graphite  
C lithium chloride  
D mercury

- 15 One mole of a sample of hydrated sodium sulfide contains 162 g of water of crystallisation. What is the correct formula of this compound?

A  $\text{Na}_2\text{S} \cdot 3\text{H}_2\text{O}$   
 B  $\text{Na}_2\text{S} \cdot 5\text{H}_2\text{O}$   
 C  $\text{Na}_2\text{S} \cdot 7\text{H}_2\text{O}$   
 D  $\text{Na}_2\text{S} \cdot 9\text{H}_2\text{O}$

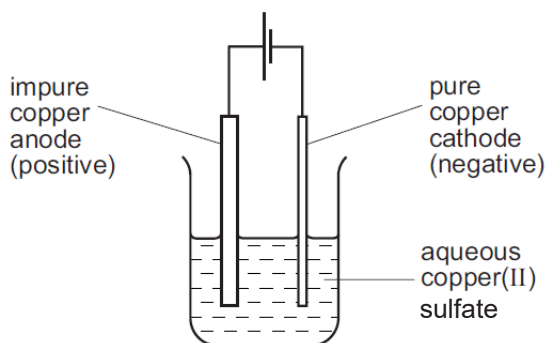
- 16 Hydrogen reacts with oxygen as shown in the equation below.



How much gas will remain if 2 dm<sup>3</sup> of hydrogen are reacted with 1 dm<sup>3</sup> of oxygen at room temperature?

A 0 dm<sup>3</sup>  
 B 1 dm<sup>3</sup>  
 C 2 dm<sup>3</sup>  
 D 3 dm<sup>3</sup>

- 17 A sample of copper contains a metal impurity which is below copper in the reactivity series. The diagram shows the apparatus used for refining the sample.



The loss in mass of the anode is 50 g and the gain in mass of the cathode is 45 g.

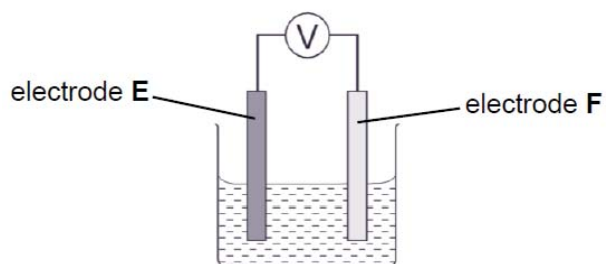
What is the percentage purity of this sample of copper?

A 10.0%  
 B 11.1%  
 C 90.0%  
 D 95.0%

- 18 What products are formed when concentrated aqueous potassium chloride is electrolysed?

	at the anode	at the cathode
A	chlorine	hydrogen
B	chlorine	potassium
C	oxygen	hydrogen
D	oxygen	potassium

- 19 A galvanic cell is set up as shown below.

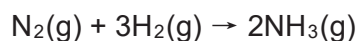


Which pair of electrodes would give the largest magnitude on the voltmeter reading?

	electrode E	electrode F
A	copper	zinc
B	magnesium	copper
C	silver	magnesium
D	zinc	iron

- 20 Which of the following is an endothermic reaction?
- A the combustion of ethanol in air
  - B the oxidation of carbon to carbon dioxide
  - C the reaction between hydrogen and oxygen
  - D the formation of a carbohydrate and oxygen from carbon dioxide and water

- 21 Nitrogen and hydrogen react to give ammonia according to the equation.



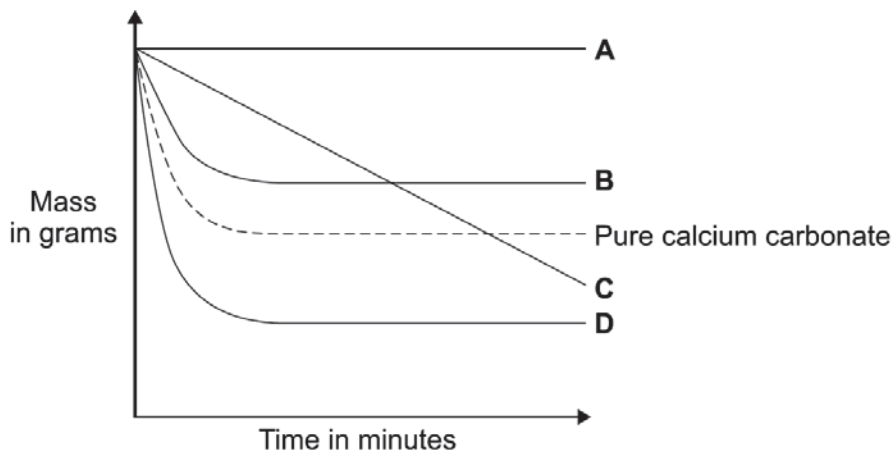
The bond energy of some covalent bonds are shown below.

bond	bond energy (kJ/mol)
$\text{N}\equiv\text{N}$	945
$\text{H}-\text{H}$	436
$\text{N}-\text{H}$	391

What is  $\Delta H$ , in kJ/mol, for the reaction above?

- A -1471
- B -93
- C 93
- D 1471

- 22** Limestone usually contains impurities.  
The diagram below shows the change in mass when pure calcium carbonate is heated.  
Which graph, **A**, **B**, **C** or **D**, shows a sample of limestone, of the same mass, containing impurities that do not thermally decompose?



- 23** The following changes could be made to the conditions in the reaction between zinc and hydrochloric acid.
- 1 increase in concentration of the acid
  - 2 increase in particle size of the zinc
  - 3 increase in pressure on the system
  - 4 increase in temperature of the system

Which pair of changes will increase the rate of reaction?

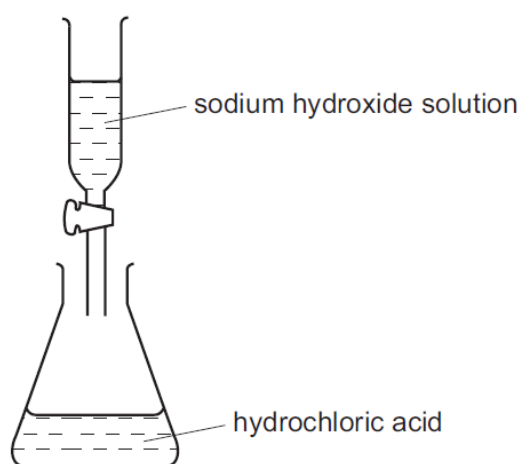
- A** 1 and 2  
**B** 1 and 4  
**C** 2 and 3  
**D** 3 and 4
- 24** Why is nickel used in the addition of hydrogen to alkenes?
- A** It increases the yield of products.  
**B** It makes the reaction more exothermic.  
**C** It prevents a reverse reaction from occurring.  
**D** It lowers the activation energy of the reaction.

- 25 Iron is extracted from its ore haematite,  $\text{Fe}_2\text{O}_3$ , by a reduction process in the blast furnace.

Which equation for reactions in the blast furnace shows the formation of the reducing agent?

- A  $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$
- B  $\text{CaO} + \text{SiO}_2 \rightarrow \text{CaSiO}_3$
- C  $\text{CO}_2 + \text{C} \rightarrow 2\text{CO}$
- D  $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$

- 26 Sodium hydroxide solution was added to dilute hydrochloric acid. The pH of the solution in the flask was measured at intervals until no further change of pH took place.



What would be the pH change in this reaction?

- A decrease to 1
  - B decrease to 7
  - C increase to 7
  - D increase to 12
- 27 Which metal has a soluble carbonate, chloride and sulfate?
- A barium
  - B calcium
  - C copper
  - D potassium
- 28 Which substance would **not** be used for preparing a pure sample of crystalline magnesium sulfate by reaction with dilute sulfuric acid?
- A magnesium carbonate
  - B magnesium hydroxide
  - C magnesium nitrate
  - D magnesium oxide

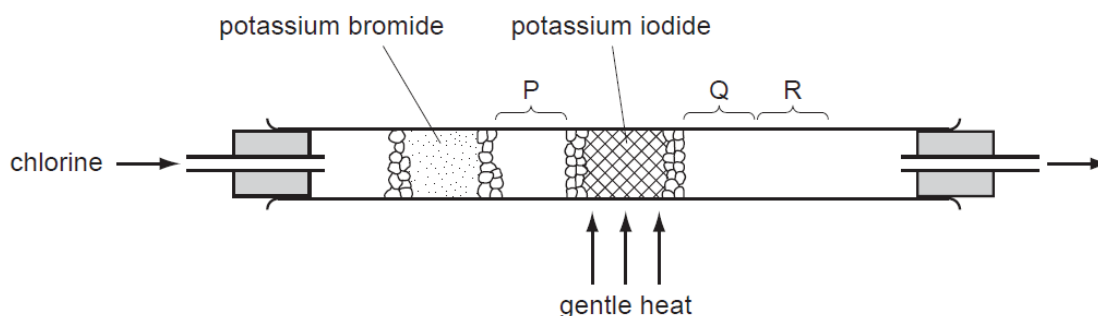


29 Which of the following methods would produce ammonia?

- 1 Heating aqueous barium nitrate with sodium hydroxide and aluminium powder.
- 2 Heating aqueous ammonium chloride with aqueous calcium hydroxide.
- 3 Heating solid ammonium sulfate with solid potassium hydroxide.
- 4 Heating aqueous ammonium chloride with dilute hydrochloric acid.

- A** 1 and 2 only  
**B** 1 and 4 only  
**C** 1, 2 and 3 only  
**D** 2, 3 and 4 only

30 Using the apparatus shown, chlorine is passed through the tube.



After a short time, coloured substances are seen at P, Q and R. What are these coloured substances?

	at P	at Q	at R
<b>A</b>	green gas	red brown vapour	violet vapour
<b>B</b>	green gas	violet vapour	black solid
<b>C</b>	red brown vapour	violet vapour	black solid
<b>D</b>	violet vapour	red brown vapour	red brown vapour

31 The table shows the reactions of metals **A**, **B**, **C** and **D** when placed in aqueous solutions of their nitrates.

metal	nitrate of <b>A</b>	nitrate of <b>B</b>	nitrate of <b>C</b>	nitrate of <b>D</b>
<b>A</b>	-	reacts	reacts	reacts
<b>B</b>	no reaction	-	reacts	no reaction
<b>C</b>	no reaction	no reaction	-	no reaction
<b>D</b>	no reaction	reacts	reacts	-

A mixture of aqueous solutions of nitrates of **A**, **B**, **C** and **D** are electrolysed using carbon electrodes.

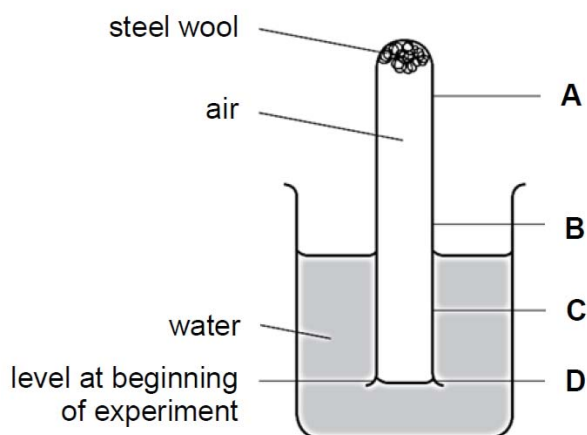
Which metal ion of metals **A**, **B**, **C** or **D** would most readily be discharged at the negative electrode?

- 32 Experiments were carried out to determine the relative reactivity of three metals, S, T and U. The results were recorded in the table.

	metal S	metal T	metal U
Can the metal react with dilute hydrochloric acid?	yes	no	yes
Can the metal oxide be reduced by heating with carbon?	yes	yes	no

Which of the following shows the metals in order of **decreasing** reactivity?

- A** S, U, T  
**B** T, S, U  
**C** U, S, T  
**D** U, T, S
- 33 The diagram shows steel wool inside a test-tube.



The test-tube is inverted in water, trapping air inside. What will be the water level inside the tube after several days?

- 34 The enthalpy change for the complete combustion of three different fuels, methane, ethanol and propene are as shown below.

fuel	formula	$M_r$	enthalpy change of combustion / kJ/mol
methane	$\text{CH}_4$	16	-100
ethanol	$\text{C}_2\text{H}_5\text{OH}$	46	-75
propene	$\text{C}_3\text{H}_6$	42	-170

What is the correct order of fuels, starting from the fuel that provides the most energy per gram of fuel, when the fuel undergoes complete combustion?

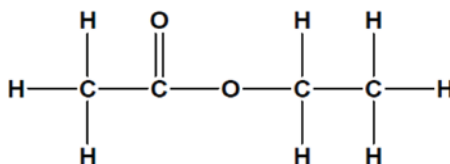
- A** methane, propene, ethanol  
**B** methane, ethanol, propene  
**C** propene, methane, ethanol  
**D** ethanol, propene, methane

- 35 The table shows the boiling points of four fractions, P, Q, R and S, obtained when crude oil is distilled.

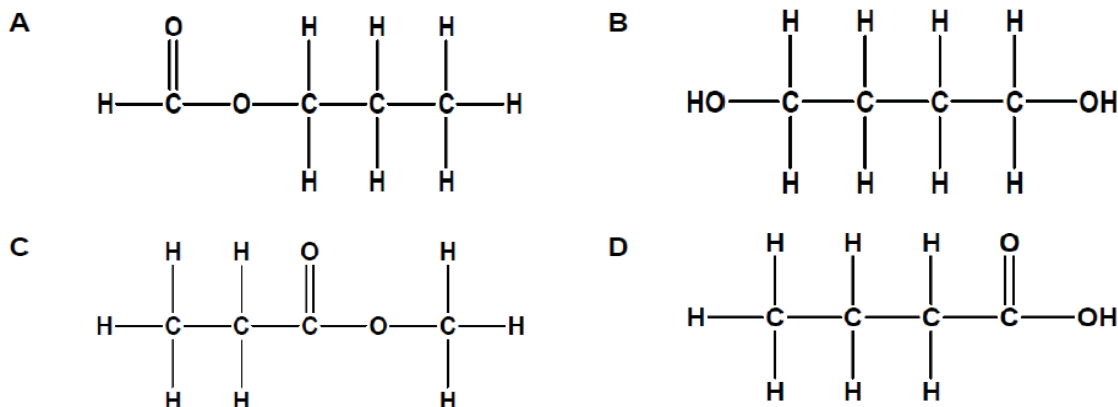
Fraction	P	Q	R	S
Boiling Range / °C	35-75	80-145	150-250	greater than 250

How is fraction P different from S?

- A Fraction P is more viscous than fraction S.  
 B Fraction P is in less demand than fraction S.  
 C Fraction P is more flammable than fraction S.  
 D Fraction P contains molecules of larger molecular masses than fraction S.
- 36 The diagram shows the structure of ethyl ethanoate.

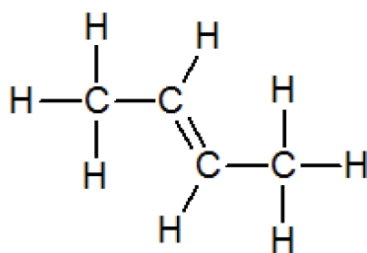


Which structure is **not** an isomer of ethyl ethanoate?

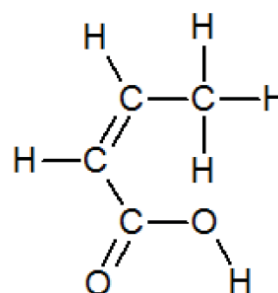


- 37 60 cm<sup>3</sup> of oxygen was mixed with 10 cm<sup>3</sup> of gaseous hydrocarbon in a closed vessel. After explosion and cooling, the gases occupied 50 cm<sup>3</sup> and after passing the gas through aqueous sodium hydroxide, 30 cm<sup>3</sup> of oxygen remained. Deduce the molecular formula of the hydrocarbon.
- A CH<sub>4</sub>  
 B C<sub>2</sub>H<sub>4</sub>  
 C C<sub>2</sub>H<sub>6</sub>  
 D C<sub>3</sub>H<sub>6</sub>

- 38 The full structural formulae of compounds X and Y are shown below.



Compound X



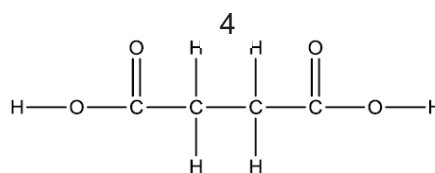
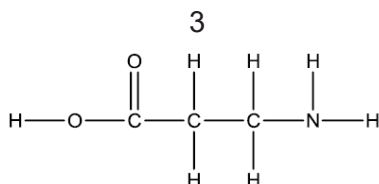
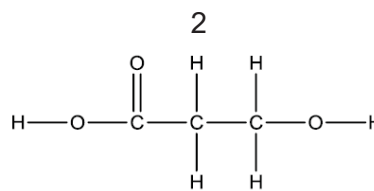
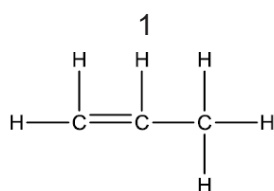
Compound Y

The **best** method to distinguish between X and Y visually is by using

- A aqueous bromine
  - B potassium hydroxide solution
  - C potassium carbonate solution
  - D acidified potassium manganate(VII) solution
- 39 A food chemist wants to create the odour of pineapples for a product. An ester with this odour has the formula  $C_3H_7CO_2C_4H_9$ .

Which pair of substances will react to produce this ester?

- A  $C_2H_5CO_2H$  and  $C_4H_9OH$
  - B  $C_2H_5CO_2H$  and  $C_3H_7OH$
  - C  $C_4H_9CO_2H$  and  $C_3H_7OH$
  - D  $C_3H_7CO_2H$  and  $C_4H_9OH$
- 40 Which compounds would undergo polymerisation on their own?



