2016 Sec 4 Chemistry

1	Anderson Secondary School
2	CHIJ Saint Nicholas Girls' School
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ANDERSON SECONDARY SCHOOL
Preliminary Examination 2016
Secondary Four Express & Five Normal

CANDIDATE NAME:

CLASS: / INDEX NUMBER:

CHEMISTRY 5073/01

Paper 1 Multiple Choice

24 August 2016

1 hour

1315 – 1415h

Additional Materials: Multiple Choice 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 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**, **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 the wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page **15**.

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

Setter: Mr Wong FK

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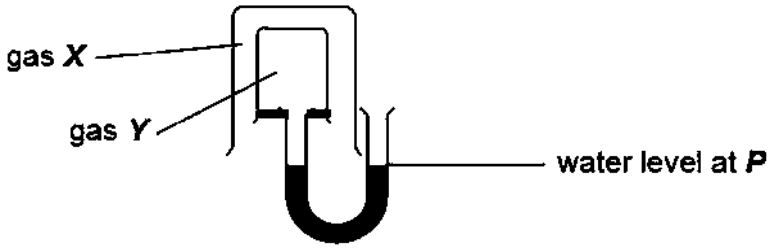
1 Benzoic acid is widely used in the food industry as a food preservative. The melting and boiling points of benzoic acid are given below.

- melting point of 122°C
- boiling point of 249°C

Which of the following will occur to the particles of benzoic acid when it is cooled from 500°C to 100°C?

	distance between particles	energy of particles
A	decreases	decreases
B	increases	decreases
C	increases	increases
D	decreases	increases

2 Which pair of gases could be ***X*** and ***Y*** that will cause a decrease in the water level at ***P*** ?



	gas ***X***	gas ***Y***
A	carbon monoxide	fluorine
B	fluorine	neon
C	methane	oxygen
D	nitrogen	carbon dioxide

3 Aminoaciduria refers to a medical condition in which certain types of amino acids in the urine are present in abnormal amount. Which of the following methods can be used by doctors to separate and identify the amino acids from a sample of urine?

A chromatography
B crystallisation
C filtration
D fractional distillation

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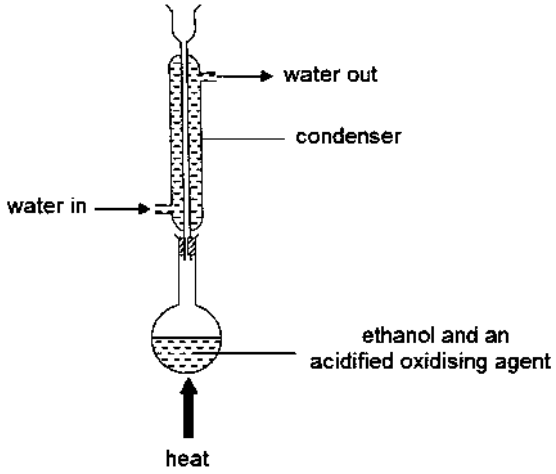
4 The following apparatus is commonly used to oxidise ethanol to ethanoic acid.



The purpose of the condenser is used to prevent

A air from oxidizing ethanoic acid formed.
B ethanoic acid from reforming back to ethanol.
C ethanol from being converted to ethene.
D the escape of any unreacted ethanol.

5 A mixture of manganese(IV) oxide and sulfur may be separated by the procedure below.

Step 1: The mixture is added into carbon disulfide and stirred.
Step 2: The resulting mixture is filtered to remove manganese(IV) oxide as the residue.
Step 3: The filtrate is distilled to recover the sulfur and the distillate is condensed by using a condenser.

Which one of the following **cannot** be deduced from the above procedure?

A Carbon disulfide has a boiling point just above that of water.
B Manganese(IV) oxide does not react with carbon disulfide.
C Sulfur is soluble in carbon disulfide.
D Sulfur is stable to heating.

6 A new substance was discovered and a series of experiments were conducted on it. Which observation suggests that the substance **cannot** be an element?

A Electrolysis of the molten substance gives two products.
B It dissolves in water to give a colourless solution.
C When exposed to air, it crumbles to a white powder.
D When heated in air, it forms a white solid.

