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Name _____

Register No.	Class
	4E1

BENDEMEER SECONDARY SCHOOL

2017 PRELIMINARY EXAMINATION 2

SECONDARY 4 EXPRESS

CHEMISTRY PAPER 1

5073/01

DATE : 24 Aug 2017

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.

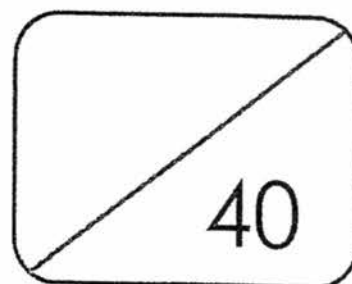
There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.Choose the **one** you consider correct and record your choice in **2B pencil** on the OTAS sheet.

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 15.



This document consists of 15 printed pages.

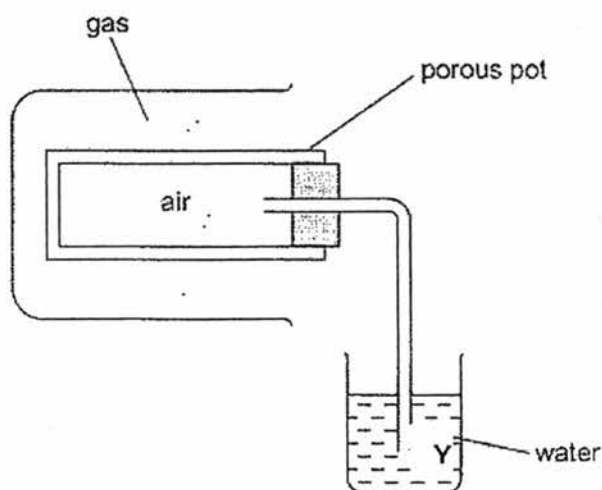
[Turn over

- 1 Camphor is a substance used in skin ointments and a natural sample of it is found to contain impurities like iron(III) oxide, iron and sodium chloride. The effects of these substances with three different types of liquids are shown below.

substance	water	ethanol	dilute nitric acid
camphor	no effect	dissolves	no effect
iron	no effect	no effect	reacts to give a solution
iron(III) oxide	no effect	no effect	reacts to give a solution
sodium chloride	dissolves	no effect	dissolves

Which is the best method to obtain pure camphor?

- A Add dilute nitric acid, filter and crystallise.
 B Add dilute nitric acid, filter, rinse and dry.
 C Add ethanol, filter, rinse and dry.
 D Add water, filter, add dilute nitric acid to filtrate and crystallise.
- 2 The apparatus shown in the diagram is used to compare the rate of diffusion of a gas with the rate of diffusion of air.

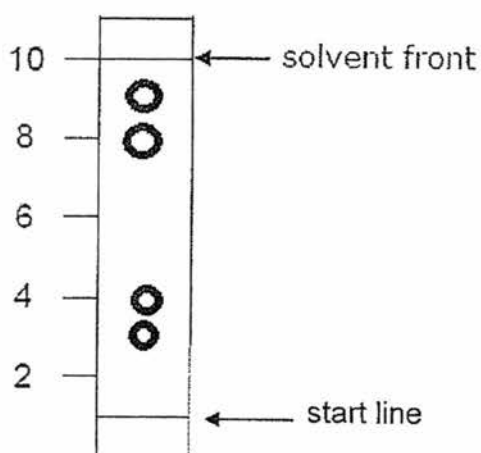


A beaker containing the gas was placed over the porous pot. Which gas is formed at Y?

- A carbon dioxide
 B hydrogen
 C oxygen
 D sulfur dioxide

[Turn over

- 3 A food dye is suspected to contain components which are harmful to the human body. The chromatogram of the food dye is obtained, as shown below. A reference table of R_f values of harmful components is provided.



R_f values of harmful components	
component	R_f value
K101	0.8
K110	0.6
K151	0.3
K122	0.1

Identify the harmful components present in the food dye.

- A K101, K122
 B K101, K151
 C K101, K151, K122
 D K101, K151, K122, K110
- 4 Why is the commercial preparation of pure oxygen from air possible?
- A Oxygen has a different boiling point from nitrogen.
 B Oxygen is denser than nitrogen.
 C Oxygen is more soluble in water than nitrogen.
 D Oxygen reacts more quickly than nitrogen.
- 5 The boiling points of some elements are given in the table.

element	boiling point ($^{\circ}\text{C}$)
X	- 138
Y	- 155
Z	- 143

A mixture of X, Y and Z is heated from $- 162^{\circ}\text{C}$ to $- 142^{\circ}\text{C}$. Which element(s) would still remain as a liquid at $- 142^{\circ}\text{C}$?

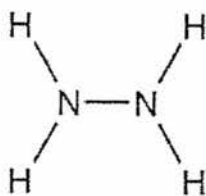
- A X only B X and Y C Y and Z D X, Y and Z

[Turn over

- 6 Which of the following decreases as the solid is being heated to become a liquid?
- A the forces of attraction between the molecules
 - B the reactivity of the molecules
 - C the shape of the molecules
 - D the strength of the covalent bonds in the molecules
- 7 An ion of formula X^{2-} contains 18 electrons. If the relative atomic mass of X is 32, what is the composition in the nucleus of the ion?
- A 14 protons and 18 electrons
 - B 16 protons and 16 neutrons
 - C 16 protons and 18 electrons
 - D 18 protons and 14 neutrons
- 8 An element has two isotopes with mass numbers 34 and 35. Its relative atomic mass is 34.3. What is the relative abundance of the isotope with mass number 34?
- A 0.3 B 0.4 C 0.6 D 0.7
- 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.

[Turn over]

- 10 The diagram shows the structural formula of the covalent molecule hydrazine, N_2H_4 .



Which statement is true of the number of electrons in the molecule?

	total number of electrons involved in bonding	total number of electrons not involved in bonding
A	5	4
B	5	8
C	10	4
D	10	8

- 11 What does a solution of hydrogen chloride in ethanol contain?

- A ethanol molecules and hydrogen chloride molecules
- B ethanol molecules, hydrogen ions and chloride ions
- C ethanol ions, hydrogen chloride molecules
- D ethanol ions, hydrogen ions and chloride ions

- 12 Which sample contains the most number of atoms?

- A 0.5 mol of C_2H_6
- B 1.0 mol of SO_3
- C 1.5 mol of CO_2
- D 3.0 mol of He

- 13 20 cm^3 of oxygen reacts with 20 cm^3 of carbon monoxide. What is the volume of gases remaining? All volume is measured at room temperature and pressure.

	oxygen (cm^3)	carbon monoxide (cm^3)	carbon dioxide (cm^3)
A	0	0	20
B	0	0	40
C	10	0	20
D	10	10	20

[Turn over

- 14 Lead(II) oxide is produced by heating lead(II) carbonate.



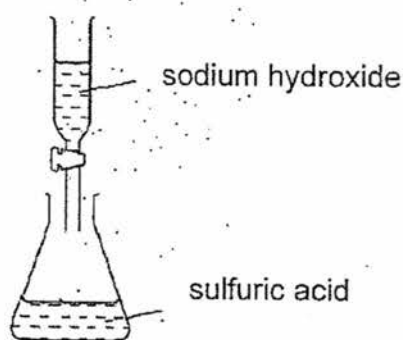
When 267 g of lead(II) carbonate is heated, 210 g of lead(II) oxide is produced. What is the percentage yield of lead(II) oxide?