- A 1 and 2 only
- B 2 and 3 only
- C 1, 2 and 3 only
- D 1, 2, 3 and 4

**End of Paper**

# The Periodic Table of Elements

Group																	
I	II	1 H hydrogen 1										III	IV	V	VI	VII	0
<div>Key</div> <div>proton (atomic) number atomic symbol name relative atomic mass</div>																	
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids La 137	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium -	85 At astatine -	86 Rn radon -
87 Fr francium -	88 Ra radium -	89 – 103 actinoids Ac 137	104 Rf rutherfordium -	105 Db dubnium -	106 Sg seaborgium -	107 Bh bohrium -	108 Hs hassium -	109 Mt meitnerium -	110 Ds darmstadtium -	111 Rg roentgenium -	112 Cn copernicium -	114 Fl flerovium -	116 Lv livermorium -	117 Ts tennessine -	118 Og oganeson -	119 Uue unbinilium -	120 Uuh ununilium -
lanthanoids																	
57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium -	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175			
actinoids																	
89 Ac actinium -	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium -	94 Pu plutonium -	95 Am americium -	96 Cm curium -	97 Bk berkelium -	98 Cf californium -	99 Es einsteinium -	100 Fm fermium -	101 Md mendelevium -	102 No nobelium -	103 Lr lawrencium -			

The volume of one mole of any gas is 24 dm<sup>3</sup> at room temperature and pressure (r.t.p.).

Name: \_\_\_\_\_

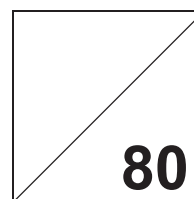
Class

Index Number



# *Jurong West Secondary School*

## **Preliminary Examinations 2018**



### **CHEMISTRY**

**6092/02**

Secondary Four Express

**21 August 2018**

Paper 2

**0800 – 0945**

**1 hour 45 minutes**

Candidates answer on the Question Paper.

#### **READ THESE INSTRUCTIONS FIRST**

Write your name, class and index number on all the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams, graphs, tables or rough working.

Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.

You may lose marks if you do not show your working or if you do not use appropriate units.

#### **Section A**

Answer **all** questions in the spaces provided.

#### **Section B**

Answer all **three** questions, the last question is in the form of either/or.

Answer **all** questions in the spaces provided.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [ ] at the end of each question or part question.

A copy of the Periodic Table is printed on page 20.

After checking of answer script		
Checked by Student	Signature	Date

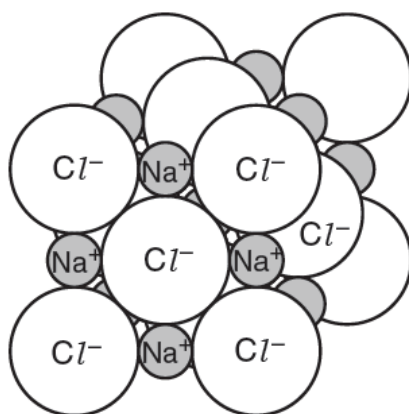
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**Setter: Mr Edwin Kwek**

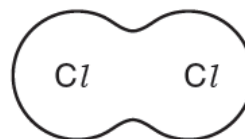
[www.KiasuExamPaper.com](http://www.KiasuExamPaper.com)



**A2** The structures of sodium chloride and chlorine are shown below.



sodium chloride



chlorine

The melting point of sodium chloride is 801 °C.

The melting point of chlorine is –101 °C.

- (a)** Explain, in terms of structure and bonding, the difference between the melting points of these two substances.

.....

.....

.....

.....

..... [4]

- (b)** Predict whether magnesium oxide would have a higher or lower melting point than sodium chloride. Explain your answer in terms of bonding.

.....

.....

..... [2]

- (c)** Chlorine exists as a gas at room temperature while bromine exists as a liquid at room temperature. Explain your answer in terms of bonding.

.....

.....

..... [2]

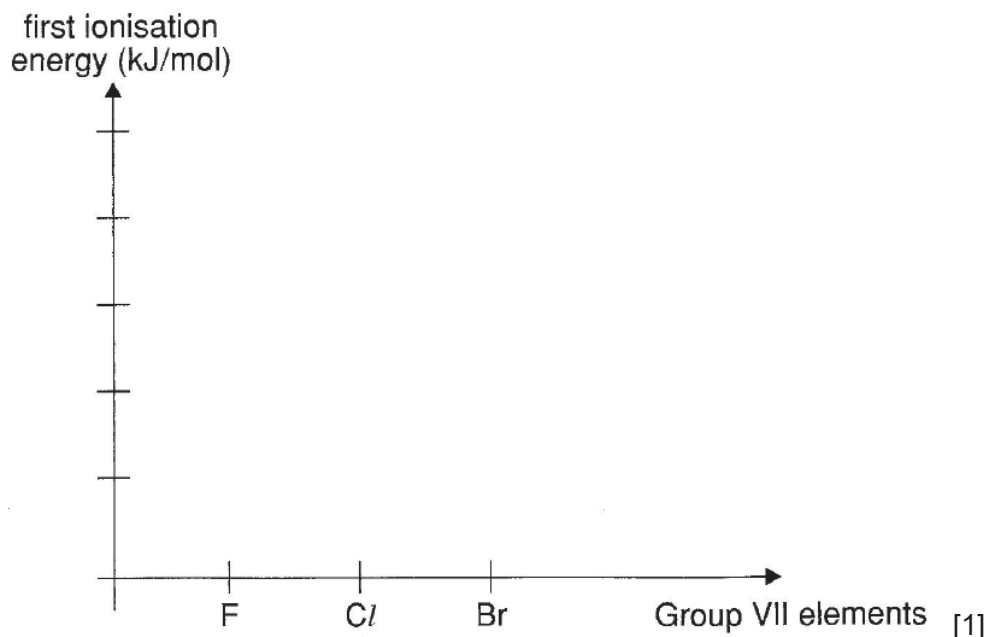
[Total: 8]



- A3** First ionisation energy is the energy required to convert one mole of gaseous atoms into one mole of gaseous ions with a charge of +1.

The magnitude of the first ionisation energy increases in general as the number of electron shells decreases.

- (a) (i) Draw, in the following graph, the trend in which the first ionisation energy changes down Group VII elements from fluorine to bromine.



- (ii) Based on the trend of the change in first ionisation energy, suggest the relationship between the first ionisation energy and the reactivities of elements in Group VII.

..... [1]

- (b) (i) What is observed if aqueous sodium iodide is reacted with aqueous chlorine?

..... [1]

- (ii) Write an ionic equation, with state symbols, for the reaction in (i) above.

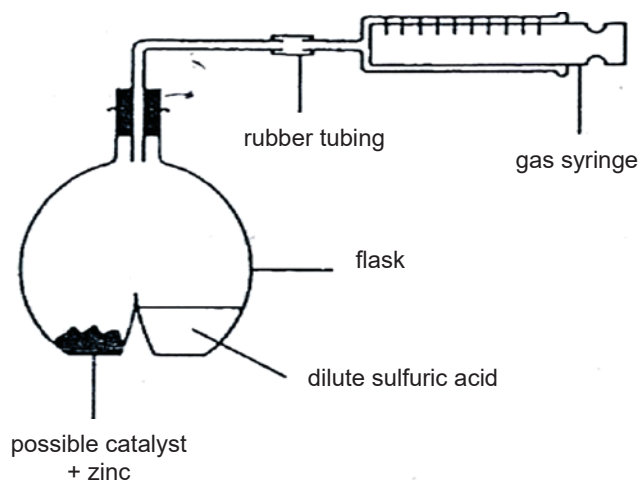
..... [2]

[Total: 5]

- A4** The apparatus shown in the diagram was used to study the catalytic effect of certain

substances on the exothermic reaction between zinc and dilute sulfuric acid.

Several experiments were carried out. In each experiment, 50 cm<sup>3</sup> of 1.0 mol/dm<sup>3</sup> sulfuric acid, 1.0 g of zinc powder and 0.1g of a possible catalyst were used.



To start the reaction, the flask was shaken. The time taken to collect 50 cm<sup>3</sup> of hydrogen was recorded. Other observations are shown in the table.

Possible catalyst added	Time to collect 50 cm <sup>3</sup> of hydrogen/s	Other observations
No added catalyst	65	-
0.1 g of copper(II) sulfate	10	colourless solution obtained and a brown solid coated the zinc
0.1 g of copper(II) chloride	15	colourless solution obtained and a brown solid coated the zinc
0.1 g of copper powder	19	pink solid remained
0.1g of copper lumps	56	pink solid remained
0.1g of sodium chloride	65	colourless solution formed

- (a) (i) Write the chemical equation for the reaction between zinc and dilute sulfuric acid.

..... [1]

- (ii) Calculate the maximum volume of hydrogen gas that can be produced at

room temperature and pressure in the reaction.

[3]

- (b) Which of the added substances behaved as a catalyst? Explain your answer using information from the table.

.....  
 .....  
 ..... [2]

- (c) Explain, in terms of activation energy, how a catalyst speeds up a reaction.

.....  
 .....  
 ..... [2]

- (d) Suggest whether the time taken to collect 50 cm<sup>3</sup> of hydrogen would be longer or shorter than 65 s when 1.0 g of zinc lumps was used in the absence of a catalyst.

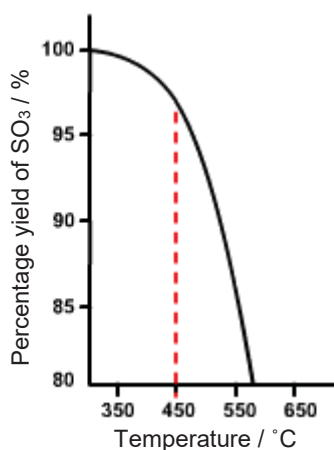
Explain your answer in terms of colliding particles.

.....  
 .....  
 ..... [2]

[Total: 10]

**A5** The graph below shows the percentage conversion to sulfur trioxide from sulfur dioxide

and oxygen gas during the Contact Process.



- (a) Give two reasons, other than cost, why the optimal temperature for Contact Process is 450 °C.

.....  
 .....  
 ..... [2]

- (b) Write down the chemical equation for the formation of sulfur trioxide from sulfur dioxide and oxygen.

..... [1]

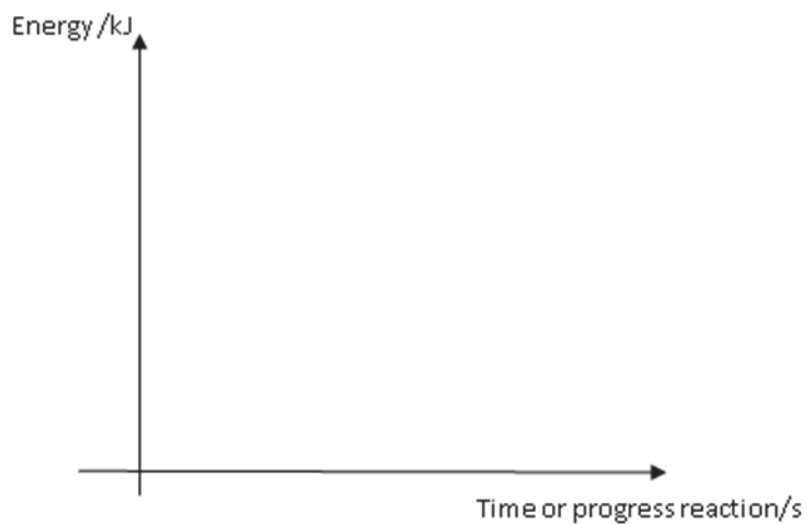
- (c) Explain, in terms of bond breaking and bond forming, why the conversion of sulfur dioxide and oxygen to sulfur trioxide is an exothermic reaction.

.....  
 .....  
 .....  
 ..... [3]

- (d) Draw an energy profile diagram to show the formation of sulfur trioxide from sulfur dioxide and oxygen.

Your diagram should show and label

- formulae of the reactants and products
- the activation energy for the reaction,
- the enthalpy change of reaction.



[3]

[Total: 9]

**A6** The graph below shows the relationship between the concentration of carbon dioxide (in micromoles per kg of seawater) and the pH of the seawater across the years.

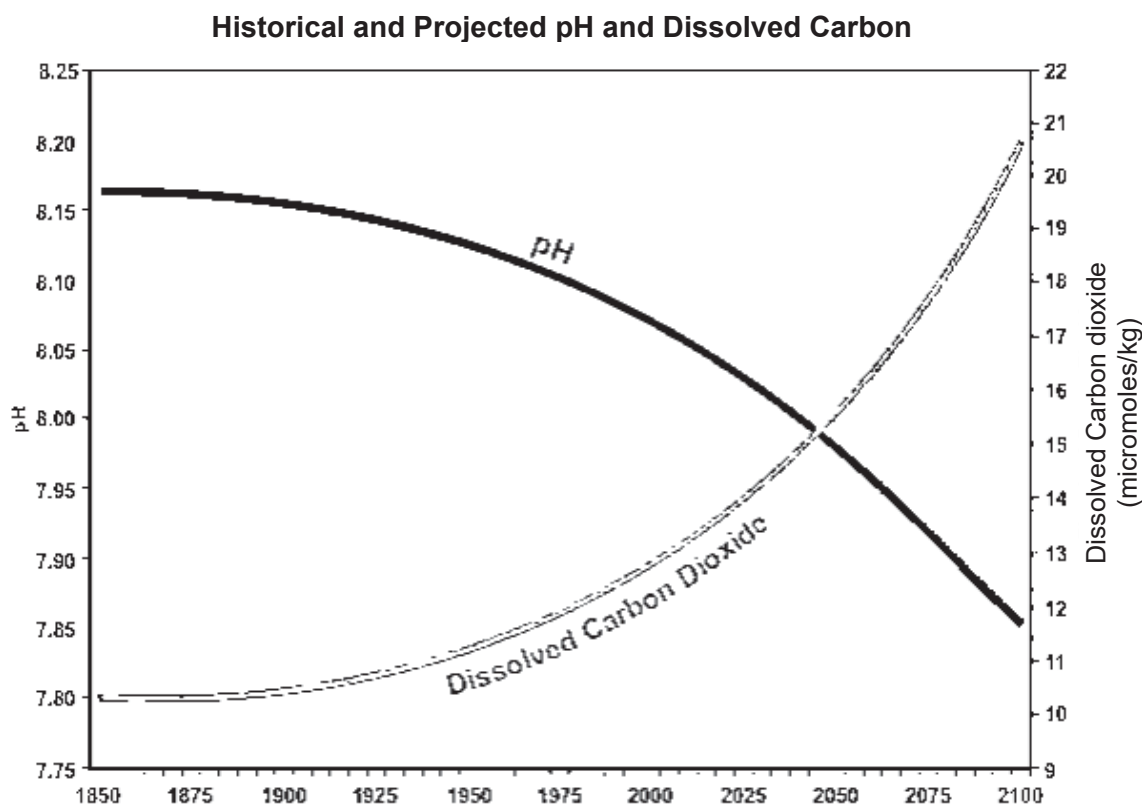


Figure 6.1

- (a) (i) Describe how the concentration of dissolved carbon dioxide has changed across the years.

.....

.....

..... [2]

- (ii) State the relationship between the concentration of carbon dioxide and the pH of the seawater across the years.

..... [1]

- (b) (i) During the test for carbon dioxide, it is observed that white precipitate would be observed when the gas is bubbled into solution **X** initially.

Upon further bubbling of the carbon dioxide, the white precipitate would dissolve to form a colourless solution.

State the identity of solution **X**.

..... [1]

- (ii) Suggest how the concentration of dissolved carbon dioxide would affect the formation of coral reefs which consist mainly of calcium carbonate.

.....

.....  
.....  
..... [2]

- (c) Scientists have discovered that when carbon-neutral fuels, such as ethanol, are burnt, the amount of carbon dioxide in the atmosphere remains relatively constant.

Mary stated that ethanol obtained from all forms is considered to be a form of carbon-neutral fuel. John argued that only those obtained from the fermentation of glucose can be considered as carbon-neutral.

- (i) Write down the chemical equation for the fermentation of glucose.

..... [1]

- (ii) Who do you agree with, Mary or John? Explain your answer.

.....  
.....  
.....  
.....  
.....  
..... [4]

[Total: 11]

## Section B

Answer all **three** questions from this section in the spaces provided.

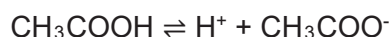
The last question is in the form of an either/or and only one of the alternatives should be attempted.

**B7** Read the information about organic acids.

**Organic acids as weak acids**

A weak acid is one which ionises partially to produce hydrogen ions when it is dissolved in water.

Ethanoic acid is a typical weak acid. It ionises in water to produce hydrogen ions and ethanoate ions, but the backward reaction occurs more readily than the forward one. So the ions react very easily to reform the acid.



At any one time, less than 1% of the ethanoic acid molecules have converted into ions. The rest remain as simple ethanoic acid molecules.

Most organic acids are weak.

**Comparing the strengths of weak acids using the acid dissociation constant,  $K_a$**

The position of equilibrium for the ionisation of each acid varies from one weak acid to another. The further to the left it lies, the weaker the acid is.

You can get a measure of the position of an equilibrium using the acid dissociation constant,  $K_a$ . The higher the value for the constant, the more the equilibrium lies to the right, the greater the extent of dissociation of the acid.

So the expression to determine the  $K_a$  of ethanoic acid is given by:

$$\frac{[\text{H}^+][\text{CH}_3\text{COO}^-]}{[\text{CH}_3\text{COOH}]},$$

where the product of the concentration of the hydrogen ion,  $[\text{H}^+]$ , and the concentration of the ethanoate ion,  $[\text{CH}_3\text{COO}^-]$ , is divided by the concentration of the undissociated ethanoic acid,  $[\text{CH}_3\text{COOH}]$ .