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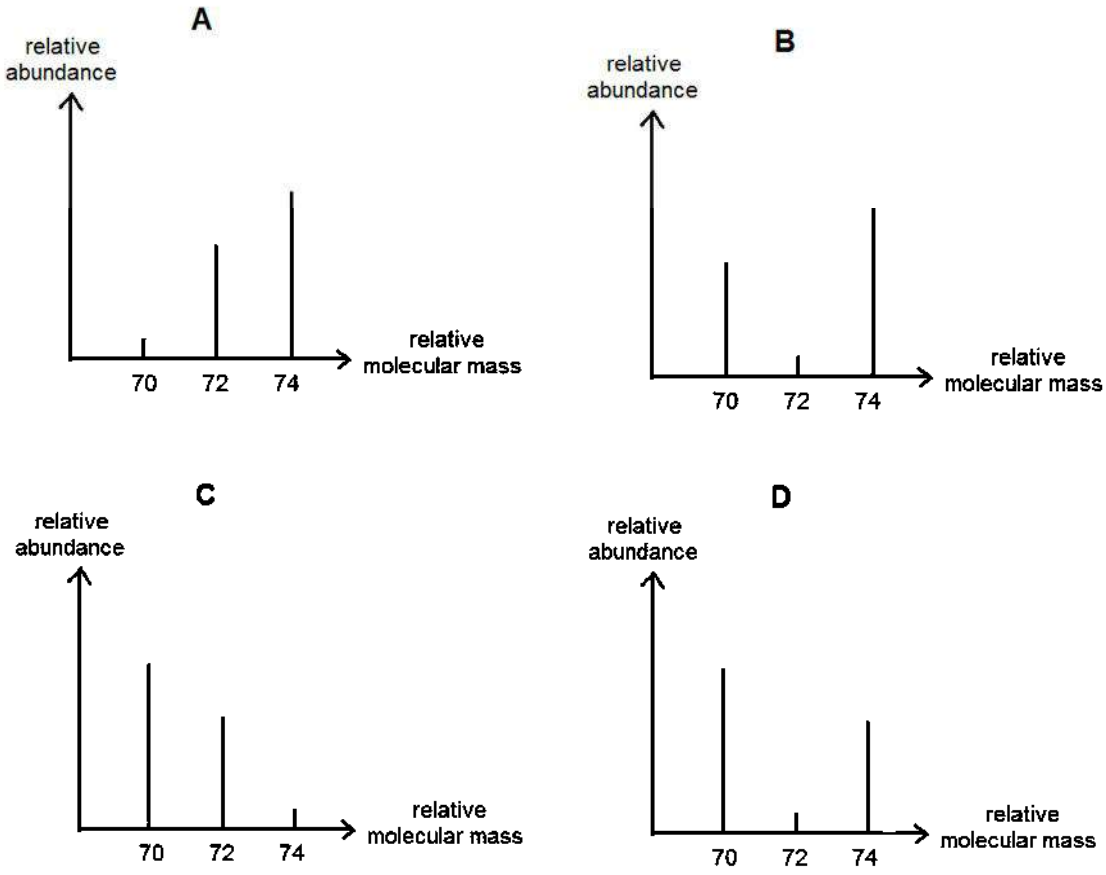
7 Chlorine has two isotopes, ^{35}Cl and ^{37}Cl, in the ratio of 3 atoms of ^{35}Cl to 1 atom of ^{37}Cl. Thus, diatomic molecules formed by chlorine have three possible relative molecular mass, 70, 72 and 74. Which of the following shows the correct relative abundance of the molecules formed by chlorine?



8 Three different atoms, ***H***, ***D*** and ***O*** are represented as $^{1}_{1}H$, $^{2}_{1}D$ and $^{16}_{8}O$ respectively.

Which ion formed by these atoms has more electrons than protons, and more protons than neutrons?

A D^-
B H^+
C OD^-
D OH^-

9 An element ***X*** has an electronic configuration 2.2. The compound formed when ***X*** combines with chlorine is most likely to be

A a compound with a low melting point.
B a gas that dissolves in water to form an electrolyte.
C a good conductor in both solid and molten state.
D an ionic solid.

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10 The reaction between dinitrogen monoxide and hydrogen is shown.

$$\boldsymbol{w}\ N_2O + \boldsymbol{x}\ H_2 \rightarrow \boldsymbol{y}\ NH_3 + \boldsymbol{z}\ H_2O$$

Which of the followings shows a balanced equation for the reaction above?

	w	***x***	***y***	***z***
A	1	1	1	2
B	1	2	1	1
C	1	2	2	1
D	1	4	2	1

11 The volume of gas inside a detergent bubble floating in the air depends on the total number of moles of gas inside it. Which of these bubbles would have the largest volume at room temperature and pressure?