- A $\frac{210}{223} \times 100$
- B $\frac{223}{210} \times 100$
- C $\frac{210}{267} \times 100$
- D $267 \times \frac{210}{223} \times 100$
- 15 Arsine (AsH_3) is a gas that behaves like ammonia. Which of the following ions are produced when Arsine dissolves in water?
- A AsH^+ and H^+
- B AsH_3^+ and OH^-
- C AsH_4^+ and H^+
- D AsH_4^+ and OH^-
- 16 Which pair of reagents is most suitable in preparing the following salts?

	salt	reagent
A	ammonium nitrate	aqueous ammonia + nitric acid
B	lead(II) chloride	lead(II) oxide + hydrochloric acid
C	magnesium sulfate	magnesium nitrate + lithium sulfate
D	sodium chloride	sodium + dilute hydrochloric acid

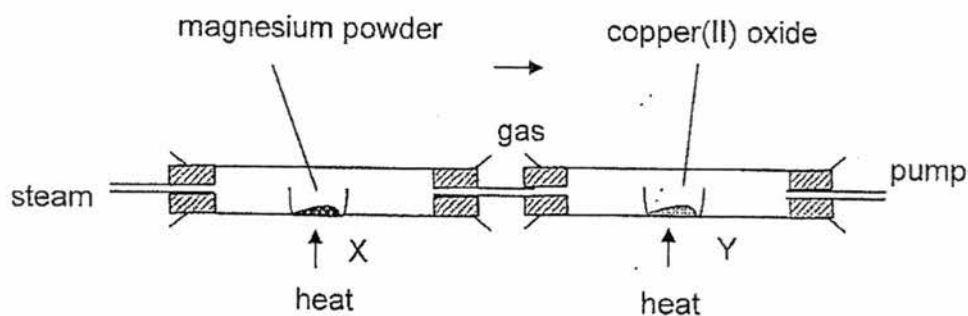
[Turn over

- 17 During an experiment, 10 cm^3 of 1.0 mol/dm^3 sodium hydroxide, NaOH , is gradually added to 10 cm^3 of 2.0 mol/dm^3 sulfuric acid, H_2SO_4 , containing methyl orange indicator.



Which change occurs in the mixture?

- A A precipitate is formed.
 - B Water molecules are formed.
 - C The concentration of the OH^- ions increases.
 - D The methyl orange changes colour.
- 18 In the experiment shown below, steam is passed into the combustion tube for some time.



What are the products at X and Y respectively?

- A magnesium hydroxide, copper
- B magnesium hydroxide, copper(II) hydroxide
- C magnesium oxide, copper
- D magnesium oxide, copper(II) hydroxide

[Turn over

- 19 Which statement about the Periodic Table is correct?
- A The colour of the elements becomes darker down Group VII.
 - B The melting point of the elements increases down Group I.
 - C The reactivity of the elements increases down Group VII.
 - D The reactivity of the elements decreases down Group I.
- 20 What is the use of argon?
- A to fill balloons
 - B to fill light bulbs
 - C to fill modern airships
 - D to manufacture advertising lights
- 21 Which method will not slow down the rusting process of an iron nail?
- A electroplate the iron nail with silver metal
 - B submerge the iron nail in a container completely filled with boiled water
 - C submerge the iron nail in oil
 - D weld a piece of copper metal to the iron nail
- 22 Study the following statements about P, Q, R and S.
- Carbonate of S decomposes to form a compound and a gas only.
 - Only oxides of P and R can be reduced by heating with carbon.
 - P and Q react with dilute hydrochloric acid but not with cold water.
 - R does not react with dilute hydrochloric acid nor water.

The order of increasing reactivity of the four metals is most likely to be:

- A $R < P < Q < S$
- B $R < S < P < Q$
- C $S < Q < P < R$
- D $S < R < P < Q$

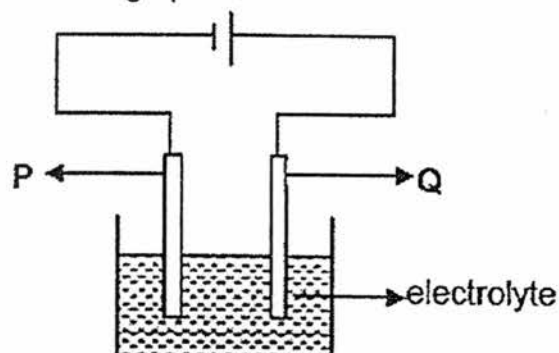
[Turn over

- 23 Different forms of steel contain differing amounts of carbon.

Steel I contains a high proportion of carbon.
Steel II contains a low proportion of carbon.

Which statement is correct?

- A I is less strong but less brittle than II.
 - B I is less strong but more brittle than II.
 - C I is stronger but less brittle than II.
 - D I is stronger but more brittle than II.
- 24 Which pair of reagents can be used to test for the presence of chloride ions in an aqueous solution?
- A aqueous barium nitrate and nitric acid
 - B aqueous barium nitrate and sulfuric acid
 - C aqueous silver nitrate and hydrochloric acid
 - D aqueous silver nitrate and nitric acid
- 25 An experiment is set up as shown in the diagram below. Both electrodes P and Q are made of graphite.



Which of the following gives the correct results as electrolysis proceeds?

	electrolytes	mass of P	mass of Q
A	aqueous copper(II) sulfate	increases	remains unchanged
B	aqueous copper(II) sulfate	remains unchanged	increases
C	aqueous sodium chloride	increases	remains unchanged
D	aqueous sodium chloride	remains unchanged	increases

[Turn over

- 26 The heat-reflecting shields of some space rockets are gold-plated, using electrolysis. Which electrodes and electrolyte would be used to gold-plate the heat shield?

	negative electrode (-)	positive electrode (+)	electrolyte
A	carbon	heat shield	gold compound
B	heat shield	gold	gold compound
C	gold	heat shield	copper compound
D	heat shield	carbon	copper compound

- 27 A catalytic converter in a car exhaust system changes pollutants into less harmful products. Which change does not occur in a catalytic converter?

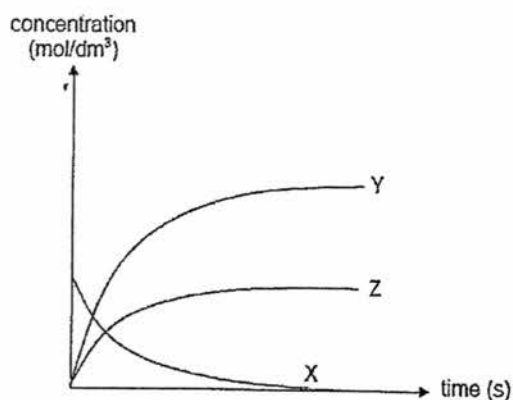
- A carbon dioxide $\rightarrow$ carbon
- B carbon monoxide $\rightarrow$ carbon dioxide
- C oxides of nitrogen $\rightarrow$ nitrogen
- D unburnt hydrocarbon $\rightarrow$ carbon dioxide and water

- 28 Which substances can be used to reduce atmospheric pollution caused by flue gases?

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

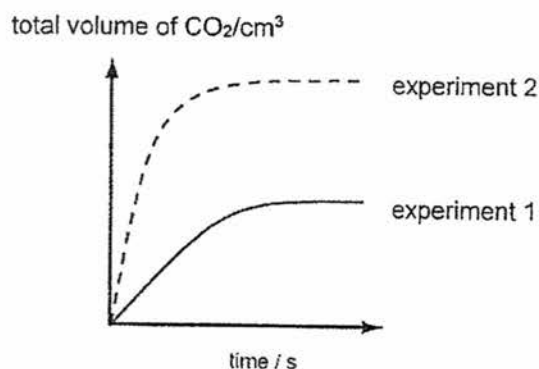
[Turn over

- 29 The following graph shows the change in reactant and product concentrations with time during a chemical reaction.