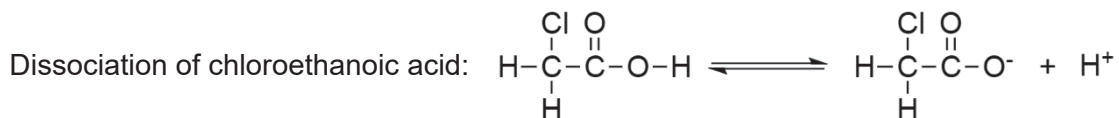
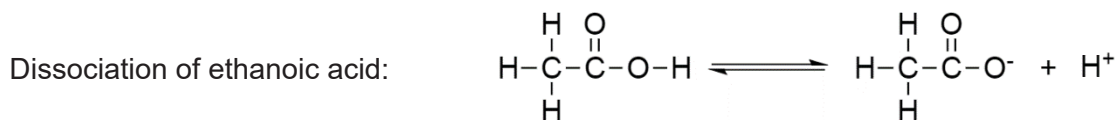
As the extent of dissociation is very little, the concentration of the undissociated acid could be taken to be the same as the concentration of the ethanoic acid before dissociation occurs.

**Electronegativity of substituents**

Electronegativity refers to the tendency of an atom to attract shared electrons from the covalent bond towards itself.

Atoms of halogens are generally electronegative. When a hydrogen atom in an organic acid is replaced by a halogen atom, the halogen atom draws the electron density towards itself. This reduces the electron density of the functional group, allowing the anion formed to be more stable and recombined with the hydrogen ion less readily.





Comparing ethanoic acid and chloroethanoic acid, chloroethanoic acid will dissociate to a larger extent.

### Acid dissociation constant, $K_a$ , of different organic acids

The table below provides you with a list of  $K_a$  values of different organic acids.

name	structure	$K_a$
methanoic acid	$\begin{array}{c} \text{O} \\    \\ \text{H}-\text{C}-\text{O}-\text{H} \end{array}$	$1.80 \times 10^{-4}$
ethanoic acid	$\begin{array}{c} \text{H} \quad \text{O} \\   \quad    \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{H} \\   \\ \text{H} \end{array}$	$1.75 \times 10^{-5}$
propanoic acid	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{O} \\   \quad   \quad    \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{O}-\text{H} \\   \quad   \\ \text{H} \quad \text{H} \end{array}$	$1.34 \times 10^{-5}$
fluoroethanoic acid	$\begin{array}{c} \text{F} \quad \text{O} \\   \quad    \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{H} \\   \\ \text{H} \end{array}$	$2.57 \times 10^{-3}$
chloroethanoic acid	$\begin{array}{c} \text{Cl} \quad \text{O} \\   \quad    \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{H} \\   \\ \text{H} \end{array}$	$1.35 \times 10^{-3}$
dichloroethanoic acid	$\begin{array}{c} \text{Cl} \quad \text{O} \\   \quad    \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{H} \\   \\ \text{Cl} \end{array}$	$4.47 \times 10^{-2}$
2-chloropropanoic acid	$\begin{array}{c} \text{H} \quad \text{Cl} \quad \text{O} \\   \quad   \quad    \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{O}-\text{H} \\   \quad   \\ \text{H} \quad \text{H} \end{array}$	$1.48 \times 10^{-3}$
3-chloropropanoic acid	$\begin{array}{c} \text{Cl} \quad \text{H} \quad \text{O} \\   \quad   \quad    \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{O}-\text{H} \\   \quad   \\ \text{H} \quad \text{H} \end{array}$	$1.05 \times 10^{-4}$

Table 7.1

Adapted from:

<https://www.chemguide.co.uk/physical/acidbaseeqia/acids.html>

[https://chem.libretexts.org/Textbook\\_Maps/Organic\\_Chemistry\\_Textbook\\_Maps/Map%3A\\_Organic\\_Chemistry\\_\(Bruice\)](https://chem.libretexts.org/Textbook_Maps/Organic_Chemistry_Textbook_Maps/Map%3A_Organic_Chemistry_(Bruice))

- (a) Calculate the concentration of hydrogen ions, in  $\text{mol/dm}^3$ , present in  $5 \text{ mol/dm}^3$  of ethanoic acid, with reference to Table 7.1 and the expression for  $K_a$  of ethanoic acid.

[2]

- (b) Write down the expression to determine the  $K_a$  of fluoroethanoic acid.

[1]

- (c) Using the information provided, describe how the number of the carbon atoms in the carboxylic acid affects the strength of the acid.

.....  
.....  
.....[2]

- (d) Using the information provided, deduce whether fluorine or chlorine is more electronegative. Explain.

.....  
.....[1]

- (e) Suggest whether 2-fluoropropanoic acid or 3-fluoropropanoic acid would be a stronger acid. Explain your answer using an example.

.....  
.....  
.....[2]

- (f) Suggest why trichloroethanoic acid would be stronger than both chloroethanoic acid and dichloroethanoic acid. Explain in terms of electron density around the carboxylate group.

.....  
 .....  
 ..... [2]

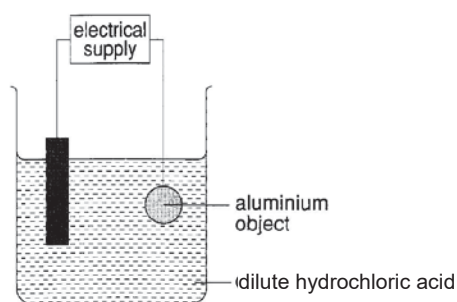
[Total: 10]

- B8 (a)** What method would you use to extract magnesium metal from its naturally occurring compound, magnesium chloride, in seawater, given that aluminium is extracted from aluminium oxide by electrolysis? Explain your answer based on the reactivity of the two metals.

.....  
 .....  
 ..... [2]

- (b) Aluminium is a reactive metal and it reacts with atmospheric oxygen to form aluminium oxide,  $Al_2O_3$ . It is a metal that is widely used in various applications.

The layer of aluminium oxide can be thickened by the process known as 'anodising'. Anodising is carried out using electrolysis, in which the electrolyte is dilute hydrochloric acid. A simplified set-up is shown below.



- (i) Write the ionic half equation, including state symbols, for the reaction occurring at the aluminium object, which is acting as the anode.

..... [2]

- (ii) Suggest how the aluminium object is anodised during electrolysis.

.....  
 ..... [1]

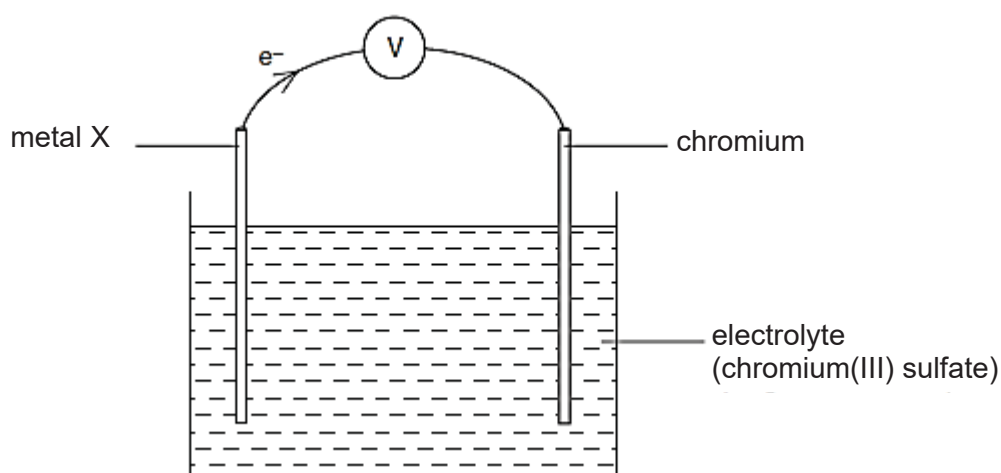
- (iii) Explain the purpose of anodising the aluminium object.

.....  
 ..... [1]

- (iv) Aluminium is coated on an iron object to prevent the object from rusting. Explain how rusting is prevented by this method.

.....  
 ..... [1]

- (c) An electric current can also be generated by a simple electrochemical cell as shown below.



- (i) Explain why the flow of electrons is in the direction shown in the diagram.

..... [1]

- (ii) Chromium(III) sulfate solution is green in colour. Suggest why the colour of the chromium(III) sulfate solution fades over time.

.....  
 .....  
 ..... [2]

[Total: 10]

## EITHER

**B9** The general structure of an amino acid is given below:

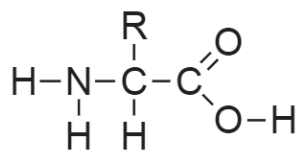


Figure 8.1

where R could just be a simple hydrogen atom or a functional group such as amino or carboxyl group.

The structure below gives a segment of a polypeptide chain with 2 amino acid residues, one with an amino group and another one with a carboxyl group for their R group, when placed in a solution with a pH of 7.

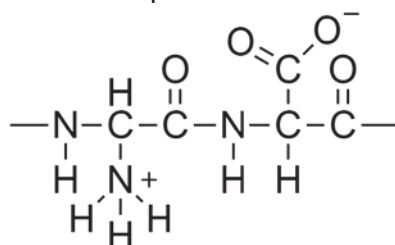


Figure 8.2

**(a)** Use the structures in Figures 8.1 and 8.2 to explain why

**(i)** an amino acid is said to be *amphoteric*; and

.....  
 .....  
 ..... [2]

**(ii)** a polypeptide chain is said to be a *condensation polymer*.

.....  
 .....  
 ..... [2]

**(b)** A protein molecule is formed by one or more polypeptide chains interacting and

folding into a three-dimensional structure.

At extreme pH values, this three-dimensional structure of the protein would be altered, causing the molecule to denature and lose its function.

With reference to Figure 8.2, suggest why the shape of the molecule would be altered at different pH values.

.....  
 .....  
 .....  
 ..... [3]

- (c) Name a synthetic polymer with similar linkage to polypeptides.

..... [1]

- (d) You are given two bottles of solution, each containing a different amino acid as shown in Figure 8.3.

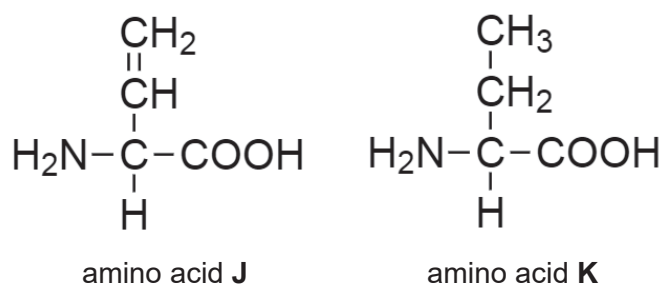


Figure 8.3

Describe a simple chemical test to distinguish between these two amino acids, **J** and **K**.

.....  
 .....  
 ..... [2]

[Total: 10]

OR

- B9** Many biological molecules are able to undergo redox reaction. An example of such a molecule would be glucose.

The Benedict's solution contains copper(II) sulfate solution and it is often used to test for the presence of a reducing sugar. If a reducing sugar is present, a brick-red precipitate would be observed in the solution.

The colour of the obtained precipitate gives an idea about the quantity of sugar present in the solution, hence the test is semi-quantitative.

- (a) Explain what it means by a *redox reaction*.

.....  
 ..... [1]

- (b) Predict what would happen to the reducing sugar, in terms of transfer of hydrogen, when the reducing sugar reacts with the Benedict's solution.

Explain your prediction.

.....  
 .....  
 ..... [2]

- (c) Samples of solutions with varying concentrations of glucose have been reacted with Benedict's solution and the results are as given below:

Solution	Observation after reaction with Benedict's solution
<b>P</b>	Solution remains blue.
<b>Q</b>	Orange-red precipitate observed.
<b>R</b>	Yellow precipitate observed.
<b>S</b>	Blue-green precipitate observed.
<b>T</b>	Brick-red precipitate observed.

- (i) Place the solutions **P**, **Q**, **R**, **S** and **T** in order of their concentration of glucose present, starting with the one with the highest concentration.

..... [1]

- (ii) It was later discovered that solution **R** contains trace amount of impurities from fructose, another reducing sugar.

Suggest the impact of this discovery on your answer in (c)(i).

.....  
 .....  
 ..... [2]

- (d) A fatty acid consists of a long hydrocarbon chain attached to a carboxyl group.

Polyunsaturated fatty acids can undergo redox reaction through the addition of hydrogen.

- (i) 1 mole of polyunsaturated fatty acid **Y** reacts completely with 8 g of hydrogen gas to become saturated.

Determine the molecular formula of **Y** given that each molecule has 16 carbon atoms.

[2]

- (ii) Describe a simple chemical test to differentiate between **Y** and the product of the addition reaction in (i).

.....  
 .....  
 ..... [2]

[Total: 10]

**End of Paper**



# The Periodic Table of Elements

Group																	
I	II	<div><div>1</div><div>H</div><div>hydrogen</div><div>1</div></div>										III	IV	V	VI	VII	0
<div><div>Key</div><div>proton (atomic) number atomic symbol name relative atomic mass</div></div>																	
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids <div><div>La</div><div>137</div></div>	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium -	85 At astatine -	86 Rn radon -
87 Fr francium -	88 Ra radium -	89 – 103 actinoids <div><div>Ac</div><div>137</div></div>	104 Rf Rutherfordium -	105 Db dubnium -	106 Sg seaborgium -	107 Bh bohrium -	108 Hs hassium -	109 Mt meitnerium -	110 Ds darmstadtium -	111 Rg roentgenium -	112 Cn copernicium -	114 Fl flerovium -	116 Lv livermorium -	117 Ts tennessine -	118 Og oganeson -	119 Nh nihonium -	120 Dh dubnium -
lanthanoids																	
57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium -	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175			
actinoids																	
89 Ac actinium -	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium -	94 Pu plutonium -	95 Am americium -	96 Cm curium -	97 Bk berkelium -	98 Cf californium -	99 Es einsteinium -	100 Fm fermium -	101 Md mendelevium -	102 No nobelium -	103 Lr lawrencium -			

The volume of one mole of any gas is 24 dm<sup>3</sup> at room temperature and pressure (r.t.p.).



Answers for 4E CHEMISTRY 6092 PAPER 1 (Prelim 2018)

- |       |       |       |       |
|-------|-------|-------|-------|
| 1. B  | 11. B | 21. B | 31. C |
| 2. B  | 12. C | 22. B | 32. C |
| 3. A  | 13. D | 23. B | 33. C |
| 4. B  | 14. C | 24. D | 34. A |
| 5. C  | 15. D | 25. C | 35. C |
| 6. A  | 16. A | 26. D | 36. B |
| 7. D  | 17. C | 27. D | 37. B |
| 8. B  | 18. A | 28. C | 38. C |
| 9. D  | 19. C | 29. A | 39. D |
| 10. A | 20. D | 30. C | 40. C |

# Answer Scheme for 4E Chemistry Prelim Paper 2

6092/2 – Setter: Edwin Kwek

Minus 1 mark overall for accuracy and units

A1	<p>a) C / Si;  b) N;  c) K;  d) Si;  e) O;  f) Rb;  g) Fe;</p>
A2	<p>a) sodium chloride is giant ionic structure / has a continuous structure of ions / ions in lattice;  strong electrostatics of forces between the ions so a lot of energy needed to break the strong forces;  chlorine is a simple molecule / chlorine has simple covalent structure;  chlorine has weak intermolecular forces between the molecules so small amount of energy required to separate the molecules;</p> <p>b) Ions of magnesium oxide have higher charges than those of sodium chloride;  so they form stronger electrostatic forces of attraction which require larger amount of energy to overcome;</p> <p>c) Bromine has higher relative molecular mass than chlorine;  so bromine has stronger intermolecular forces between the molecules than chlorine so more energy is required to separate the molecules;</p>
A3	<p>a(i) Downward trend;  a(ii) The higher the first ionisation energy, the higher the reactivity of the halogen;</p> <p>b(i) The solution turns from colourless to reddish brown;  b(ii) <math>\text{Cl}_2(\text{aq}) + 2\text{I}^-(\text{aq}) \rightarrow 2\text{Cl}^-(\text{aq}) + \text{I}_2(\text{s})</math>  (balanced equation; state symbols;)</p>
A4	<p>a(i) <math>\text{Zn} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2</math>  a(ii) Number of moles of Zn = <math>1/65 = 0.015385</math> mol  Number of moles of <math>\text{H}_2\text{SO}_4 = 50/1000 \times 1 = 0.0500</math> mol;    Zinc is the limiting reactant  Number of moles of <math>\text{H}_2 = 0.015385</math> mol;    Volume of <math>\text{H}_2 = 0.015385 \times 24 = 0.369 \text{ dm}^3</math>;</p> <p>b) Copper metal/powder/lumps. It speeds up the rate of reaction;  while remains chemically unchanged at the end of the reaction;</p> <p>c) A catalyst provides an alternative pathway with a lower activation energy;  more particles would have sufficient energy to overcome the activation energy;</p> <p>d) Longer. Lumps of zinc have less total surface area compared to powdered zinc;  So the frequency of effective collisions decreases and speed of reaction decreases;</p>