A
4.0×10^{19} of molecules hydrogen

B
7.0×10^{-4} moles of ethane gas

C
4.0 mg of helium

D
7.0×10^{-4} moles of ethene gas

12 What is the concentration of 2.5 dm^3 of dilute hydrochloric acid needed to react completely with 100 g of calcium carbonate which is only 85% pure?

A 0.34 mol/dm^3
B 0.40 mol/dm^3
C 0.68 mol/dm^3
D 0.80 mol/dm^3

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13 The combustion reaction between hydrogen gas and oxygen gas is shown.

$$2H_2\,(g) + O_2\,(g) \rightarrow 2H_2O\,(g)$$

A mixture of 24 dm^3 of hydrogen gas and 100 dm^3 of oxygen gas was ignited. The reaction mixture was cooled to room temperature and pressure. What would be the total volume of gases remaining at the end of the reaction?

A 66 dm^3
B 76 dm^3
C 88 dm^3
D 112 dm^3

14 Which of the following does **not** show the appropriate reagents used for preparation of the named salts?

	salt	reagents
A	barium sulfate	barium nitrate solution + sulfuric acid
B	lead (II) chloride	lead (II) carbonate + hydrochloric acid
C	lithium nitrate	lithium hydroxide solution + nitric acid
D	magnesium chloride	magnesium + hydrochloric acid

15 Which of the following solutions will give a precipitate when added to dilute sulfuric acid?

A aluminium nitrate
B calcium nitrate
C silver nitrate
D zinc nitrate

16 A mixture of the oxides of two elements of the third period is dissolved in water. This solution is approximately neutral. What could be the constituents of the mixture?

A Al_2O_3 and Na_2O
B Na_2O and MgO
C Na_2O and P_4O_{10}
D SO_3 and P_4O_{10}

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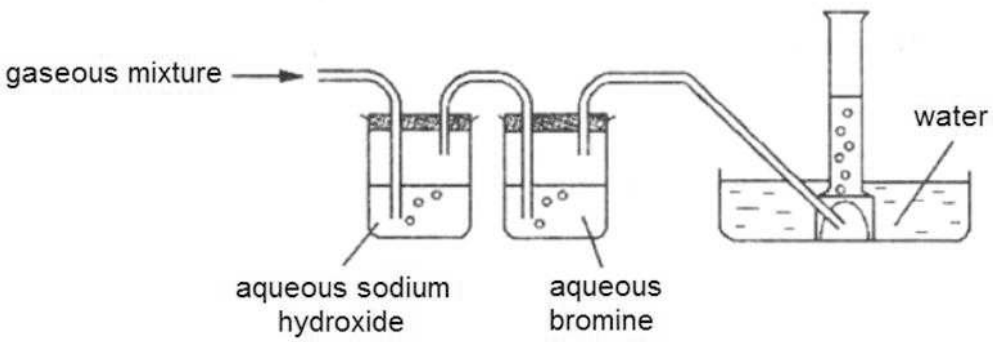
17 In which of the following reactions is zinc hydroxide **not** behaving as a base?

A $Zn(OH)_2 + 2HCl \rightarrow ZnCl_2 + 2H_2O$
B $Zn(OH)_2 + 2NaOH \rightarrow Na_2Zn(OH)_4$
C $\mathbf{3}Zn(OH)_2 + 2H_3PO_4 \rightarrow Zn_3(PO_4)_2 + 6H_2O$
D $Zn(OH)_2 + (NH_4)_2SO_4 \rightarrow ZnSO_4 + 2NH_3 + 2H_2O$

18 A gaseous mixture of ethene, oxygen and sulfur dioxide is passed through the apparatus shown. Only one of the gases is collected.



Which of the following is a property of the gas collected?

A It burns with a yellow flame.
B It forms white precipitate in limewater.
C It relights a glowing splint.
D It turns moist blue litmus paper to red.

19 Which of the following are true of the Haber process?

I Ammonia formed is condensed and obtained as a liquid.
II Hydrogen gas used is obtained from cracking of petroleum.
III Iron catalyst is used to increase the yield of ammonia.
IV Nitrogen gas is oxidised to form ammonia.