Which equation represents the reaction?

- A $X \rightarrow Y + Z$
 B $X \rightarrow 2Y + Z$
 C $Z \rightarrow 2X + Y$
 D $Z \rightarrow 2Y + X$
- 30 The reaction of iron(II) carbonate with an excess of dilute hydrochloric acid is investigated.
 In experiment 1, 100 cm³ of 0.10 mol/dm³ hydrochloric acid and 0.5 g of iron(II) carbonate chips are used.



What conditions will produce the curve for experiment 2?

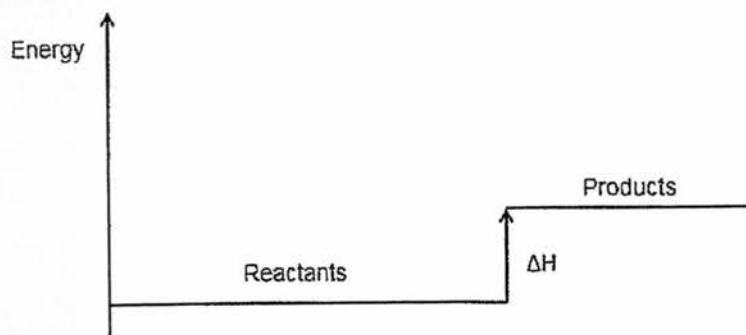
- A 100 cm³ of 0.10 mol/dm³ of dilute hydrochloric acid and 1.0 g of iron(II) carbonate chips
 B 100 cm³ of 0.20 mol/dm³ of dilute hydrochloric acid and 0.5 g of iron(II) carbonate chips
 C 100 cm³ of 0.20 mol/dm³ of dilute hydrochloric acid and 1.0 g of iron(II) carbonate chips
 D 200 cm³ of 0.10 mol/dm³ of dilute hydrochloric acid and 0.5 g of iron(II) carbonate chips

[Turn over

31 Which process is endothermic?

- A addition of aqueous sodium hydroxide to hydrochloric acid
- B combustion of butanol
- C oxidation of carbon
- D sublimation of iodine crystals

32 What can be deduced from the energy level diagram shown below?



- A Heat energy is released.
- B The reactants are less stable than the products.
- C The surrounding temperature increases during the reaction.
- D The energy change for bond breaking is higher than the energy change for bond formation.

33 Crysolite, $\text{Mg}_3\text{Si}_2\text{O}_5(\text{OH})_4$ is an asbestos mineral. What is the oxidation state of silicon in the mineral?

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

34 A reducing agent is added separately to four different reagents and the colour changes are recorded.

What is the correct description of the colour change?

	reagent	colour change
A	aqueous bromine	colourless to brown
B	acidified potassium dichromate(VI)	green to orange
C	aqueous potassium iodide	colourless to brown
D	acidified potassium manganate(VII)	purple to colourless

[Turn over

35 Which is the correct use of the different fractions in crude oil?

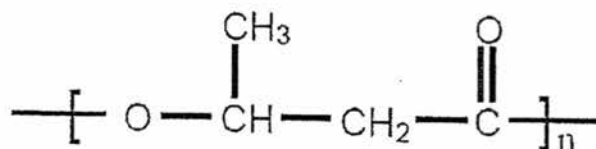
	fraction	use
A	bitumen	lubricating machine parts
B	kerosene	fuel for aircraft
C	naphtha	pave road
D	petrol	making chemicals

36 Which substances have the same number of carbon atoms in each molecule?

- I ethyl methanoate
- II ethanoic acid
- III methyl propanoate
- IV butanol

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

37 PHB (polyhydroxybutyric acid) is a natural polymer produced by a range of micro-organisms. The structure of this polymer is shown below.



Which statements are true about PHB?

- 1 PHB is a condensation polymer.
- 2 PHB molecule contains many ester groups.
- 3 PHB is made from two different types of unsaturated monomers.

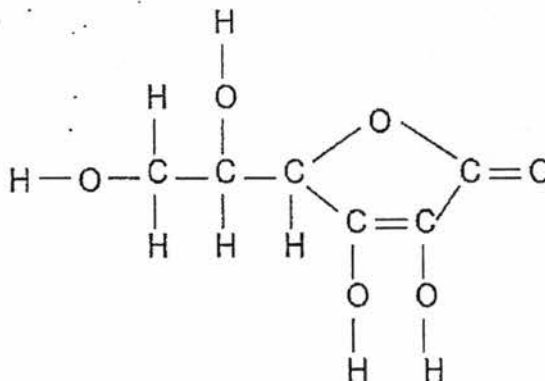
- A 1 and 2
- B 1 and 3
- C 2 and 3
- D 1, 2 and 3

[Turn over

- 38 Arachidonic acid is one of the most abundant polyunsaturated fatty acids in the brain. It has a molecular formula of $C_{19}H_{31}COOH$. How many $C=C$ double bond(s) is/are present in 1 molecule of arachidonic acid?

A 1 B 2 C 3 D 4

- 39 The structural formula of Vitamin C is shown below.



Which of the following substances does not react with Vitamin C?

- A aqueous bromine
B acidified potassium manganate(VII)
C sodium carbonate
D steam

- 40 What are the uses of sulfuric acid?

- I making fertilizers
II sterilising water
III making detergents
IV used in car batteries

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

[Turn over

Group															
I	II	III						IV	V	VI	VII	0			
		I H I hydrogen													
7 Li Lithium	9 Be Beryllium							11 B Boron	12 C Carbon	14 N Nitrogen	16 O Oxygen	19 F Fluorine	20 Ne Neon		
23 Na Sodium	24 Mg Magnesium							27 Al Aluminium	28 Si Silicon	31 P Phosphorus	32 S Sulfur	35.5 Cl Chlorine	40 Ar Argon		
39 K Potassium	40 Ca Calcium	45 Sc Scandium	48 Ti Titanium	51 V Vanadium	52 Cr Chromium	55 Mn Manganese	56 Fe Iron	59 Co Cobalt	59 Ni Nickel	64 Cu Copper	65 Zn Zinc	73 Ge Germanium	75 As Arsenic	79 Se Selenium	84 Kr Krypton
85 Rb Rubidium	88 Sr Strontium	89 Y Yttrium	91 Zr Zirconium	93 Nb Niobium	96 Mo Molybdenum	101 Ru Ruthenium	101 Rh Rhodium	103 Pd Palladium	106 Ag Silver	108 Cd Cadmium	112 In Indium	115 Sn Tin	122 Sb Antimony	128 Te Tellurium	131 Xe Xenon
133 Cs Cesium	137 Ba Barium	139 La Lanthanum	178 Hf Hafnium	181 Ta Tantalum	184 W Tungsten	186 Re Rhenium	190 Os Osmium	192 Ir Iridium	195 Pt Platinum	197 Au Gold	201 Hg Mercury	204 Tl Thallium	209 Pb Lead	209 Bi Bismuth	226 Rn Radon
87 Fr Francium	88 Ra Radium	89 Ac Actinium	72 Hf Hafnium	73 Ta Tantalum	74 W Tungsten	75 Re Rhenium	76 Os Osmium	77 Ir Iridium	78 Pt Platinum	79 Au Gold	80 Hg Mercury	81 Tl Thallium	82 Pb Lead	83 Bi Bismuth	86 Rn Radon