A5	<p>a) When the temperature is too low, the speed of reaction is slow; When the temperature is too high, the yield of the reaction is low;</p> <p>b) <math>2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3</math>;</p> <p>c) The total energy absorbed to break bonds in 2 moles of <math>\text{SO}_2</math> and 1 mole of <math>\text{O}_2</math> is less than the total energy released to form bonds in 2 moles of <math>\text{SO}_3</math>. (energy absorbed to break bonds; energy released to form bonds; correct comparison; (minus 1 if reactants and products are not specified))</p> <p>d) reaction pathway with names of products and reactants; activation energy; enthalpy change;</p>
A6	<p>a(i) The concentration of dissolved carbon dioxide remains fairly constant from 1850 to 1880; The concentration of dissolved carbon dioxide increases at an increasing rate after 1880;</p> <p>a(ii) The higher the concentration of dissolved carbon dioxide, the lower the pH;</p> <p>b(i) Calcium hydroxide / limewater; b(ii) Under high concentration of dissolved carbon dioxide, calcium carbonate would dissolve to form a colourless solution; This prevents calcium carbonate from accumulating to form coral reefs;</p> <p>c(i) <math>\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow 2\text{CO}_2 + 2\text{C}_2\text{H}_5\text{OH}</math>; c(ii) I agree with John. The amount of carbon dioxide absorbed by plants to make glucose during photosynthesis is equal to; the release of carbon dioxide during fermentation of glucose and combustion of ethanol; However, ethene is obtained by cracking of crude oil, a non-renewable source; So the carbon dioxide released from the burning of ethanol produced from addition of steam to ethene would increase the carbon dioxide in the atmosphere;</p>
B7	<p>a) <math>[\text{H}^+][\text{CH}_3\text{COO}^-] = 1.75 \times 10^{-5} \times 5 = 8.75 \times 10^{-5}</math>; <math>[\text{H}^+] = 0.0093541 \approx 0.00935 \text{ mol/dm}^3</math>;</p> <p>b) <math>\frac{[\text{H}^+][\text{CH}_2\text{FCOO}^-]}{[\text{CH}_2\text{FCOOH}]}</math>;</p> <p>c) When the number of carbon atoms increases from methanoic acid to propanoic acid increases, <math>K_a</math> decreases; So the strength of the carboxylic acid decreases;</p> <p>d) Fluorine is more electronegative; Fluoroethanoic acid is a stronger acid / has a higher <math>K_a</math> than chloroethanoic acid;</p> <p>e) 2-fluoropropanoic acid would be a stronger acid; Comparing 2-chloropropanoic acid and 3-chloropropanoic acid, when the chlorine atom is closer to the carboxyl group as in 2-chloropropanoic acid, the <math>K_a</math> would be higher;</p> <p>f) Trichloroethanoic acid has more electronegative chlorine atoms than the other 2; so this reduces the electron density of the carboxylate group, allowing the anion formed to be more stable and recombined with the hydrogen ion less readily;</p>

B8	<p>a) Magnesium would be extracted by electrolysis; as magnesium is more reactive than aluminium;</p> <p>b(i) <math>4\text{OH}^-(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g}) + 4\text{e}^-</math>;  b(ii) The oxygen produced during the electrolysis reacts with the aluminium metal to form a layer of aluminium oxide;</p> <p>b(iii) The layer acts as an impermeable layer to prevent the unreacted aluminium from reacting with other substances;</p> <p>b(iv) Aluminium acts as a coat around iron, preventing iron from coming into contact with water and oxygen; OR  Aluminium is also more reactive than iron, so it would lose electrons more readily than iron, preventing iron from being oxidised;</p> <p>c(i) Metal X is more reactive than chromium;  c(ii) Chromium(III) ions are discharged/reduced at the cathode (chromium metal);  This causes the concentration of chromium(III) ions to decrease over time;</p>
B9E	<p>a(i) The amino group is able to gain hydrogen ion to act as a base;  the carboxyl group is able to lose hydrogen ion to act as an acid;</p> <p>a(ii) It is formed when many small molecules link together to form a long-chained molecule;  without the loss of a small molecule;</p> <p>b) At low pH, the polypeptide chain may gain hydrogen ions and become positively charged;  At high pH, the polypeptide chain may lose hydrogen ions and become negatively charged;  The change in the charges would affect the electrostatic interactions within the molecules;</p> <p>c) Nylon;</p> <p>d) Add aqueous bromine to a sample of each. Amino acid J will turn red-brown aqueous bromine colourless; amino acid K will not cause a change in colour in aqueous bromine;</p>
B9O	<p>a) It is a reaction where oxidation and reduction occur simultaneously;</p> <p>b) The reducing sugar would lose hydrogen atoms;  Since copper(II) ions in Benedict's solution are reduced to form copper(I) ions, the reduced sugar would be oxidised;</p> <p>c(i) T, Q, R, S, P;  c(ii) R would have a lower than expected amount of glucose present;  Fructose can also reduce copper(II) ion to copper(I) ions, forming the precipitate;</p> <p>d(i) Number of moles of <math>\text{H}_2 = 8/2 = 4</math> moles;  <math>\text{C}_{15}\text{H}_{23}\text{COOH}</math>;</p> <p>d(ii) Add aqueous bromine to a sample of each. Y will turn red-brown aqueous bromine colourless; the product will not cause a change in colour in aqueous bromine;</p>



Name and Index Number:	Class:
(       )	



## SENG KANG SECONDARY SCHOOL PRELIMINARY EXAMINATION

**CHEMISTRY (REVISED)**

**6092/01**

**Secondary 4 Express**

**16 August 2018**

Paper 1 Multiple Choice

**1 hour**

Additional Materials: Multiple Choice Answer Sheet

**READ THESE INSTRUCTIONS FIRST**

Write your index number and name on all the work you hand in.  
You may use a soft pencil for any diagrams, graphs or rough working.  
Do not use staples, paper clips, highlighters, glue or correction fluid.

There are **forty** questions in this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.

Choose the **one** you consider correct and record your choice in soft pencil on the Multiple Choice Answer Sheet.

**Read the instructions on the Answer Sheet very carefully.**

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.  
Any rough working should be done in this question paper.  
The use of an approved scientific calculator is expected, where appropriate.

A copy of the Periodic Table is printed on page 16.

Parent's / Guardian's Signature: .....

This document consists of **15** printed pages and **1** blank page.

***Do not turn over the page until you are told to do so.***

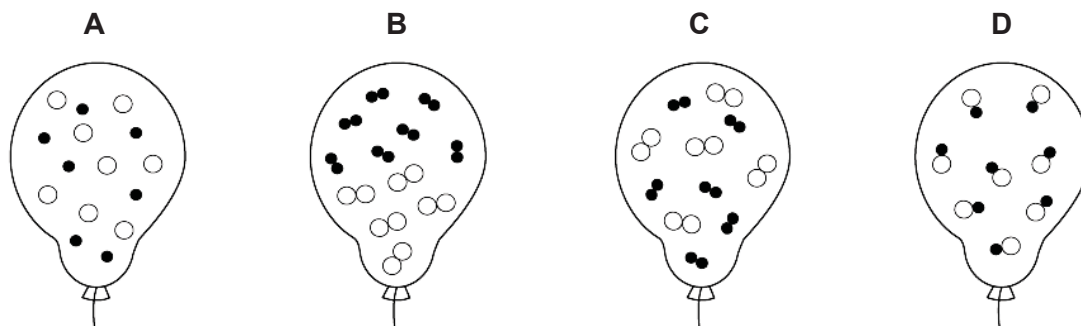


- 1 Which diagram shows the arrangement of particles inside a balloon containing a mixture of the gases nitrogen and oxygen?

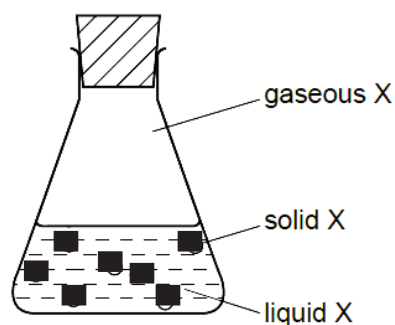
key

● nitrogen atom

○ oxygen atom

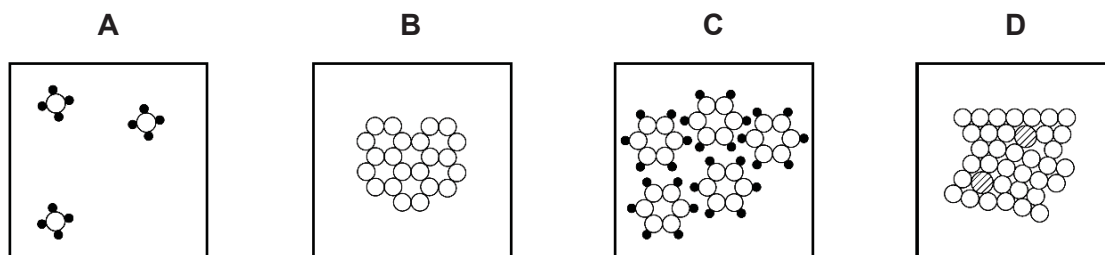


- 2 The conical flask contains compound X which is present in solid, liquid and gaseous states.



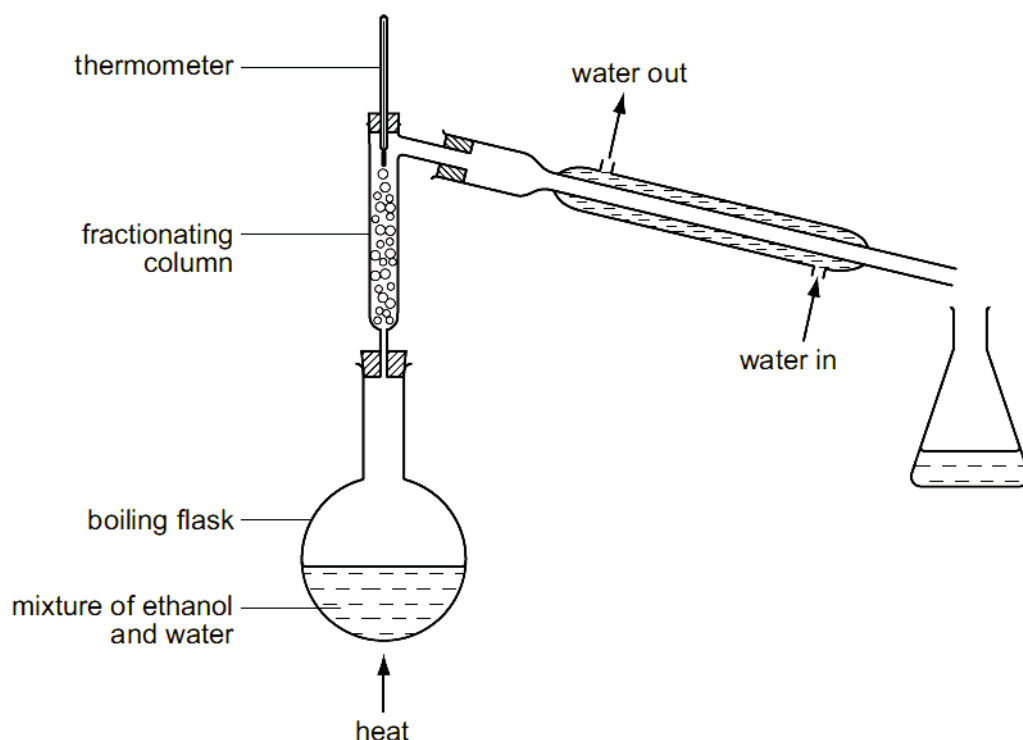
Which statement is correct?

- A A gaseous X molecule has a lower mass than a liquid X molecule.  
 B Energy is released when X changes from liquid to solid.  
 C Liquid X is at a higher temperature than solid X.  
 D Liquid X molecules vibrate about fixed positions.
- 3 Which diagram represents the arrangement of particles in an alloy?

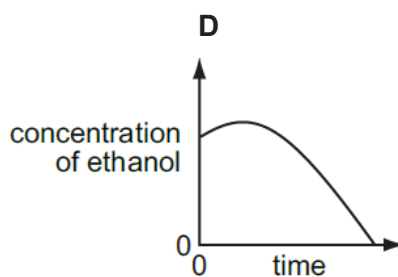
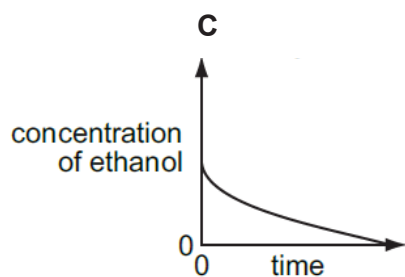
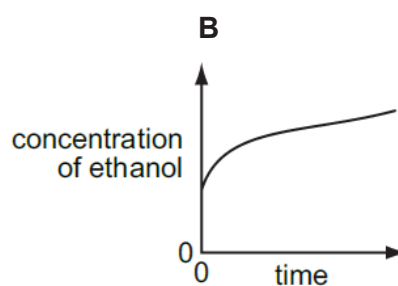
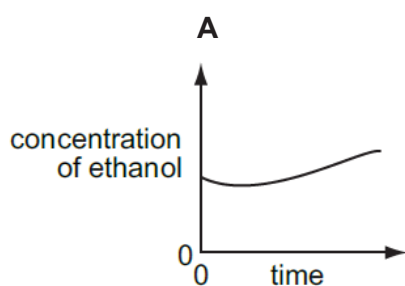


[Turn over

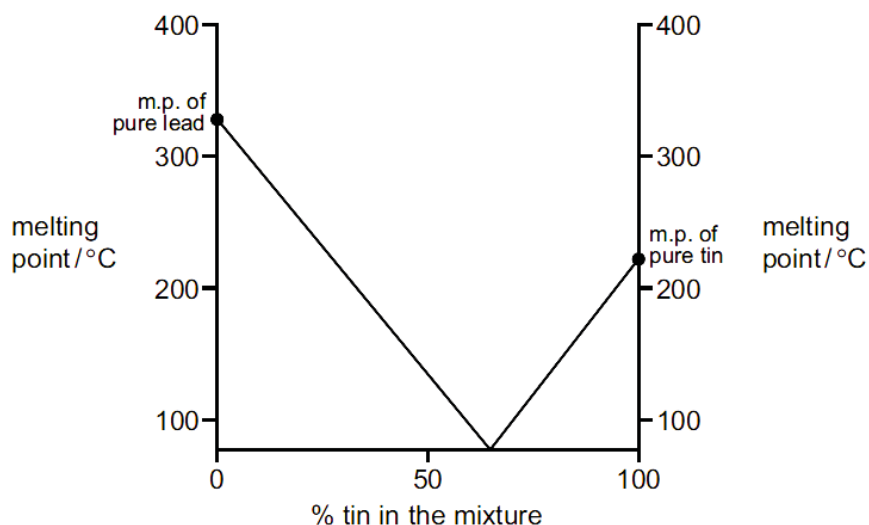
- 4 The apparatus shown is used to distil a dilute solution of ethanol (boiling point:  $78^{\circ}\text{C}$ ) in water.



Which graph shows a change in concentration of the ethanol in the boiling flask as the distillation proceeds?



- 5 The graph shows the melting points (m.p.) of mixtures of lead and tin.



The graph shows that any mixture of lead and tin must have a melting point that is

- A above that of tin.
  - B below that of lead.
  - C below that of both lead and tin,
  - D between that of lead and tin.
- 6 Naturally-occurring bromine has a relative atomic mass of 80 and consists entirely of two isotopes of relative isotopic masses 79 and 81.

What can be deduced about the naturally-occurring bromine from this information only?

- A Bromine contains the two isotopes in equal proportions.
  - B Bromine has different oxidation states.
  - C Bromine isotopes have different number of protons.
  - D Bromine is radioactive.
- 7 Which statement about diamond and graphite is correct?
- A Both diamond and graphite are used as abrasives.
  - B Diamond and graphite have different arrangements of carbon atoms.
  - C The carbon atoms in graphite have a different number of neutrons from those in diamond.
  - D The carbon atoms in both graphite and diamond have four covalent bonds.

- 8 The complete combustion of 20 cm<sup>3</sup> of a gaseous alkane, Y, requires 130 cm<sup>3</sup> of oxygen. Both volumes were measured at r.t.p..

What could be the identity of Y?

- A butane  
B ethane  
C methane  
D propane

- 9 1.0 mole of Cu<sub>3</sub>FeS<sub>3</sub> and 1.0 mole of O<sub>2</sub> are allowed to react according to the equation.



Which of the following is true?

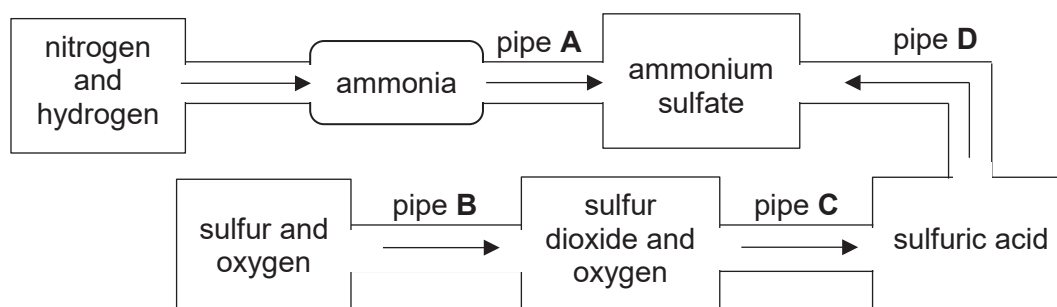
- A 0.286 mole of Cu<sub>3</sub>FeS<sub>3</sub> is in excess  
B 0.714 mole of Cu<sub>3</sub>FeS<sub>3</sub> is in excess  
C 5.0 moles of O<sub>2</sub> is in excess  
D no reagent is in excess

- 10 A solution containing lead(II) ions is added to a solution containing iodide ions. A yellow precipitate is formed.

What is the equation for the reaction that occurs?

- A  $\text{Pb}^+ + \text{I}^- \rightarrow \text{PbI}$   
B  $\text{Pb}^+ + 2\text{I}^- \rightarrow \text{PbI}_2$   
C  $\text{Pb}^{2+} + \text{I}^- \rightarrow \text{PbI}$   
D  $\text{Pb}^{2+} + 2\text{I}^- \rightarrow \text{PbI}_2$

- 11 The diagram shows some of the stages in the manufacture of ammonium sulfate.



From which of the connecting pipes would a major leak result in the highest increase in the pH of the rain?

- 12 A colourless solution is known to contain a sodium salt.

Tests were carried out to determine the identity of the anion in the solution.

test	observation
dilute hydrochloric acid	no reaction
dilute nitric acid followed by aqueous silver nitrate	no precipitate
dilute nitric acid followed by aqueous barium nitrate	no precipitate

Which anion could the solution contain?

- A carbonate      B chloride      C nitrate      D sulfate

- 13 Which equation represents a redox reaction?

- A  $4\text{CuO} + \text{CH}_4 \rightarrow 4\text{Cu} + 2\text{H}_2\text{O} + \text{CO}_2$   
 B  $\text{CuO} + \text{H}_2\text{SO}_4 \rightarrow \text{CuSO}_4 + \text{H}_2\text{O}$   
 C  $\text{CuCO}_3 \rightarrow \text{CuO} + \text{CO}_2$   
 D  $\text{CuSO}_4 + 2\text{NaOH} \rightarrow \text{Cu}(\text{OH})_2 + \text{Na}_2\text{SO}_4$

- 14 Disproportionation is a reaction in which the same element is both oxidised and reduced.