*58-71 Lanthanoid series

+90-103 Actinoid series

140 Ce Cerium	141 Pr Praseodymium	144 Nd Neodymium	150 Sm Samarium	152 Eu Europium	157 Gd Gadolinium	159 Tb Terbium	162 Dy Dysprosium	165 Ho Holmium	167 Er Erbium	169 Tm Thulium	173 Yb Ytterbium	175 Lu Lutetium	
232 Th Thorium	238 Pa Protactinium	238 U Uranium	238 Np Neptunium	238 Pu Plutonium	238 Am Americium	238 Cm Curium	238 Bk Berkelium	238 Cf Californium	238 Es Einsteinium	238 Fm Fermium	238 Md Mendelevium	238 No Nobelium	238 Lr Lawrencium

a

X

b

a = relative atomic mass

X = atomic symbol

b = proton (atomic) number

Key

Name _____

Register No. _____

Class _____

4E1



BENDEMEER SECONDARY SCHOOL
2017 PRELIMINARY EXAMINATION 2
SECONDARY 4 EXPRESS
CHEMISTRY SPA PAPER 2
5073/02

DATE : 22 Aug 2017
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

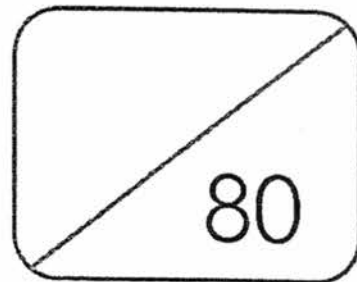
Answer **all** three questions in the spaces provided. The last question is in the form of either/or and only one of the alternatives should be attempted.

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 to 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 Use the compounds listed below to answer the following questions.

$\text{Zn}(\text{NO}_3)_2$	Fe_2O_3	$\text{Pb}(\text{NO}_3)_2$
NaI	Al_2O_3	KBr

You may use the compound once, more than once or not at all.

- (a) State the compound that reacts with excess aqueous ammonia to produce a white precipitate.

..... [1]

- (b) State the compound that reacts with aqueous chlorine to form a reddish brown solution.

..... [1]

- (c) State the metal oxide that can be reduced by hydrogen gas.

..... [1]

- (d) State the compound that reacts with sodium hydroxide to form a salt and water.

..... [1]

- (e) Name 2 aqueous salts that can react to form a yellow precipitate.

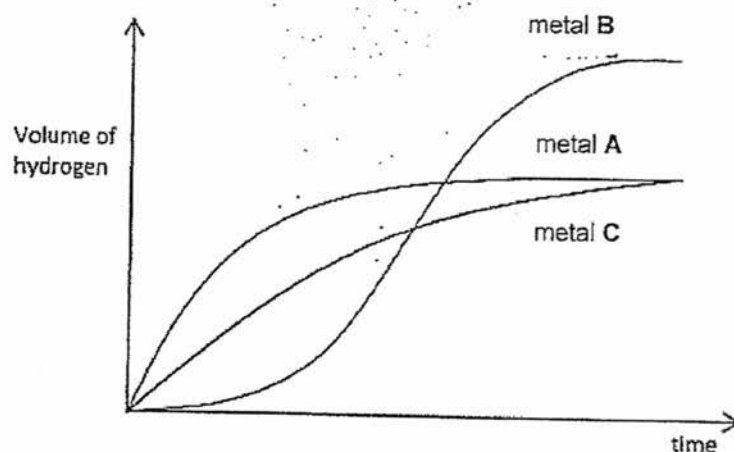
..... [1]

[Total: 5 marks]

[Turn over

- A2** Excess sulfuric acid is added to powdered zinc. The hydrogen evolved is collected and its volume measured every 20 seconds. The experiment is repeated at the same temperature using the same number of moles of powdered magnesium and aluminium.

The graph below shows the volume of hydrogen produced from each metal against time.



- (a) Identify metal **B** and account for the shape of its graph.

.....

.....

.....

..... [3]

- (b) Identify metals **A** and **C**.

..... [1]

- (c) Using the concept of moles, explain why metals **A** and **C** form the same volume of hydrogen but metal **B** forms a larger volume of hydrogen.

.....

.....

.....

..... [2]

[Turn over

- (d) On the graph above, sketch the curve obtained when excess sulfuric acid is added to powdered calcium of the same mass.
Label this curve as "Ca" and explain the shape of the curve.

.....

.....

..... [2]

[Total: 8 marks]

- A3 The relative positions of the elements rubidium(Rb), beryllium(Be) and bismuth(Bi) in the reactivity series are shown in Table 3.1.

Table 3.1

Position in the reactivity series
Rubidium
Sodium
Magnesium
Beryllium
Zinc
Iron
Hydrogen
Bismuth
Copper

- (a) An unknown photo showing specks of silvery deposits with the following caption was posted on social media and has gone viral.

"Pure rubidium found on a tiny island in the Pacific Ocean"

Use your chemistry knowledge to discuss the validity of this post.

.....

..... [1]

[Turn over

- (b) Predict with reasons, the reactions of beryllium with cold water and with steam.

.....

.....

.....

[3]

- (c) Suggest a suitable method to extract bismuth from its ore.

.....

[1]

- (d) Underground iron pipelines are used in transporting substances such as natural gas from place to place. When underground, these iron pipes will rust relatively rapidly.

- (i) Pieces of magnesium are often attached to underground iron pipes. Explain how this helps prevent iron from rusting.

.....

.....

.....

[2]

- (ii) A sample of a compound of iron is analysed. The sample contains 0.547 g of potassium, 0.195 g of iron, 0.252 g of carbon and 0.294 g of nitrogen. Determine the empirical formula of this compound.

[2]

[Total: 9 marks]

[Turn over]

- A4** The Hydra is a 22-person hydrogen fuelled ship that gets its electricity from a hydrogen fuel cell. It converts chemical energy from hydrogen fuel into electricity through a chemical reaction with oxygen, using aqueous sodium hydroxide as the electrolyte. Fig. 4.1 shows the hydrogen fuel cell.

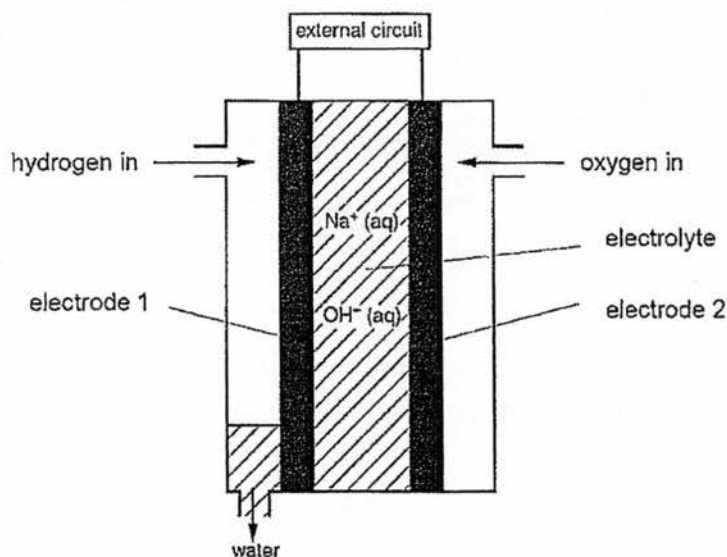
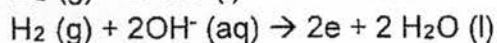
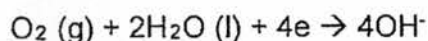


Fig. 4.1

The electrode reactions are:



- (a)** Identify which electrode in Fig. 4.1 is an anode, and which is a cathode.

..... [1]

- (b)** Describe how electricity is generated in the fuel cell.

.....

.....

.....

..... [2]

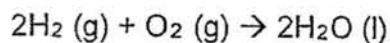
[Turn over

- (c) Give two reasons why aqueous sodium hydroxide is preferred over molten sodium hydroxide as an electrolyte for the fuel cell.

.....

..... [2]

- (d) The overall equation of the hydrogen fuel cell is as such:



- (i) Explain, in terms of oxidation states, if the overall reaction is a redox reaction.

.....

.....

.....

..... [2]

- (ii) The generation of electrical energy from fuel cell is similar to the exothermic reaction that occurs when hydrogen gas reacts with oxygen gas. Using ideas about bond breaking and bond making, explain why this reaction generates electrical energy.

.....

.....

.....

..... [2]

- (iii) Hence sketch an energy profile diagram for the generation of electrical energy from fuel cells.

[2]

[Turn over

- (e) Alternatively, methanol can be used as a fuel to form a methanol fuel cell. Other than in terms of energy produced, suggest a possible advantage of using the methanol fuel cell over the hydrogen fuel cell.

[1]

[Total: 12 marks]

A5 Fig. 5.1 shows the reactions that lead to the depletion of ozone layer.

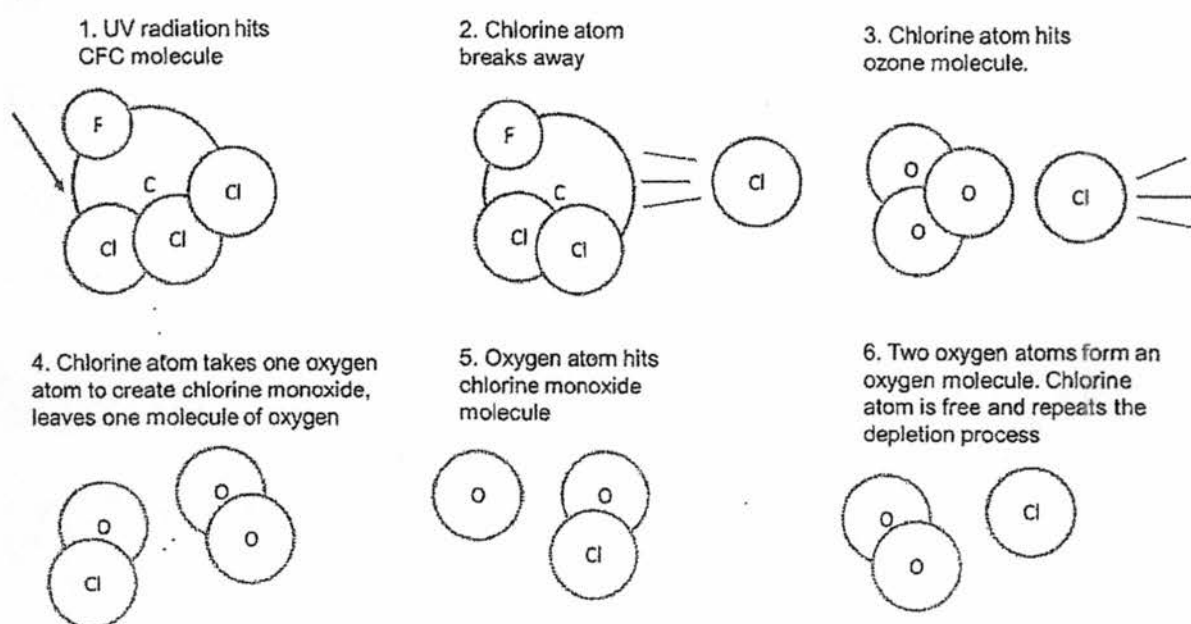


Fig. 5.1

- (a) Identify an endothermic reaction in Fig. 5.1 and provide evidence to support your answer.

[2]

- (b) Suggest why a small amount of CFC is sufficient to threaten the depletion of the ozone layer.

[2]

[Turn over]

- (c) With reference to Fig. 5.1, suggest whether the C – F bond is stronger or weaker than the C – Cl bond.

[1]

Fig. 5.2 shows an impact of ozone depletion.



Fig. 5.2

- (d) Explain how ozone depletion causes the impact shown in the cartoon.

[2]

[Total: 7 marks]

[Turn over

- A6** An aldehyde is an organic compound containing a formyl functional group. This functional group, with the structure —CHO , consists of a carbonyl centre (a carbon double bonded to oxygen) bonded to hydrogen.

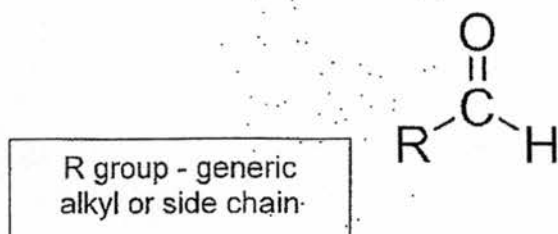
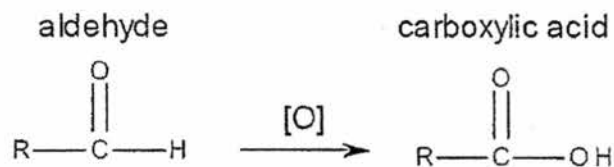


Table 6.1 shows some properties of aldehydes.

Table 6.1

chemical name	chemical formula	structural formula	boiling point/ $^{\circ}\text{C}$
methanal	CH_2O	$\begin{array}{c} \text{O} \\ \parallel \\ \text{H}-\text{C}-\text{H} \end{array}$	-19
ethanal	CH_3CHO	$\begin{array}{c} \text{H} \quad \text{O} \\ \quad \parallel \\ \text{H}-\text{C}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$	20
propanal	$\text{CH}_3\text{CH}_2\text{CHO}$	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{O} \\ \quad \quad \parallel \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$	50

Due to the high reactivity of aldehyde, it can be oxidised easily to form carboxylic acid as shown below.



Possibly because of the high reactivity of the formyl group, aldehydes are not commonly found in nature's building blocks such as amino acids, nucleic acids and lipids. Amino acids are monomers that form protein polymers. Proteins have the same linkage as nylon. An amino acid contains an amine functional group and a carboxyl functional group. These two groups can react to form a condensation polymer.

[Turn over

- (a) Use the information above to give two pieces of evidence that suggest that the aldehydes are a homologous series.

.....

..... [2]

- (b) Deduce the general formula of the aldehydes and hence predict the formula of the aldehyde that contains 8 carbon atoms.

..... [2]

- (c) Draw the structural formula of butanal.

[1]

- (d) When propanal is reacted with potassium manganate (VII), product **A** is formed. Product **A** can also be formed by reactant **B** via a two-step process. Reactant **B** undergoes addition polymerisation to form a polymer. Name product **A** and draw the polymer of **B**, showing 2 repeat units.

Product **A**:

[1]

Polymer **B**:

[2]

[Turn over

Protein is a condensation polymer. Polymer **B** is an addition polymer.
Fig. 6.2 shows a section of a protein structure.

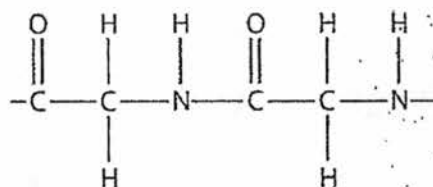


Fig. 6.2

(e) Draw the amino acid that forms this protein structure.

[1]

[Total: 9 marks]

[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.

B1 Read the information about elements in Group VII of the Periodic Table.

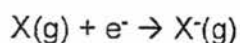
Halogens and its properties

Fluorine, chlorine, bromine, iodine and astatine are elements that are found in Group VII of the Periodic Table. They are reactive non-metals which exists as diatomic molecules. Some trends that can be observed as we go down Group VII are atomic radius and ionic radius. Table 1.1 gives the atomic radii and the ionic radii of halogens.