Which reaction is **not** an example of disproportionation?

- A  $2\text{CuCl} \rightarrow \text{CuCl}_2 + \text{Cu}$   
 B  $\text{Cl}_2 + 2\text{NaOH} \rightarrow \text{NaCl} + \text{NaOCl} + \text{H}_2\text{O}$   
 C  $2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$   
 D  $2\text{Pb}(\text{NO}_3)_2 \rightarrow 2\text{PbO} + 4\text{NO}_2 + \text{O}_2$

- 15 What is the function of silica,  $\text{SiO}_2$ , in the equation shown below?

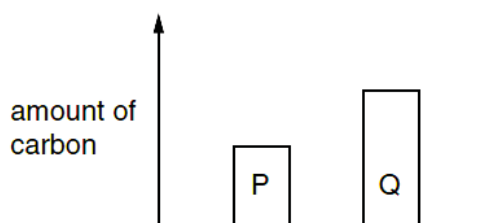


- A a basic oxide      C an acidic oxide  
 B a reducing agent      D an oxidising agent

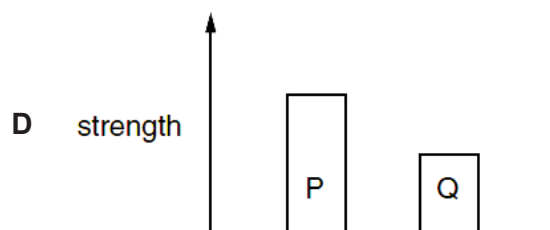
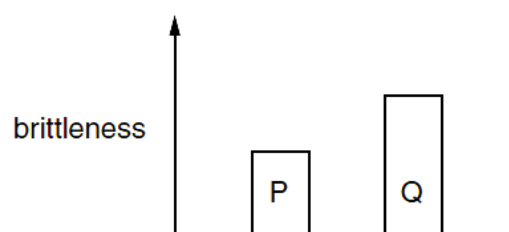
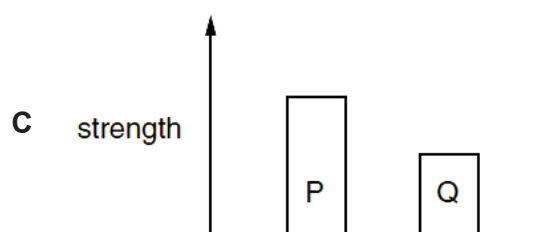
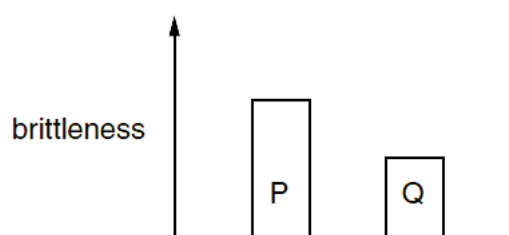
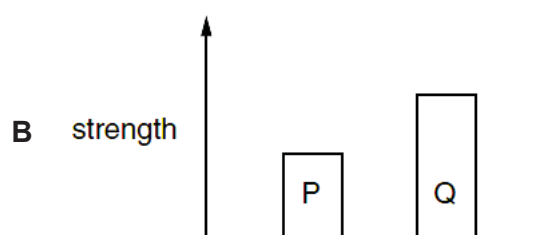
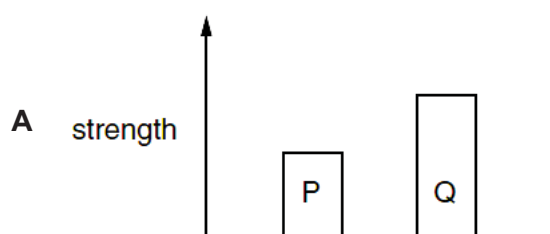
- 16 Which statement is true for both aluminium and iron?

- A Both are transition metals.  
 B Both form amphoteric oxides.  
 C The manufacture of both metals involves the reduction of the metal ions.  
 D They are both normally manufactured by electrolysis.

- 18** The diagram compares the amount of carbon in two steels, P and Q.



Which two diagrams correctly compare the strength and brittleness of P and Q?



- 19** The element chromium liberates hydrogen from dilute hydrochloric acid although it does not react with cold water.

When a piece of chromium is placed in lead(II) nitrate solution, crystals of lead appear.

What is the order of decreasing reactivity on the three metals, lead, calcium and chromium?

- A** calcium, chromium, lead  
**B** calcium, lead, chromium  
**C** chromium, calcium, lead  
**D** lead, chromium, calcium
- 20** Aluminium is often used to make caps for bottles. When thrown away and buried in the soil, the caps do not corrode.
- Which of the following explains the observation above?
- A** Aluminium does not react with acids.  
**B** Aluminium does not react with alkalis.  
**C** Aluminium is alloyed with other metals.  
**D** Aluminium is protected by a layer of oxide.

- 21** Which arrangement is used to electroplate copper onto a steel key?

	electrolyte	anode (positive electrode)	cathode (negative electrode)
<b>A</b>	aqueous copper(II) sulfate	piece of pure copper	steel key
<b>B</b>	aqueous copper(II) sulfate	steel key	piece of pure copper
<b>C</b>	aqueous sulfuric acid	piece of pure copper	steel key
<b>D</b>	aqueous sulfuric acid	steel key	piece of pure copper

- 22** In an electrolysis experiment, the same amount of charge deposited 54.0g of silver and 8.5g of vanadium.

What is the charge on the vanadium ion?

- A** 1+                      **B** 2+                      **C** 3+                      **D** 4+

- 23** A simple cell can be made using two different metals as the electrodes and an aqueous solution as the electrolyte.

Which statements about simple cells are correct?

- 1 A greater voltage is produced using magnesium and silver than using magnesium and copper.
- 2 The electrolyte is an aqueous solution that contains both positive and negative ions.
- 3 The more reactive metal will lose electrons more readily than the less reactive metal.

**A** 1, 2 and 3      **B** 1 and 3 only      **C** 1 only      **D** 2 and 3 only

- 24** Lithium and rubidium are both in Group I of the Periodic Table.

Which statement is correct?

- A** Lithium atoms and rubidium atoms have the same number of electrons in their outer shell.
- B** Lithium atoms are larger than rubidium ions.
- C** Lithium ions and rubidium ions have the same number of electrons in their outer shell.
- D** Rubidium ions are larger than rubidium atoms.

- 25** Which statement about both the Group I and Group VII elements is correct?

- A** They conduct electricity when molten.
- B** They form covalent compounds when bonded to non-metals.
- C** They exist as diatomic molecules.
- D** When Group I elements combine with Group VII elements, ionic compounds form.

- 26** The table compares the strengths of the bonds for the reactions of  $X_2 + Y_2 \rightarrow 2XY$ .

Which reaction will be most exothermic?

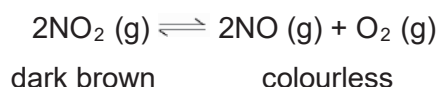
	bond in $X_2$	bond in $Y_2$	bond in $XY$
<b>A</b>	strong	strong	strong
<b>B</b>	strong	strong	weak
<b>C</b>	weak	weak	strong
<b>D</b>	weak	weak	weak



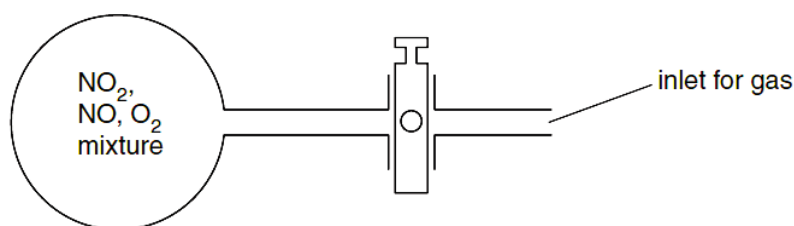
- 27 It has been suggested that the cars of the future could be powered by fuel cells. One type of fuel cell uses the chemical reaction between oxygen and hydrogen to produce electricity.

What would be a disadvantage of using this type of fuel cell to power a car?

- A A car cannot be powered by electricity.
  - B The hydrogen tank might split in an accident, leading to an explosion.
  - C The product of the reaction between oxygen and hydrogen is toxic.
  - D The oxygen would need to be obtained from air.
- 28 Nitrogen dioxide,  $\text{NO}_2$ , is a dark brown gas that decomposes at equilibrium, as shown.



The diagram shows a glass flask containing a mixture of the three gases. The mixture is pale brown.



More oxygen is formed in the flask.

What colour change is seen in the flask?

- A There is no change.
  - B It turns colourless.
  - C It becomes darker brown.
  - D It becomes paler brown.
- 29 In the Haber process, nitrogen and hydrogen react to form ammonia.

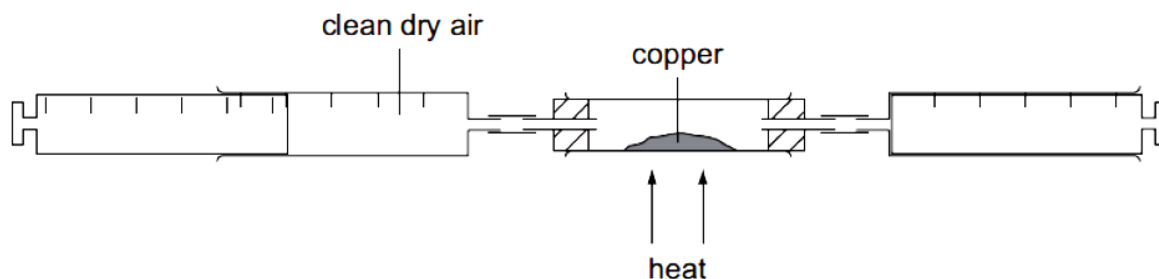


Which factor increases both the speed of reaction and the amount of ammonia produced?

- A addition of a catalyst
- B decreasing the temperature
- C increasing the pressure
- D increasing the temperature

[Turn over

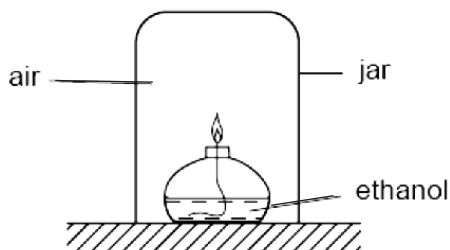
- 30 A sample of clean, dry air is passed over hot copper until all the oxygen in the air reacts with the copper.



The volume of air decreases by  $30 \text{ cm}^3$ .

What was the initial volume of the sample of air?

- A  $60 \text{ cm}^3$                       B  $100 \text{ cm}^3$                       C  $150 \text{ cm}^3$                       D  $300 \text{ cm}^3$
- 31 Why are catalytic converters fitted to car exhausts?
- A to decrease the amount of carbon dioxide emitted  
 B to decrease the amount of nitrogen oxides emitted  
 C to improve energy conservation  
 D to reduce global warming
- 32 Dry air is a mixture of gases of which 99% is nitrogen and oxygen.  
 What is the main constituent of the remaining 1%?
- A argon                                      C hydrogen  
 B helium                                      D water vapour
- 33 The diagram shows ethanol burning in a sealed jar.



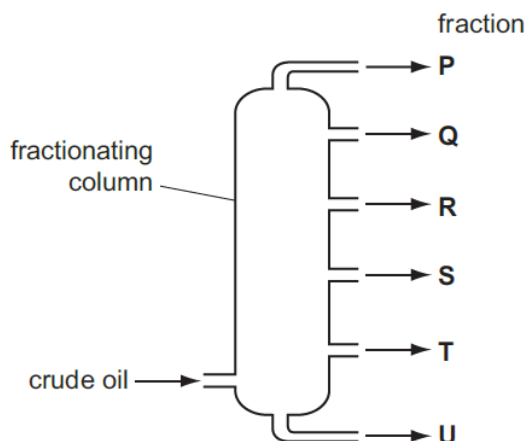
The mass of one gas in the jar does not change.

Which gas is this?

- A carbon dioxide                      C oxygen  
 B nitrogen                                      D water vapour

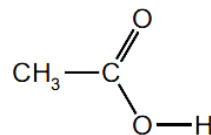
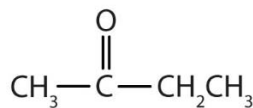
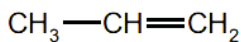
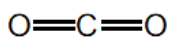
[Turn over

- 34 The diagram shows the fractional distillation of crude oil.



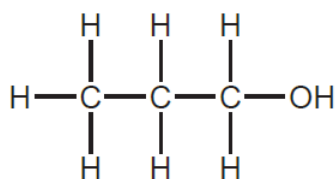
Which statement is correct?

- A Each fraction consists of a single compound.  
 B Fraction P has the highest boiling point.  
 C The highest temperature is at the top of the column.  
 D The naphtha fraction is used as feedstock for the chemical industry.
- 35 Which property of a liquid ester can be used to check its purity before use as a food flavouring?
- A boiling point  
 B colour  
 C smell  
 D solubility in water
- 36 Which compound is the most viscous and the least flammable?
- A  $C_6H_{14}$   
 B  $C_8H_{18}$   
 C  $C_{10}H_{22}$   
 D  $C_{12}H_{26}$
- 37 How many of the following structures show an unsaturated hydrocarbon molecule?



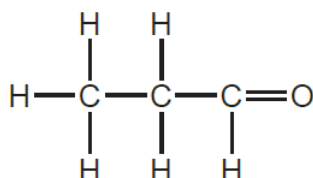
- A 1  
 B 2  
 C 3  
 D 4

- 38 This is the structural of propan-1-ol.

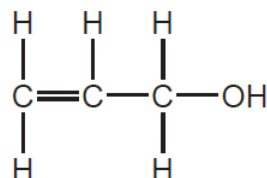


Which of the following is an isomer of propan-1-ol?

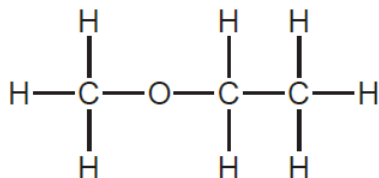
**A**



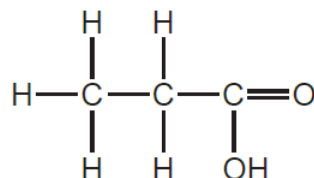
**C**



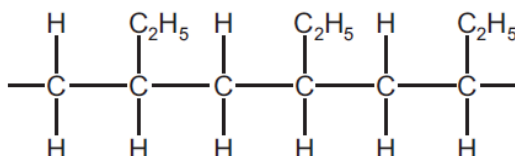
**B**



**D**



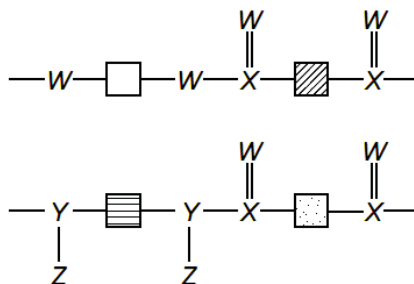
- 39 The diagram shows a section of a polymer.



Which alkene is used to make this polymer?

- A**  $\text{CH}_3\text{CH}=\text{CH}_2$   
**B**  $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$   
**C**  $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_2$   
**D**  $\text{CH}_3\text{CH}=\text{CHCH}_3$

- 40 The diagram shows the partial structures of two different polymers.



Which chemical symbols should replace  $W$ ,  $X$ ,  $Y$  and  $Z$ ?

	$W$	$X$	$Y$	$Z$
<b>A</b>	C	N	H	O
<b>B</b>	N	H	O	C
<b>C</b>	O	C	H	N
<b>D</b>	O	C	N	H

**END OF PAPER**

# The Periodic Table of Elements

Group																		
I	II	Key										III	IV	V	VI	VII	0	
		proton (atomic) number atomic symbol name relative atomic mass																
		1 H hydrogen 1																
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20	
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40	
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84	
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131	
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium -	85 At astatine -	86 Rn radon -	
87 Fr francium -	88 Ra radium -	89 – 103 actinoids	104 Rf Rutherfordium -	105 Db dubnium -	106 Sg seaborgium -	107 Bh bohrium -	108 Hs hassium -	109 Mt meitnerium -	110 Ds darmstadtium -	111 Rg roentgenium -	112 Cn copernicium -		114 Fl flerovium -		116 Lv livermorium -			

lanthanoids

actinoids

57	La	lanthanum	139	58	Ce	cerium	140	59	Pr	praseodymium	141	60	Nd	neodymium	144	61	Pm	promethium	—	62	Sm	samarium	150	63	Eu	euroium	152	64	Gd	gadolinium	157	65	Tb	terbium	159	66	Dy	dysprosium	163	67	Ho	holmium	165	68	Er	erbium	167	69	Tm	thulium	169	70	Yb	ytterbium	173	71	Lu	lutetium	175
89	Ac	actinium	—	90	Th	thorium	232	91	Pa	protactinium	231	92	U	uranium	238	93	Np	neptunium	—	94	Pu	plutonium	—	95	Am	americium	—	96	Cm	curium	—	97	Bk	berkelium	—	98	Cf	californium	—	99	Es	einsteinium	—	100	Fm	fermium	—	101	Md	mendelevium	—	102	No	nobelium	—	103	Lr	lawrencium	—

The volume of one mole of any gas is 24 dm<sup>3</sup> at room temperature and pressure (r.t.p.).

Name and Index Number:  (       )	Class:
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## SENG KANG SECONDARY SCHOOL PRELIMINARY EXAMINATION

### CHEMISTRY (REVISED)

**6092/02**

### Secondary 4 Express

7 August 2018

Paper 2 Theory

**1 hour 45 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

#### READ THESE INSTRUCTIONS FIRST

Write your index number and name on all the work you hand in.

Write in dark blue or black pen on both sides of the paper.

You may use a soft pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

#### Section A

Answer **all** questions in the spaces provided.

#### Section B

Answer all **three** questions, the last question is in the form either/or.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [   ] at the end of each question or part question.

A copy of the Periodic Table is printed on page 22.

The use of an approved scientific calculator is expected, where appropriate.

For Examiner's use	
<b>Section A</b>	<b>/ 50</b>
<b>1</b>	<b>/ 5</b>
<b>2</b>	<b>/ 3</b>
<b>3</b>	<b>/ 10</b>
<b>4</b>	<b>/ 7</b>
<b>5</b>	<b>/ 7</b>
<b>6</b>	<b>/ 9</b>
<b>7</b>	<b>/ 9</b>
<b>Section B</b>	<b>/ 30</b>
<b>8</b>	<b>/ 13</b>
<b>9</b>	<b>/ 7</b>
<b>10</b>	<b>/ 10</b>
<b>Total</b>	<b>/ 80</b>
<b>Total %</b>	<b>/ 100</b>

Parent's / Guardian's Signature: .....

This document consists of **22** printed pages.

***Do not turn over the page until you are told to do so.***

## Section A

Answer **all** the questions in this section in the spaces provided.

**A1** Fig. 1.1 shows part of the Periodic Table.

										He
					B	C	N	O	F	Ne
					Al	Si	P	S	Cl	Ar
Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
									I	Xe

**Fig. 1.1**

Answer the following questions using **only** the elements shown in Fig. 1.1.

Each element can be used once, more than once or not at all.

Write the **symbol** for

- (a) an element which is used as a gas in balloons, ..... [1]
- (b) an element which forms an ion of type  $X^{3-}$ , ..... [1]
- (c) an element which is a catalyst for the production of ammonia, ..... [1]
- (d) two elements which combine to form a compound that causes acid rain, ..... and ..... [1]
- (e) an element which forms ions in aqueous solution which gives a white precipitate on reaction with acidified silver nitrate. .... [1]

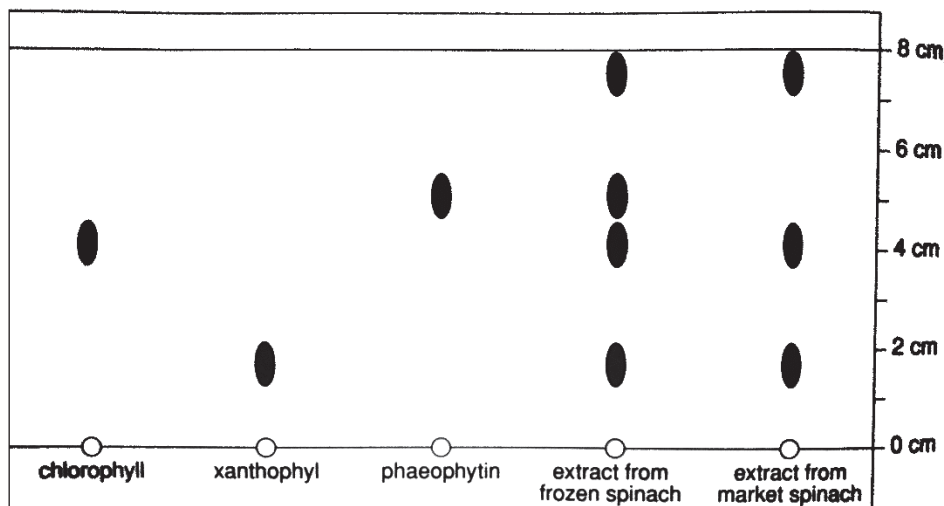
[Total: 5]



- A2** Chlorophyll is a green pigment found in green leaves. 'Old' chlorophyll can decompose into phaeophytin, a grey pigment molecule.

A student carried out a chromatography to compare the extracts of spinach leaves obtained from two different sources.

Fig. 2.1 shows the results on the chromatogram.



**Fig. 2.1**

- (a) Using the information in Fig. 2.1, describe the result obtained for the extract from frozen spinach.

.....  
 ..... [1]

- (b) Calculate the  $R_f$  value of chlorophyll in the experiment.

$R_f$  value of chlorophyll ..... [1]

- (c) The student concluded that the spinach bought from the market is fresher than the frozen spinach bought from the supermarket.

Using the information in Fig. 2.1, explain his reasoning.

..... [1]

[Total: 3]

[Turn over

- A3 (a)** Silicon has three naturally occurring isotopes.  
Complete Table 3.1 for two of these isotopes.

**Table 3.1**

isotope	$^{28}\text{Si}$	$^{30}\text{Si}$
atomic number		14
number of neutrons	14	
nucleon number		

[2]

- (b)** Silicon(IV) chloride is a simple molecular compound and exists as a liquid at room temperature.

- (i)** Suggest **two** physical properties of silicon(IV) chloride, other than solubility.

.....

..... [2]

- (ii)** Draw a diagram to show the arrangement of electrons in a molecule of silicon(IV) chloride. You only need to show outer shell electrons.

[2]

- (c) Silicon(IV) chloride reacts with water to form silicon(IV) oxide and an acidic product.

Fig. 3.2 shows part of the structure of silicon(IV) oxide.

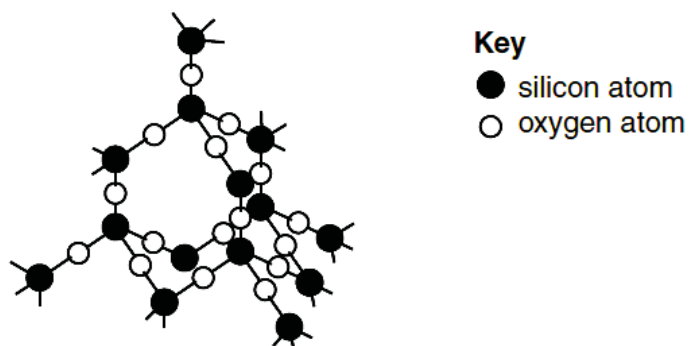


Fig. 3.2

- (i) Construct an equation, including state symbols, for the reaction between silicon(IV) chloride with water.

..... [2]

- (ii) A student claims that the physical properties of silicon(IV) oxide is similar to that of silicon(IV) chloride.

Explain, in terms of structure and bonding, why the student's claim is wrong.

.....

.....

.....

..... [2]

[Total: 10]

**A4** Methane, ethane and propane are all gases at room temperature.

- (a) State one possible environmental consequence of the presence of methane in the atmosphere.

..... [1]

- (b) Ethane reacts with chlorine in the presence of ultraviolet light to give a number of different compounds.

A 1.00g sample of one of these compounds contains 0.040g of hydrogen, 0.242g of carbon and 0.718g of chlorine.

- (i) Calculate the empirical formula of this compound.

empirical formula ..... [2]

- (ii) The relative molecular mass of the compound is 99.

Deduce the molecular formula of the compound.

..... [1]

- (c) (i) Explain why propane diffuses faster at 100°C than at 60°C.

.....

..... [1]

- (ii) Explain why diffusion could be used to separate a mixture of methane and propane.

.....

.....

..... [2]

[Total: 7]

**[Turn over**

**A5** Lead is widely used to make lead-acid car batteries.

Lead can be extracted from cerrusite,  $\text{PbCO}_3$ , in a two-stage process.



(a) Explain if the reaction from stage 1 is exothermic or endothermic.

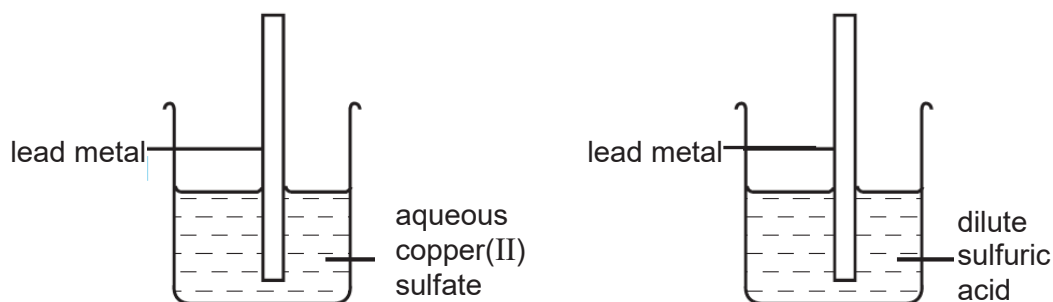
.....  
 ..... [2]

(b) Explain why the gas from stage 2 must be removed for the safety of the workers.

..... [1]

(c) In the laboratory, two experiments were set up using lead metal, as shown in Fig. 5.1.

Both experiments were conducted at room temperature of  $25^\circ\text{C}$ .



**Fig. 5.1**

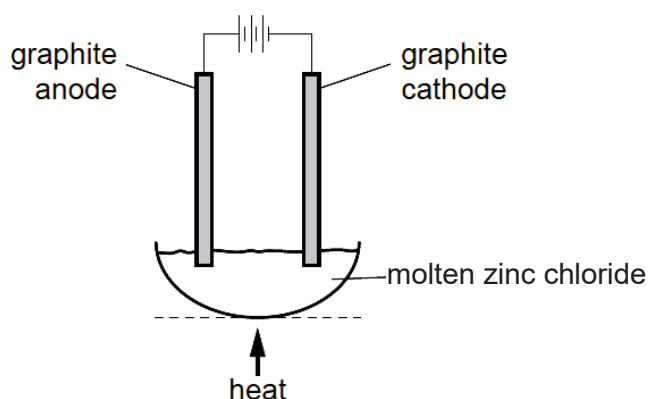
For each experiment, describe what you would observe and how you would test any gas(es) evolved, if any. Write an equation for any **one** of the reactions in Fig. 5.1.

.....  
 .....  
 .....  
 .....  
 ..... [4]

[Total: 7]

**[Turn over**

**A6** Molten zinc chloride can be electrolysed using the apparatus as shown in Fig. 6.1.



**Fig. 6.1**

- (a)** Explain why zinc chloride conducts electricity when molten, but not when solid.

.....  
 .....  
 ..... [2]

- (b)** Predict the products of this electrolysis at

the anode, ..... [1]

the cathode. .... [1]

- (c)** When a dilute aqueous solution of zinc chloride is electrolysed, hydroxide ions are converted to oxygen at the anode.

Write the ionic equation for the reaction that happens at the anode.

..... [1]

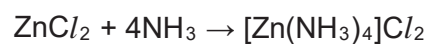
- (d)** Describe a positive test for zinc ions.

test .....

observations .....

..... [2]

- (e) Solid zinc chloride absorbs ammonia to form tetra-ammine zinc chloride,  $[\text{Zn}(\text{NH}_3)_4]\text{Cl}_2$ .



Calculate the maximum yield, in grams, of tetra-ammine zinc chloride formed when 3.4g of zinc chloride reacts with excess ammonia.

[2]

[Total: 9]

**A7** This question is about the large scale production of ethanol.

- (a) Ethanol can be made by reacting ethene with steam in the presence of a catalyst.

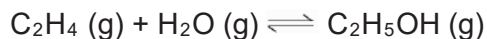


Fig. 7.1 shows how the percentage yield of ethanol changes as the pressure is changed at three different temperatures.

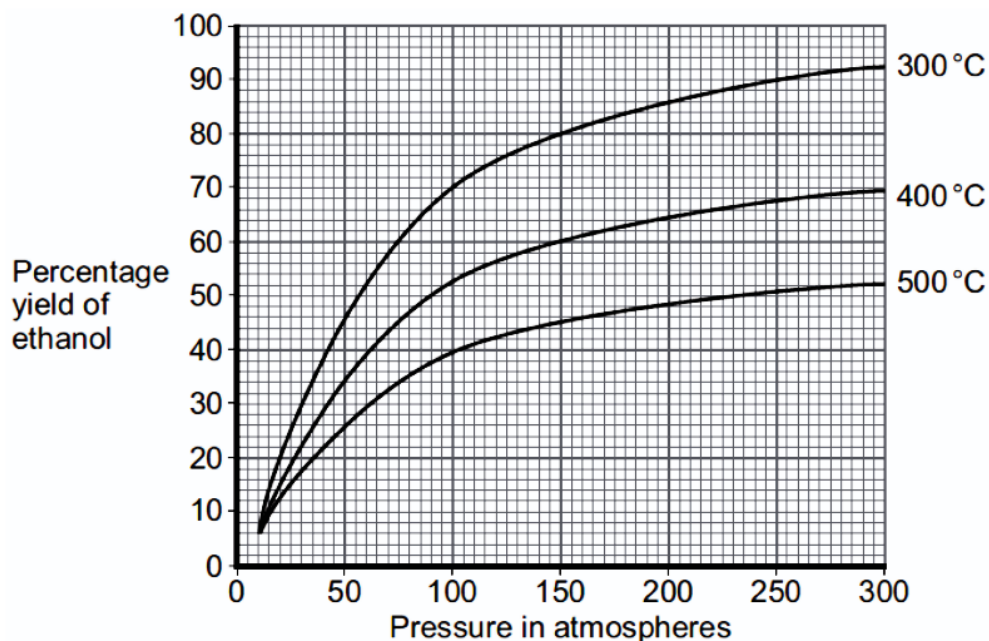


Fig. 7.1

Fig. 7.2 shows how the rate of reaction changes as the temperature changes at three different pressures.

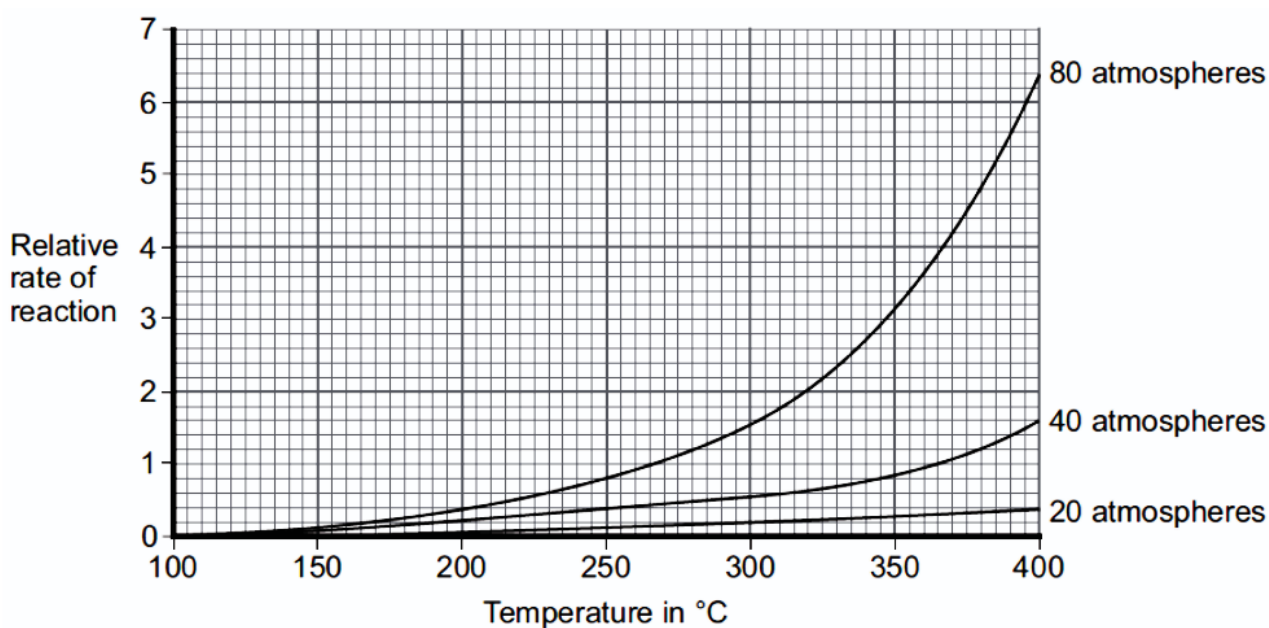


Fig. 7.2



In one process for the reaction of ethene with steam, the conditions are:

- 300°C
- 65 atmospheres
- a catalyst

Use the information in Fig. 7.1 and 7.2, and relevant chemistry knowledge, justify why the above three conditions are used.

.....

.....

.....

.....

.....

.....

.....

.....

[6]

- (b) Other than the reaction of ethene with steam, ethanol can also be manufactured on a large scale by the fermentation of sugar.

Compare these two processes of making ethanol, in terms of

- the rate of reaction,
- concentration of the ethanol produced,
- the use of finite resources.

.....

.....

.....

.....

.....

[3]

[Total: 9]

[Turn over

## Section B

Answer all **three** questions in this section in the spaces provided.

The last question is in the form of an either/or and only one of the alternatives should be attempted.

- B8** Fats and oils are triglycerides formed from the condensation reaction of propane-1,2,3-triol with long chain carboxylic acids (fatty acids). Each triglyceride is formed from three fatty acids.

Fig. 8.1 shows the structural formula of a triglyceride likely to be found in peanut oil.

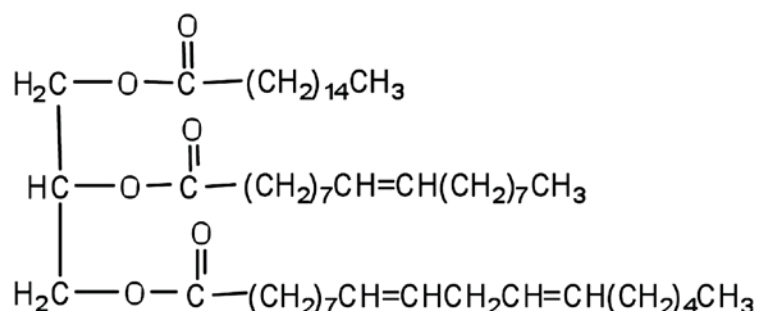


Fig. 8.1

A triglyceride is considered a fat if it is a solid at 25°C, whereas it is considered an oil if it is a liquid at 25°C. These differences in melting points reflect the differences in the degree of unsaturation and molar mass of the constituent fatty acids.

One method for checking the unsaturation level in fatty acids is to determine the iodine number. *Iodine number* is the number of grams of iodine consumed by 100 g of fat or oil. A higher iodine value indicates a higher degree of unsaturation.

Table 8.2 shows average figures for the percentage fatty acid composition of some common fats and oils.