Table 1.1

halogen	atomic radius/ nm	ionic (X ⁻) radius/ nm
F	0.071	0.133
Cl	0.099	0.181
Br	0.114	0.196
I	0.133	0.220
At	0.150	-

Electron affinity is a measure of the attraction between the incoming electron and the nucleus. The first electron affinity is the energy released when 1 mole of gaseous atoms each acquire an electron to form 1 mole of gaseous ions. For example, in this reaction,



The first electron affinity is the energy released per mole of X when this change occurs. By convention, the negative sign shows a release of energy.

Table 1.2 gives the first electron affinities of Group 7 elements.

Table 1.2

halogen	first electron affinity (kJ/mol)
F	- 328
Cl	- 349
Br	- 324
I	- 295
At	- 270

[Turn over

Halogens also react with hydrogen to form hydrogen halides.



Table 1.3 gives the bond energies of various H – X bonds.

Table 1.3

bond	bond energy (kJ / mol)
H – F	562
H – Cl	431
H – Br	366
H – I	299

- (a) State the general trend observed in the first electron affinities going down Group VII.

..... [1]

- (b) Suggest why the atomic size of the atoms increases down the group and hence use this knowledge to explain the pattern described in (a).

.....

 [2]

- (c) Both chlorine and fluorine are gases at room temperature and pressure. Using the information in Table 1.1, state and explain which gas is likely to have a lower boiling point.

.....

 [3]

[Turn over

- (d) Two students discuss the information provided..

Student 1: 'I think the atomic size of the halogen attached to H is linked to the strength of the H-X bond.'

Student 2: 'I think the strength of the H-X bond is due to its ionic (X^-) radii.'

Does the information in the data given support the ideas of the students?
Explain your reasoning.

.....

.....

.....

.....

[2]

- (e) All hydrogen halides dissolve in water to form acids.
Use Table 1.3 to predict the trend in the acid strength of the hydrogen halides.
Explain your answer.

.....

.....

.....

[2]

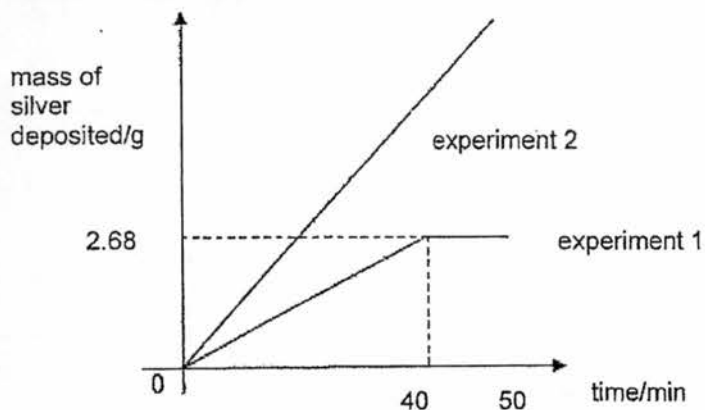
[Total: 10 marks]

[Turn over]

B2 A pupil carried out two separate experiments using different electrodes in the laboratory.

In each experiment, he electrolysed 2.00 dm^3 of aqueous silver nitrate containing 2.68 g of silver ions. The same amount of current was passed in both experiments and the increase in mass of the cathode was weighed every 5 minutes for 50 minutes.

The diagram below shows the results of the two experiments.



- (a) Describe how the mass of silver deposited at the cathode changes with time in each experiment.

.....

 [2]

- (b) Write the half equation for the formation of silver at the cathode for both experiments.

..... [1]

- (c) Carbon electrodes were used in experiment 1. Using this knowledge, explain the shape of the graph in experiment 1.

.....

 [2]

[Turn over

- (d) Write the half equation for the reaction at the anode of experiment 1.

..... [1]

- (e) Suggest another material for the electrodes used in experiment 2 and explain the shape of the graph.

.....

..... [2]

- (f) A circuit was connected as shown in Fig. 2.1 and a current passed through it for a period of time.

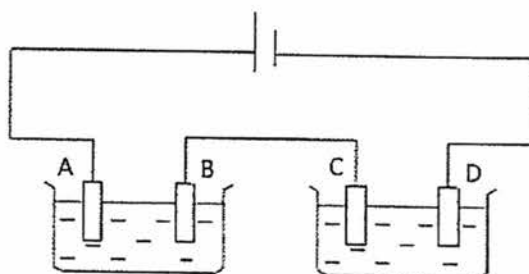


Fig. 2.1

Given that 12.8 g of copper and 14.0 g of cerium were deposited at electrodes **B** and **D** respectively, calculate the charge on a cerium ion.

[2]

[Total: 10 marks]

[Turn over

B3 EITHER

Nylon and Terylene are condensation polymers.

Fig. 3.1 and Fig. 3.2 show the structures of Nylon and Terylene respectively.

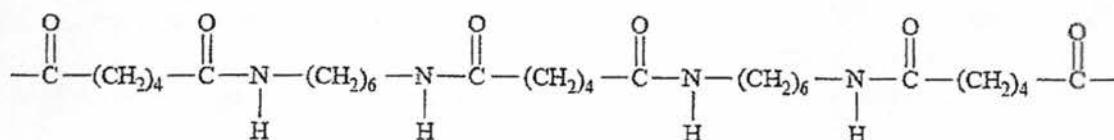


Fig. 3.1

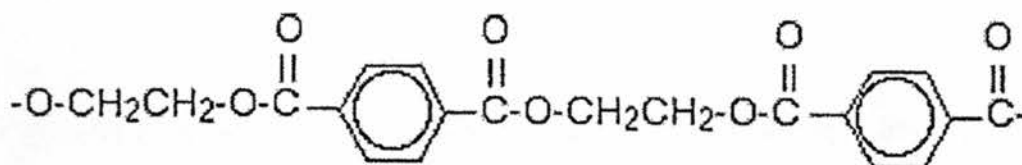


Fig. 3.2

(a) Compare and contrast the two polymers in terms of the following:

- The type of linkage present
- The monomers used in each polymer
- The side product when the polymer forms

.....

.....

.....

.....

.....

[3]

(b) Both Nylon and Terylene are condensation polymers.
Explain what condensation polymers are.

.....

.....

[1]

[Turn over

- (c) These condensation polymers are non-biodegradable.
Explain why being non-biodegradable is both an advantage and a disadvantage.

.....

.....

..... [2]

- (d) The combustion of these condensation polymers produce a much larger amount of carbon monoxide and soot as compared to the combustion of their respective monomers. Explain the phenomena.

.....

.....

..... [2]

- (e) Lactic acid can be made from corn starch. It polymerises to form the polymer, poly(lactic acid) (PLA).
Suggest two advantages that PLA has compared with a polymer made from petroleum.

.....

.....

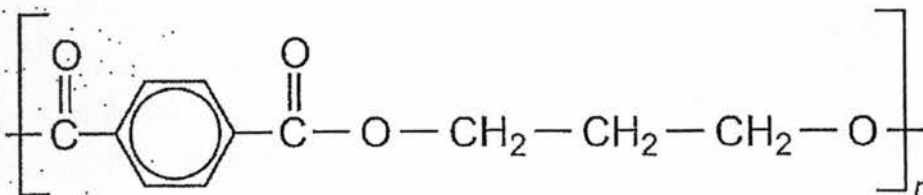
..... [2]

[Total: 10 marks]

[Turn over

B3 OR

Many soft drinks bottles are made of thermoplastics, polyethylene terephthalate (PET), which is formed from polymerisation of two different monomers and has the following structures:



- (a) (i) Draw the structural formula of the two monomers that can be polymerised to PET.