Table 8.2

source of fat or oil	% saturated fatty acids (total)	% monounsaturated fatty acid, oleic acid (C <sub>17</sub> H <sub>33</sub> COOH)	% polyunsaturated fatty acids	
			linoleic acid (C <sub>17</sub> H <sub>31</sub> COOH)	linolenic acid (C <sub>17</sub> H <sub>29</sub> COOH)
beef fat	59	38	3	—
coconut oil	90	8	2	—
corn oil	25	26	47	2
cotton seed oil	22	35	43	—
olive oil	15	78	7	—
soybean oil	14	28	50	8

[Turn over

The *polyunsaturated/saturated (P/S) index* of a fat or oil is the ratio of polyunsaturated fat to saturated fat. It is sometimes used to compare the relative health benefits of different fats and oils in the diet.

The above passage is modified from <https://2012books.lardbucket.org/books/introduction-to-chemistry-general-organic-and-biological/s20-lipids.html>.

(a) (i) State the chemical linkage which is observed in Fig. 8.1.

..... [1]

(ii) Identify the by-product formed for the reaction of propane-1,2,3-triol with three long chain carboxylic acids (fatty acids).

..... [1]

(iii) Draw the structural formulae of **two** reactants that are used to produce the triglyceride, as seen in Fig. 8.1.

- reactant 1: propane-1,2,3-triol

- reactant 2: one of the carboxylic acids

[2]

(b) Using the information in Table 8.2, deduce and explain which fat or oil has the lowest iodine number.

.....

..... [2]

[Turn over

- (c) Although cotton seed oil and corn oil have similar iodine numbers, the melting point of cotton seed oil is higher than that of corn oil.

Suggest an explanation, in terms of the structure and bonding, in these two oils.

.....

.....

.....

.....

..... [2]

- (d) Linoleic acid is a polyunsaturated fatty acid with molecular formula of  $C_{17}H_{31}COOH$ .  
How many double bonds between carbon atoms are present in one molecule of linoleic acid? Explain your reasoning.

.....

.....

.....

.....

..... [2]

- (e) A P/S value of greater than 1 is considered beneficial for health.  
Calculate the P/S index of coconut oil and soybean oil, giving your answers to 3 significant figures.  
Hence, determine which oil, coconut oil or soybean oil, is more beneficial for health.

..... [3]

[Total: 13]

[Turn over

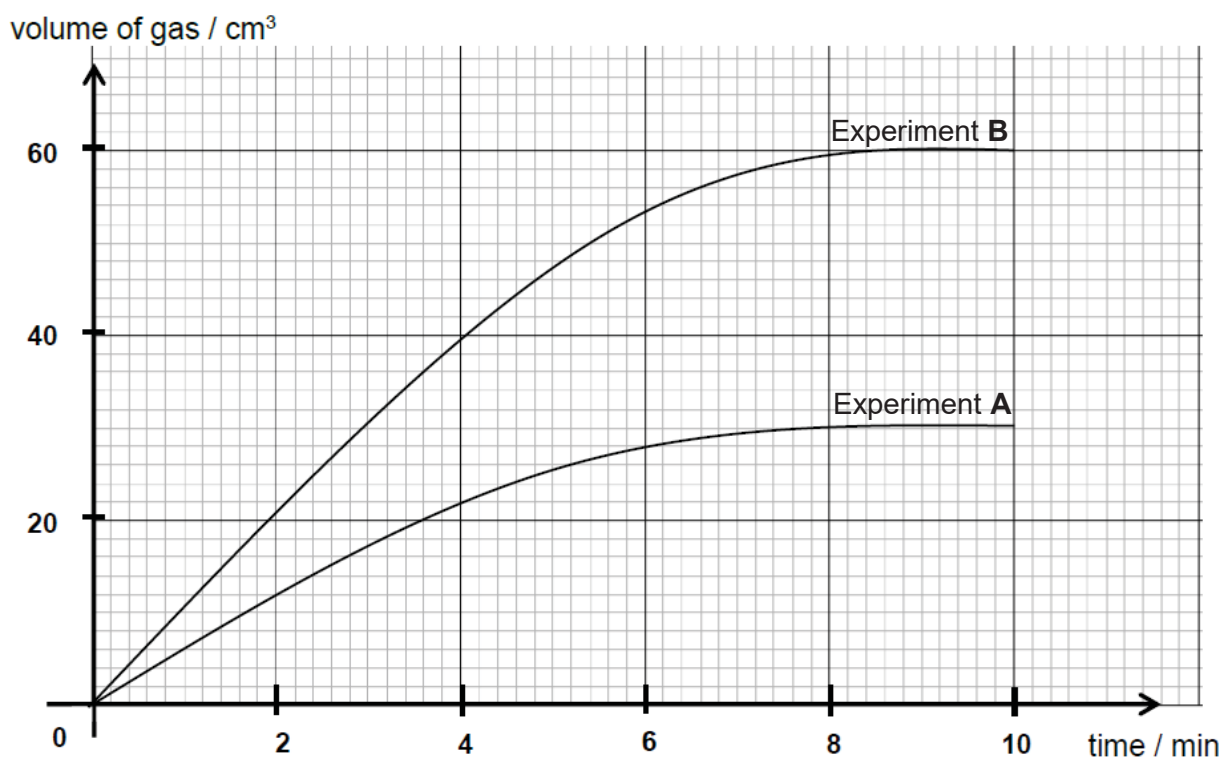
- B9 (a)** A series of experiments was carried out to compare the rate of reaction of acid with magnesium under different conditions.

Excess magnesium and  $25.0 \text{ cm}^3$  of acid were used. The conditions for each experiment are shown in Table 9.1.

**Table 9.1**

experiment	particle size of magnesium	concentration and type of acid used
<b>A</b>	lumps	$0.1 \text{ mol/dm}^3 \text{ HCl}$
<b>B</b>	lumps	$0.2 \text{ mol/dm}^3 \text{ HCl}$
<b>C</b>	lumps	$0.1 \text{ mol/dm}^3 \text{ CH}_3\text{COOH}$
<b>D</b>	powder	$0.2 \text{ mol/dm}^3 \text{ HCl}$

The gas evolved was collected and its total volume was measured every 30 seconds for 10 minutes. The results obtained for experiment **A** and **B** were plotted in Fig. 9.2.



**Fig. 9.2**

- (i) Sketch on Fig. 9.2 the curve that you would expect for experiment **C**, assuming that the reaction ended at the tenth minute. Label this curve as 'Experiment **C**'.

[1]

[Turn over

- (ii) Explain, in terms of collisions between reacting particles, why there is a difference in the initial rate of reaction between experiments **B** and **D**.

.....

.....

.....

..... [2]

- (b) The acids from experiments **A** and **C** are used in titration experiments with potassium hydroxide.

In experiment **A-2**,  $0.1 \text{ mol/dm}^3$  of potassium hydroxide was added from a burette to  $24.0 \text{ cm}^3$  of dilute hydrochloric acid. A pH probe attached to a computer measured the pH during the titration experiment.

Fig. 9.3 shows the results.

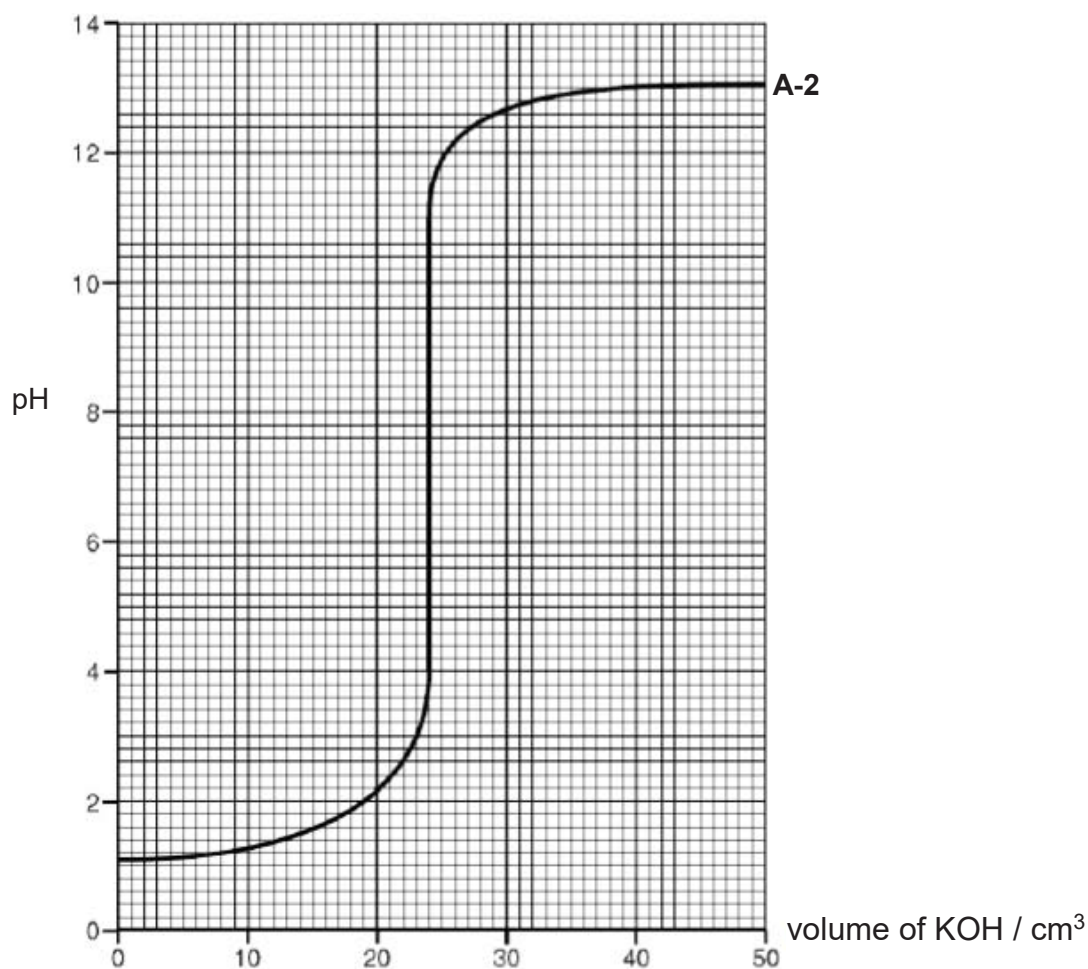


Fig. 9.3

In experiment **C-2**,  $0.1 \text{ mol/dm}^3$  of potassium hydroxide was added from a burette to  $24.0 \text{ cm}^3$  of dilute ethanoic acid.

[Turn over

- (i) Using the graph in Fig. 9.3, state the pH value of hydrochloric acid used in experiment **A-2**.

..... [1]

- (ii) The pH value of the ethanoic acid used in experiment **C-2** is 4. On the same axes on Fig. 9.3, sketch the curve you would expect for this experiment. Label this curve as '**C-2**'. [1]

- (iii) The acids used in experiment **A-2** and **C-2** have the same concentration. Explain why they have different pH values.

.....  
.....  
.....  
..... [2]

[Total: 7]

**EITHER**

**B10** This question is about the chemistry of chlorine and some of its compounds.

- (a) Describe, with the aid of an ionic equation, the reaction of chlorine with aqueous potassium bromide. Explain why this reaction involves the reduction of chlorine.

.....

.....

.....

.....

..... [3]

- (b) Describe a way to prepare a dry, pure sample of silver chloride,  $\text{AgCl}$ , from silver metal.

Use the following information to help you

- silver does not react with dilute hydrochloric acid,
- silver reacts with hot concentrated nitric acid to form silver nitrate,
- all nitrates are soluble in water,
- silver chloride is insoluble in water.

.....

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.....

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..... [4]

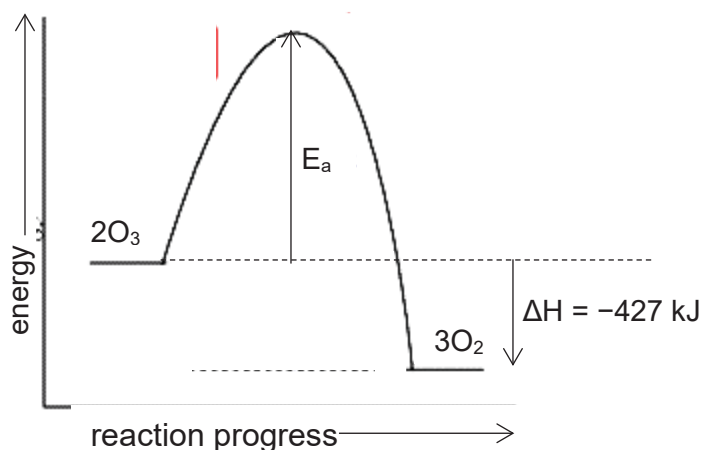


- (c) The ozone layer in the atmosphere contains ozone,  $O_3$ .  
The ozone absorbs ultraviolet light and breaks down to form oxygen.



The ultraviolet light provides the activation energy for the reaction.

Fig. 10.1 shows the energy profile diagram for the above reaction.



**Fig. 10.1**

- (i) Chlorine atoms, pollutants in the ozone layer, catalyse the reaction that breaks down ozone and increase its rate.

Sketch the energy profile of the catalysed reaction in Fig. 10.1.

[1]

- (ii) Explain, in terms of energy and particle collisions, how a catalyst increases the rate of reaction.

.....

.....

.....

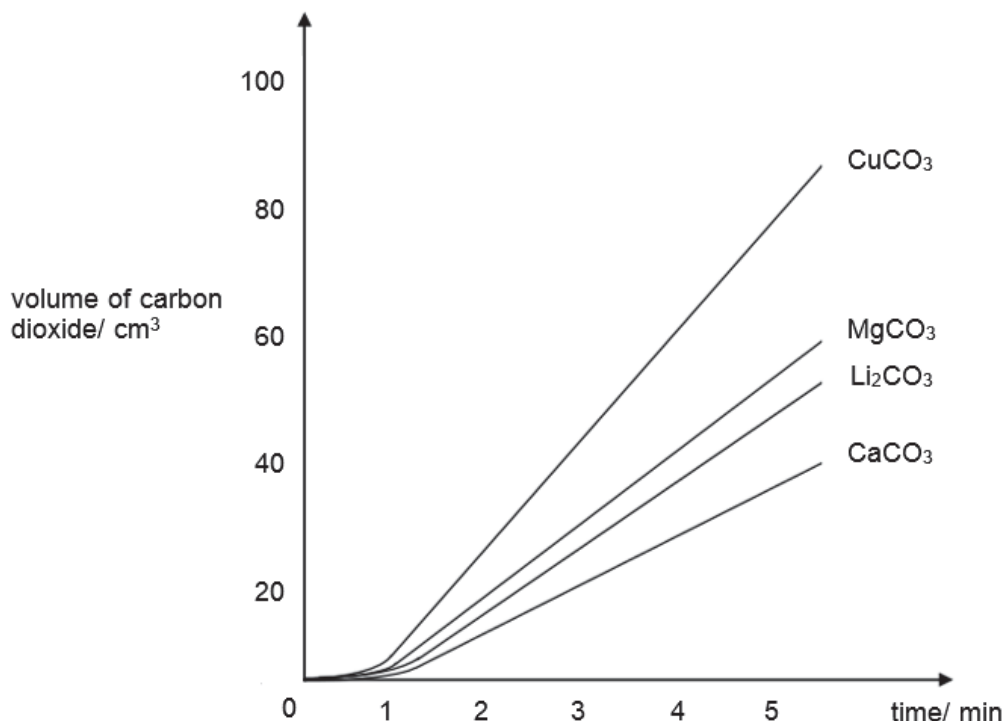
[2]

[Total: 10]

OR

**B10 (a)** Some metal carbonates, when heated, decompose to produce carbon dioxide.

Fig. 10.2 shows the results from an investigation on the rate of decomposition of four metal carbonates.



**Fig. 10.2**

In each experiment, 1.00 g of metal carbonate was heated to the same temperature using flame of the same intensity. The volume of carbon dioxide produced was measured at every minute interval.

- (i) Suggest why very little carbon dioxide was collected at the start of each experiment.

.....

..... [1]

- (ii) Using the information in Fig. 10.2, explain why the decomposition of metal carbonates were **not** completed at the end of the investigation.

.....

..... [1]

- (iii) Using **only** the information in Fig. 10.2, state and explain which metal carbonate decomposed at the fastest rate.

.....

.....

..... [2]

- (iv) Describe and explain how the volume of carbon dioxide will change with time if sodium carbonate was used for the experiment.

.....

..... [2]

- (b) Two samples of a copper ore have been discovered. They contain different amounts of copper(II) carbonate but no other carbonate.

When excess dilute acid is mixed with the powdered ore, a gas is produced. The volume of gas evolved is a measure of the amount of copper(II) carbonate in the ore.

Outline an experiment that compares the amounts of copper(II) carbonate in the two different ores. You may include a diagram if it helps you to answer the question.

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 10]

**END OF PAPER**

# The Periodic Table of Elements

Group																		
I	II	1 H hydrogen 1					III	IV	V	VI	VII	0						
<div>Key</div> <div>proton (atomic) number atomic symbol name relative atomic mass</div>																		
3 Li lithium 7	4 Be beryllium 9												5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24												13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84	
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131	
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium -	85 At astatine -	86 Rn radon -	
87 Fr francium -	88 Ra radium -	89 – 103 actinoids	104 Rf Rutherfordium -	105 Db dubnium -	106 Sg seaborgium -	107 Bh bohrium -	108 Hs hassium -	109 Mt meitnerium -	110 Ds darmstadtium -	111 Rg roentgenium -	112 Cn copernicium -		114 Fl flerovium -		116 Lv livermorium -			

lanthanoids

57	La	lanthanum	139	58	Ce	cerium	140	59	Pr	praseodymium	141	60	Nd	neodymium	144	61	Pm	promethium	—	62	Sm	samarium	150	63	Eu	euroium	152	64	Gd	gadolinium	157	65	Tb	terbium	159	66	Dy	dysprosium	163	67	Ho	holmium	165	68	Er	erbium	167	69	Tm	thulium	169	70	Yb	ytterbium	173	71	Lu	lutetium	175
89	Ac	actinium	—	90	Th	thorium	232	91	Pa	protactinium	231	92	U	uranium	238	93	Np	neptunium	—	94	Pu	plutonium	—	95	Am	americium	—	96	Cm	curium	—	97	Bk	berkelium	—	98	Cf	californium	—	99	Es	einsteinium	—	100	Fm	fermium	—	101	Md	mdendelevium	—	102	No	nobelium	—	103	Lr	lawrencium	—

actinoids

The volume of one mole of any gas is 24 dm<sup>3</sup> at room temperature and pressure (r.t.p.).



## SECONDARY FOUR CHEMISTRY PRELIM EXAM MARKING SCHEME

### PAPER 1 [40 marks]

1	2	3	4	5	6	7	8	9	10
C	B	D	C	B	A	B	A	B	D
11	12	13	14	15	16	17	18	19	20
A	C	A	D	C	C	B	A	A	D
21	22	23	24	25	26	27	28	29	30
A	C	A	A	D	C	B	D	C	C
31	32	33	34	35	36	37	38	39	40
B	A	B	D	A	D	A	B	B	D

### PAPER 2 [80 marks]

#### Section A [50 marks]

- A1 (a) He [1] (b) N/P/As [1] (c) Fe [1] (d) S and O/ N and O/ C and O [1]  
(e) Cl [1]

[Overall of 1 m will be deducted if candidates never follow the instruction to write chemical symbol.]

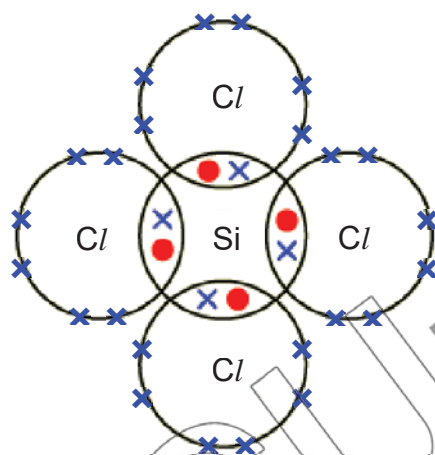
- A2 (a) The extract from frozen spinach contains xanthophyll, chlorophyll, phaeophytin and a / one unknown spot / substance. [1]  
(b)  $R_f = \frac{4}{8} = 0.500$  (3 sig. fig.) [1]  
(c) The frozen spinach contains the 'old' chlorophyll, phaeophytin, [1] indicating that it is no longer fresh. or The spinach bought from the market does not contain the 'old' chlorophyll, phaeophytin.

- A3 (a) [1 m for every 2 correct answers; max. of 2 m]

isotope	$^{28}\text{Si}$	$^{30}\text{Si}$
atomic number	14	14
number of neutrons	14	16
nucleon number	28	30

- (b) (i) 1 m for any correct answer; max. of 2 m:  
- low melting point and boiling point  
- poor electrical conductor / cannot conduct electricity / good insulator

(ii)



[1 m for showing 1 Si atom with 4 Cl atoms;  
1 m for showing correct number of electrons, including the sharing of electrons]



[1 m for all correct chemical formulae and balanced equation; 1 m for all correct state symbols]

(ii) 1 m for mentioning  $\text{SiO}_2$  having a three-dimensional giant molecular structure (whereas  $\text{SiCl}_4$  has a simple molecular structure)

1 m for any following description related to bonding:

- each silicon atom is covalently bonded to 4 oxygen atoms and each oxygen atom is covalently bonded to 2 silicon atoms
- the strong covalent bonds in silicon(IV) oxide are difficult to overcome and hence, has a high melting point, unlike silicon(IV) chloride which has weak van der Waals forces of attraction / weak intermolecular forces of attraction between the molecules that is easy to overcome and hence, has a low melting point

A4 (a) Methane traps heat, causing global warming. [1]

(b) (i)

	C	H	Cl	
Mass / g	0.242	0.04	0.718	
$A_r$	12	1	35.5	
No. of moles	$\frac{0.242}{12} = 0.02016$	$\frac{0.04}{1} = 0.04$	$\frac{0.718}{35.5} = 0.02022$	[1]
Ratio	$\frac{0.02016}{0.02016} = 1$	$\frac{0.04}{0.02016} \approx 2$	$\frac{0.02022}{0.02016} \approx 1$	or [1]

Empirical formula =  $\text{CH}_2\text{Cl}$  [1]

(ii)  $M_r$  of  $\text{CH}_2\text{Cl} = 12 + 1 + 35.5 = 49.5$

$$n = \frac{99}{49.5} = 2$$

Hence, molecular formula =  $(\text{CH}_2\text{Cl})_2 = \text{C}_2\text{H}_4\text{Cl}_2$  [1]

(c) (i) At higher temperature of  $100^\circ\text{C}$ , the propane molecules have more kinetic energy [1] and hence move faster, as compared to a lower temperature of  $60^\circ\text{C}$ .

(ii) Molecules/particles have different (relative molecular) masses, such that methane has a  $M_r$  of 16 whereas propane has a  $M_r$  of 44. [1]

Methane (molecules) move or diffuse faster / propane (molecules) move or diffuse slowest [1]



**A5 (a)** Endothermic [1], because heat is taken in during decomposition [1] to break down the lead(II) carbonate into smaller compounds.

**(b)** Carbon monoxide is a toxic (poisonous) gas/pollutant.

or carbon monoxide combines with haemoglobin in our red blood cells to form a stable carboxyhaemoglobin, which deprives our body of oxygen.

**Reject:** CO is an air pollutant / causes death / breathing difficulty as no scientific explanation was given.

**(c)** Reaction of lead metal with aqueous copper(II) sulfate:

**NOTE:** Lead is a more reactive metal than copper and hence able to displace copper from copper(II) sulfate.

Observation: blue copper(II) sulfate fades (turns colourless) / Reddish-brown (pink) deposits seen. [1]

Equation:  $\text{Pb} + \text{CuSO}_4 \rightarrow \text{PbSO}_4 + \text{Cu}$  [2]

Reaction of lead metal with dilute sulfuric acid:

**NOTE:** Lead(II) sulfate is an insoluble salt, which prevents further reaction of lead with dilute sulfuric acid. Hence, reaction will not go to completion and that lead will appear as if it is unreactive with the acid. No effervescence will be seen as the reaction is way too slow.

Observation: no visible (observable) change or white deposits on lead metal [1]

**Reject:** Effervescence (bubbles) seen. / Hydrogen gas evolved, which extinguishes the lighted splint with a 'pop' sound.

Equation:  $\text{Pb} + \text{H}_2\text{SO}_4 \rightarrow \text{PbSO}_4 + \text{H}_2$  [2] (but reaction will NOT go to completion)

**A6 (a)** When molten, the strong electrostatic forces of attraction between the oppositely charged ions,  $\text{Zn}^{2+}$  and  $\text{Cl}^-$ , are overcome. or In solid state, the oppositely-charged ions are held together by the strong electrostatic forces of attraction and can only vibrate about in fixed position. [1]

In molten state, the ions can slide around / move / are mobile to carry the charges across to conduct electricity. [1] or There are free moving (mobile) ions in molten state.

**(Reject:** any phrase on 'electrons' / 'sea of delocalised ions')

**(b)** at anode: Chlorine gas evolved.  $(2\text{Cl}^-(l) \rightarrow \text{Cl}_2(g) + 2e^-)$  [1]

at cathode: Zinc metal deposited on the cathode.  $(\text{Zn}^{2+}(l) + 2e^- \rightarrow \text{Zn}(s))$  [1]

**(c)**  $4\text{OH}^-(\text{aq}) \rightarrow 2\text{H}_2\text{O}(l) + \text{O}_2(g) + 4e^-$  [1]

**(d)** Test: add aqueous sodium hydroxide (aqueous ammonia) dropwise, followed by in excess [1]

Observations: White precipitate, soluble in excess giving a colourless solution [1]

**(e)**  $M_r$  of  $\text{ZnCl}_2 = 65 + 35.5 + 35.5 = 136$

No. of moles of  $\text{ZnCl}_2 = \frac{3.4}{136} = 0.025$  mol. [1]

No. of moles of  $[\text{Zn}(\text{NH}_3)_4]\text{Cl}_2 = 0.025$  mol.

$M_r$  of  $[\text{Zn}(\text{NH}_3)_4]\text{Cl}_2 = 65 + 4(14 + 3) + (35.5 \times 2) = 204$

Mass of  $[\text{Zn}(\text{NH}_3)_4]\text{Cl}_2 = 0.025 \times 204 = 5.10$  g (3 sig. fig.) [1]



**A7 (a) Temperature:**

A lower (higher) temperature gives a higher (lower) yield

**or** A higher (lower) temperature gives a higher (lower) rate [1]

**Pressure:**

A higher pressure gives a higher yield (increase in yield gets less as pressure increases)

**or** A higher pressure gives a higher rate (increase in rate increases as pressure increases) [1]

**Catalyst:** using a catalyst speeds up the reaction [1]

**Compromised conditions:**

A higher pressure gives a higher rate and thereby a higher yield but increases costs and/or risk [1]

A lower temperature gives a higher yield but a lower rate resulting in lower economical production of ethanol. [1]

Catalyst makes reaction faster so a lower temperature can be used. [1]

- (b) Formation of ethanol is faster for reaction of ethene with steam / faster reaction between ethene and steam (slower for fermentation) [1]

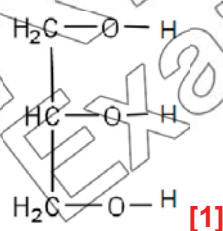
Concentration of ethanol is higher for reaction of ethene with steam (lower for fermentation) [1]

Non-renewable resource such as crude oil is used to produce ethene needed for the reaction of ethene with steam while renewable resources such as sugar cane plants are used to extract sugar for fermentation [1]

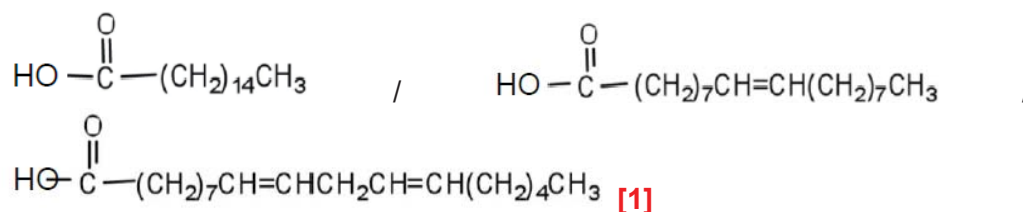
**Section B [30 marks]**

- B8 (a) (i)** Ester linkage [1] **(ii)** Water / H<sub>2</sub>O [1]

- (iii)** Structural formula of propane-1,2,3-triol:



Structural formula of one of the carboxylic acids:



- (b) Coconut oil [1], as the percentage of unsaturation adds up to (8% + 2% =) 10% [1], which is the lowest.
- (c) **NOTE: Since cotton seed molecules and corn oil molecules have similar iodine numbers, their melting points is not dependent on the degree of unsaturation.**

Cotton seed oil (molecules) have higher molar mass / relative molecular mass than

corn oil (molecules) [1]. More energy is needed to overcome the stronger intermolecular forces / Van der Waals' forces of attraction between the molecules. [1] or Corn oil (molecules) have lower molar mass / relative molecular mass than cotton seed oil (molecules). Lesser energy is needed to overcome the lesser intermolecular forces / Van der Waals' forces of attraction between the molecules.

**Reject:** the phrase 'bonds' in replacement of 'forces', 'break' in replacement of 'overcome', and 'atoms' in replacement of 'molecules'

- (d) Since general formula of carboxylic acid is  $C_nH_{2n+1}COOH$ , a saturated fatty acid with 18 carbon atoms should have a molecular formula of  $C_{17}H_{35}COOH$ . [1]

Since a decrease in 2 hydrogen atoms indicates the present of one carbon-carbon double bond in each molecule, each molecule of linoleic acid ( $C_{17}H_{31}COOH$ ) will contain two carbon-carbon double bonds. [1]

- (e) P/S of coconut oil =  $\frac{2}{90} = 0.0222$  (3 sig. fig.) [1]

P/S of soybean oil =  $\frac{50+8}{14} = 4.14$  (3 sig. fig.) [1]

Soybean oil [1] is more beneficial for health than coconut oil.

- B9 (a) (i) [1 m for correct curve drawn, such that shallower gradient and same volume of gas collected as compared to Experiment A]

- (ii) Powdered magnesium was used in Experiment D, indicating that more surface area is exposed for more collisions [1] to occur. Hence, initial rate of reaction is higher [1] than that of Experiment B.

or Magesium lumps was used in Experiment B, indicating that lesser surface area is exposed for lesser collisions to occur. Hence, initial rate of reaction is lower than that of Experiment D.

**Reject:** 1) rate of reaction between Experiment B and D is different as this is a sweeping statement, which shows the lack of scientific content.

2) discuss about the concentration of acid.

- (b) (i) pH 1.1 [1]

**Reject:** pH is 1 as this shows that students did not read off from the graph properly

- (ii) [1 m for similar curve to A-2, except for an initial pH value of 4 (same volume of KOH used & same height at the end of the reaction)]

- (iii) In experiment A, hydrochloric acid, a strong acid, ionises/dissociates completely to produce a lot of hydrogen ions, while in experiment C, ethanoic acid, a weak acid, ionises/dissociates partially to produce little hydrogen ions. [1]

1 m for linking pH value to concentration of hydrogen ions, with any one of the following:

- Ethanoic acid has a lower concentration of hydrogen ions and therefore has a higher pH value.
- Hydrochloric acid has a higher concentration of hydrogen ions and therefore has a lower pH value.

**EITHER**

**B10 (a)** Chlorine is more reactive than bromine, and hence displaces bromine from potassium bromide (its salt solution). [1]



**NOTE:** Ionic equation should come with state symbols.

**Reject:** chemical equation

Chlorine is reduced due to a decrease in its oxidation state from 0 to -1. [1]

**or** chlorine is reduced due to a gain in electrons.

**(b)** Step:

- 1) Add **excess** silver metal to the hot concentrated nitric acid to form aqueous silver nitrate. [1]
- 2) **Filter to collect the aqueous silver nitrate as filtrate / to remove the unreacted silver as residue.** [1]
- 3) Add aqueous silver nitrate to sodium chloride (or any soluble chloride salt) to produce the white precipitate of silver chloride. [1]
- 4) Filter to collect the silver chloride as the residue. [1]
- 5) *(optional)* Wash the residue with deionised water and dry between filter papers.

**(c) (i)** [1 m for showing a lower  $E_a$  but with same height for energy level of reactants and products]

**(ii)** The catalyst provides a lower activation energy, whereby more colliding particles possess energy equal to or greater than the activation energy. [1]

The number of effective collisions increases, leading to higher rate of formation of product particles. [1]

OR

- B10 (a) (i)** Energy was still being absorbed to **overcome** the activation energy / most reactant particles have insufficient activation energy to undergo decomposition. **[1]**

**Accept:** little or not enough energy for decomposition

**Reject:** 'break' in replacement of 'overcome'

- (ii)** Volume of carbon dioxide has not reached a constant / is still increasing at the end of 5 minutes. **[1]**

**Accept:** CO<sub>2</sub> was still being produced

- (iii)** Copper(II) carbonate/ CuCO<sub>3</sub> **[1]**

Highest volume of carbon dioxide produced per unit time / most carbon dioxide produced throughout the experiment. **[1]**

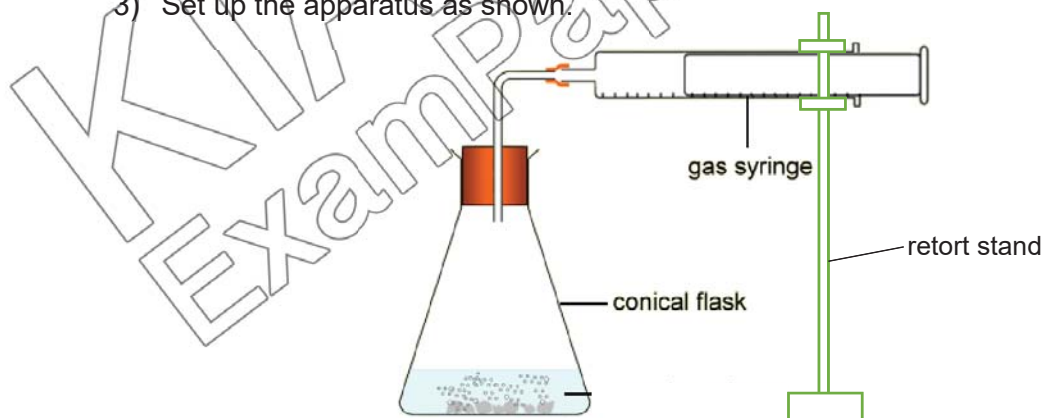
- (iv)** **No carbon dioxide** will be collected as time pass / volume of carbon dioxide remains zero / volume of carbon dioxide collected will be a horizontal / straight line. **[1]**

Sodium carbonate is stable to heat / does not decompose upon heating / very hard / hard to decompose sodium carbonate / **sodium carbonate is thermally stable.** **[1]**

- (b)** **NOTE: 'Outline' means you need to describe how the experiment works, what measurement(s) to take and state the expected conclusion from the experiment.**

Step:

- 1) Measure **5.0g (or any reasonable mass)** of one of the copper ore using an electronic balance and transfer into a conical flask. **[1]**
- 2) Measure **25.0cm<sup>3</sup> of 0.1 mol/dm<sup>3</sup> dilute hydrochloric acid (or any appropriate acid)** using a pipette (or use a measuring cylinder/burette to measure volume of any other acid). **[1]**
- 3) Set up the apparatus as shown.



- 4) Record the final volume of carbon dioxide gas produced. **[1]**
- 5) Repeat step 1 to 4 for the other copper ore.

**Conclusion:** The ore that gives out more gas contains more copper(II) carbonate. **[1]**