[2]

- (ii) Name the type of polymerisation involved and give the reason for your choice.

[1]

- (b) Most environmental friendly green bags are made of 100% non-woven polypropene which is recyclable but not biodegradable.

- (i) Write an equation, showing the structural formula, to illustrate the formation of polypropene from its monomer.

[1]

- (ii) Name the type of polymerization involved.

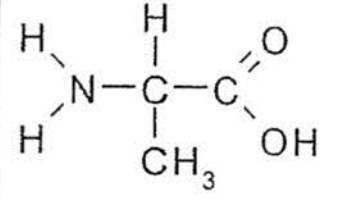
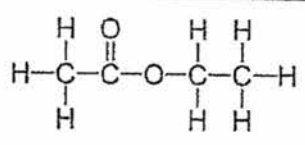
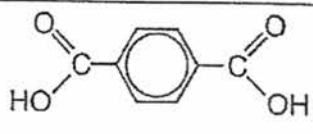
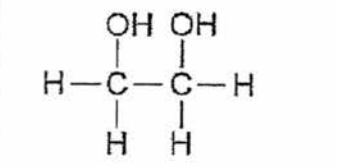
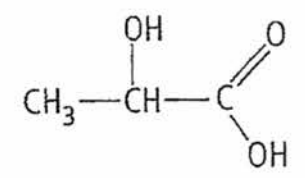
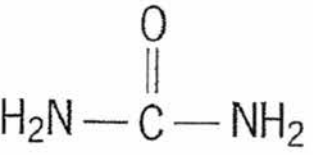
[1]

- (iii) Suggest why non-woven polypropene is still not considered environmentally friendly.

[1]

[Turn over]

(c) Two of the following molecules can form condensation polymers by itself.

		
molecule A	molecule B	molecule C
		
molecule D	molecule E	molecule F

Identify the two molecules (A, B, C, D, E and/or F) and draw the structure of the repeating unit of each polymer in the boxes provided.

molecule that can form a condensation polymer by itself:	molecule: _____
structure of repeating unit:	

molecule that can form a condensation polymer by itself:	molecule: _____
structure of repeating unit:	

[4]

[Total: 10 marks]

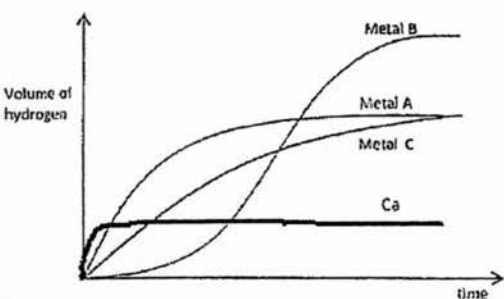
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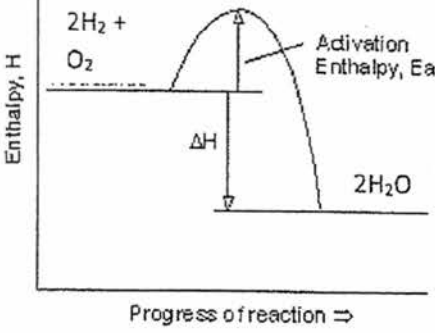
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[illegible]

2017 Chemistry SPA
Preliminary 2
OTAS ANSWERS

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

A1(a)	$\text{Pb}(\text{NO}_3)_2 / \text{Al}_2\text{O}_3$	1
(b)	KBr	1
(c)	Fe_2O_3	1
(d)	Al_2O_3	1
(e)	Lead(II) nitrate and sodium iodide.	1
A2(a)	B is aluminium. Reaction is slow at start, because of the oxide layer reacting with acid. Reaction is fast when the oxide layer is removed, exposing the aluminium which reacts with the acid.	1 1 1
(b)	Metal A – magnesium Metal C – Zinc	$\frac{1}{2}$ $\frac{1}{2}$
(c)	$2\text{Al} + 3\text{H}_2\text{SO}_4 \rightarrow \text{Al}_2(\text{SO}_4)_3 + 3\text{H}_2$ $\text{Zn} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2$ $\text{Mg} + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2$ For both magnesium and zinc, 1 mol of metal produces 1 mol of H_2 , therefore same volume of hydrogen produced. For aluminium, 1 mol of metal produces 1.5 mol of H_2 , therefore higher volume of hydrogen produced.	1 1
(d)	 Graph must show that initial reaction is fast. Initial reaction is fast as Ca is very reactive. However, reaction stops due to the formation of a layer of insoluble calcium sulfate. This prevents further reaction between calcium and acid, therefore no more hydrogen is produced.	1 1
A3(a)	The photograph is unlikely to show deposits of pure rubidium / hoax. Rubidium is a highly reactive metal which will react violently when exposed to air / water	1
(b)	Beryllium is less reactive than magnesium. It has no reaction with cold water / reacts very much slower than magnesium with water. It will react with steam to form beryllium oxide and hydrogen gas.	1 1 1
(c)	Reduction by carbon / carbon monoxide	1

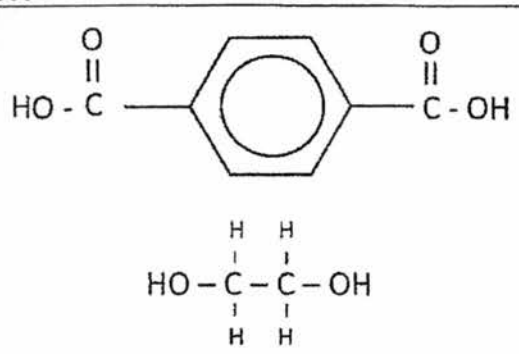
(d)(i)	Magnesium is more reactive than iron. It will undergo sacrificial protection/ corrode in its place/ lose electrons to iron.	1 1
(ii)	Simplest mole ratio of Fe, K, C, N $= \frac{0.195}{56} : \frac{0.547}{39} : \frac{0.252}{12} : \frac{0.294}{14}$ $= 0.003482 : 0.01403 : 0.021 : 0.021$ $= \frac{0.003482}{0.003482} : \frac{0.01403}{0.003482} : \frac{0.021}{0.003482} : \frac{0.021}{0.003482}$ $= 1 : 4 : 6 : 6$ Empirical formula is $\text{FeK}_4\text{C}_6\text{N}_6$. [1] for working, [1] for giving empirical formula.	2
A4(a)	Anode: electrode 1 / on the left Cathode: electrode 2 / on the right	$\frac{1}{2}$ $\frac{1}{2}$
(b)	Hydrogen gas is oxidised and releases electrons and water. These electrons flow from the anode to the cathode. Oxygen is then reduced to form hydroxide ions. The movement of electron flow from hydrogen to oxygen in the cell generates electricity.	$\frac{1}{2}$ $\frac{1}{2}$ 1
(c)	High temperature is required to maintain sodium hydroxide in the molten state . Sodium metal deposited at the positive electrode would react with the oxygen supplied, reducing the efficiency of the fuel cell.	1 1
(d)(i)	The overall reaction for the hydrogen fuel cell is a redox reaction. The hydrogen is oxidised as the oxidation state of hydrogen increases from 0 in H_2 to +1 in H_2O while oxygen is reduced as the oxidation state of oxygen decreases from 0 in O_2 to -2 in H_2O .	1 1
(ii)	The amount of electrical energy absorbed to break 2 moles of H-H and 1 mole of O=O bonds in H_2 and O_2 is lesser than energy released when the 4 moles of H-O bonds in H_2O are formed . Thus, it is an exothermic reaction and there is a net amount of electrical energy released .	2
(iii)		2
(e)	Methanol is a liquid and is not required to be stored under highly pressurized vessels unlike hydrogen. Thus it is safer to transport as a fuel.	1

A5(a)	Step 2. This is where the Cl atom breaks away from the compound as UV radiation is absorbed in order to break the C – Cl bond.	2
(b)	At the end of the reaction to convert ozone to oxygen, chlorine atom is regenerated and can be used again to convert more ozone to oxygen to repeat the depletion process.	1 1
(c)	C – F bond is stronger. (As UV rays is only able to break C – Cl bond but not C – F bond.)	1
(d)	Ozone layer absorbs harmful UV rays from the sun. If ozone layer is depleted, the earth will be exposed to harmful UV rays which can cause skin cancer in human.	1 1
A6 (a)	As the number of carbon atom increases/As the molecules get larger, the boiling point increases. They share the same general formula. OR The consecutive members of the group differ by $-\text{CH}_2$ OR They have the same functional group.	1 1
(b)	$\text{C}_n\text{H}_{2n+1}\text{CHO}$ where $n = 0$ for first member / $\text{C}_n\text{H}_{2n}\text{O}$ where $n = 1$	1
	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CHO}$ OR $\text{C}_7\text{H}_{15}\text{CHO}$ OR $\text{C}_8\text{H}_{16}\text{O}$	1
(c)	$ \begin{array}{ccccccc} & \text{H} & & \text{H} & & \text{H} & & \cdot\ddot{\text{O}}\cdot \\ & & & & & & & \\ \text{H} & - \text{C} & - & \text{C} & - & \text{C} & - & \text{C} - \text{H} \\ & & & & & & & \\ & \text{H} & & \text{H} & & \text{H} & & \end{array} $	1
(d)	Product A: Propanoic acid [1] Polymer B:	1 2
	$ \begin{array}{cccc} \text{H} & \text{CH}_3 & \text{H} & \text{CH}_3 \\ & & & \\ -\text{C} & - & \text{C} & - & \text{C} & - & \text{C}- \\ & & & \\ \text{H} & \text{H} & \text{H} & \text{H} \end{array} $	
(ii)	$ \begin{array}{ccccc} & \text{O} & & \text{H} & & \text{H} \\ & & & & & \\ \text{HO} & - \text{C} & - & \text{C} & - & \text{N} - \text{H} \\ & & & & & \\ & & & \text{H} & & \end{array} $	2

B1(a)	Decreases down the group.	
(b)	Atomic radius increases as the number of electron shells increases down the group.	1
	As the electron shells increase, the distance between the nucleus and the incoming electron increases .	1
	Therefore, the electrostatic forces of attraction between the nucleus and the incoming electron decreases , thus the amount of energy released decreases when the atom takes in an electron.	1
(c)	Fluorine has lower boiling point.	1
	Fluorine molecules are smaller in size than that of chlorine/ lower relative molecular mass than that of chlorine	1
	The intermolecular forces of attraction between fluorine molecules are weaker than that of chlorine. Less energy is needed to overcome the weaker intermolecular forces of attraction.	1
(d)	Student 1 is supported . The smaller the halogen, the stronger the H – X bond.	1
	Student 2 is not supported as HX is a covalent compound and there are no halogen ions in HX. Therefore, the ionic radii is not relevant to the strength of the H – X bond.	1
(e)	Acid strength increases down the group.	1
	The smaller the bond energy, the easier it is for the acid to ionize to form H ⁺ ions.	1

B2	Expt 1- mass of cathode increases until 2.68g and stops increasing thereafter.	2
(a)	Expt 2- mass of cathode kept increasing even after 2.68g.	
(b)	$\text{Ag}^+(\text{aq}) + \text{e}^- \rightarrow \text{Ag}(\text{s})$	1
(c)	Ag ions present in the solution discharges at the cathode. At the anode, hydroxide ions are discharged and no new Ag ions are released into the solution . Hence, once all the Ag ions in the solution are discharged, no more Ag can be formed.	2
(d)	$4\text{OH}^-(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g}) + 4\text{e}^-$	1
(e)	Silver electrodes are used in experiment 2. The silver anode dissolves into the solution, replenishing the silver ions that have been discharged at the cathode, hence the increasing mass of silver deposited.	2
(f)	No of moles of Cu = $12.8\text{g} \div 64 = 0.2 \text{ mol}$ No of moles of Cerium = $14.0\text{g} \div 140 = 0.1\text{mol}$ Amt of electrons to discharge Cu = $0.2 \times 2 = 0.4 \text{ mole}$ Charge of Cerium = +4	1
	OR No of moles of Cu = $12.8\text{g} \div 64 = 0.2 \text{ mol}$ No of moles of Cerium = $14.0\text{g} \div 140 = 0.1\text{mol}$ Amt of electrons to discharge Cu = $0.2 \times 1 = 0.2 \text{ mole}$ Charge of Cerium = +2	1

B3	Either	
(a)	The linkage present in nylon is amide linkage. The one in terylene is ester linkage. Nylon is made up of dicarboxylic acid monomers and diamine monomers while terylene is made up of dicarboxylic acid monomers and diols monomers. The side products from formation of both polymers are water molecules.	1 1 1
(b)	Condensation polymers are macromolecule made from combining many monomers , with an elimination of a small molecule like water .	1
(c)	Being non-biodegradable will allow the polymer to be durable and resistant to corrosion. However, being non-biodegradable will also create more landfills when the polymer is disposed off and thus, causing land pollution.	1 1
(d)	The polymer has much higher carbon content than its monomers thus are less flammable and would undergo incomplete combustion with oxygen to form carbon monomers and soot. In contrast, its monomers have lower carbon content and is more flammable and undergoes complete combustion to form carbon dioxide.	1 1
(e)	It is biodegradable and thus does not take up landfill space and reduce land pollution. It is carbon neutral as the same amount of carbon dioxide that is <u>used</u> to grow the corn plant is released upon decomposition/combustion of PLA.	1 1

B3	OR	
(a)(i)		1 1
(ii)	Condensation polymerisation as a small molecule of water is eliminated when 2 monomers polymerised.	1
(b)(i)	(a) <i>doc b</i> $n \begin{array}{c} \text{CH}_3 \\ \\ \text{C} = \text{C} \\ \quad \\ \text{H} \quad \text{H} \end{array} \rightarrow \begin{array}{cccc} \text{CH}_3 & \text{H} & \text{CH}_3 & \text{H} \\ & & & \\ -\text{C} & - & \text{C} & - & \text{C} & - & \text{C}- \\ & & & \\ \text{H} & \text{H} & \text{H} & \text{H} \end{array} \quad \text{or in 'shorthand'} \quad \left(\begin{array}{cc} \text{CH}_3 & \text{H} \\ & \\ -\text{C} & - & \text{C}- \\ & \\ \text{H} & \text{H} \end{array} \right)_n$ n = a big number of monomers polymer n units long (2 shown)	1
(ii)	Addition polymerisation	1
(iii)	Since is not biodegradable, it remains as a waste material in the environment and takes up landfill space. Or when burnt, it produces carbon dioxide and other harmful pollutants	1

(c)	molecule that can form a condensation polymer by itself:	A	
	structure of repeating unit:	$ \begin{array}{c} \text{H} \quad \quad \text{O} \\ \quad \quad \\ -\text{C}-\text{C}-\text{N}- \\ \quad \quad \\ \text{CH}_3 \quad \quad \text{H} \end{array} $	
	molecule that can form a condensation polymer by itself:	E	4
	structure of repeating unit:	$ \begin{array}{c} \quad \quad \text{O} \\ \quad \quad \\ -\text{CH}-\text{C}-\text{O}- \\ \\ \text{CH}_3 \end{array} $	