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

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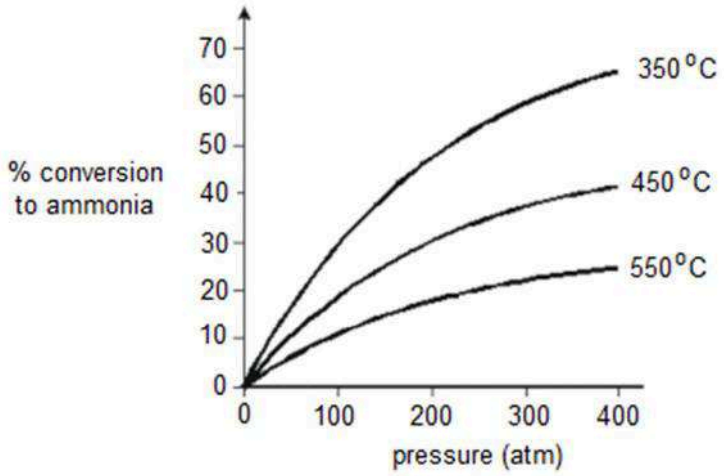
20 The following graph shows the different yields of ammonia at different temperatures and pressures.



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

A A higher percentage yield of ammonia can be obtained at higher pressures.
B A higher percentage yield of ammonia can be obtained at lower temperatures.
C Ammonia is produced at all conditions of temperatures and pressures.
D At 500°C and 300 atm, the percentage conversion to ammonia is about 30%.

21 You are given the information below:

element	atomic number
W	11
X	12
Y	16
Z	17

Which of the following pairs of elements would react with each other most readily?

A ***W*** and ***Y***
B ***W*** and ***Z***
C ***X*** and ***Y***
D ***X*** and ***Z***

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22 The atomic radius of some Group I elements of the Periodic Table is given.

element	atomic radius / pm
K	231
L	152
M	248
N	186

Which of the following shows the correct ascending order of melting point for the elements?

	lowest → highest			
A	***L***	***K***	***N***	***M***
B	***L***	***N***	***K***	***M***
C	***M***	***K***	***L***	***N***
D	***M***	***K***	***N***	***L***

23 The reaction between hydrogen and chlorine can be shown as $H_2 + Cl_2 \rightarrow 2HCl$.
Why is the reaction exothermic?

A The energy involved in the bonds breaking is greater than that of bonds forming.
B The energy involved in the bonds forming is greater than that of the bond breaking.
C The number of bonds broken is greater than the number of bonds formed.
D The number of bonds formed is greater than the number of bonds broken.

24 Which of the following reaction(s) are endothermic?

I $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$
II $Cl_2 \rightarrow 2Cl$
III $CuSO_4 + 5H_2O \rightarrow CuSO_4.5H_2O$
IV $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

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

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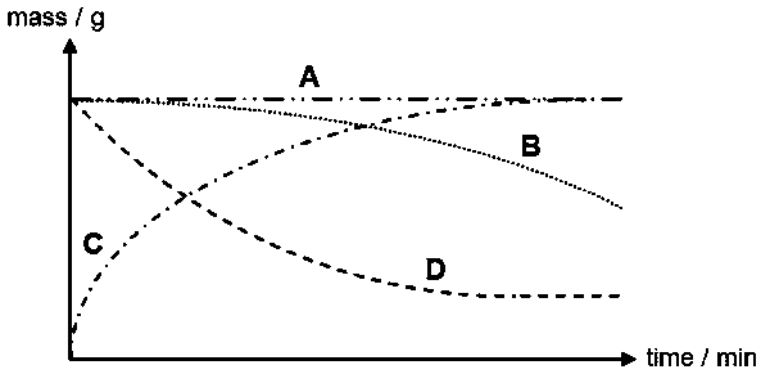
25 In an experiment, a conical flask containing 50 cm^3 of hydrogen peroxide and 0.5 g of manganese(IV) oxide was placed on an electronic balance. The balance reading was recorded at regular time intervals. Hydrogen peroxide decomposes to form water and oxygen gas.

Which of the curves show the correct change in mass for this experiment?



26 In the testing of ions for qualitative analysis, which of the following ions undergo reduction?

A ammonium
B chloride
C nitrate
D sulfate

27 ***R*** is a solution of a reducing agent. It is added to each of the four reagents shown in the table below. Which of the following shows the correct description of the change in colour?

	reagent	effect of adding ***R***
A	acidified potassium manganate(VII)	purple to colourless
B	aqueous bromine	colourless to reddish-brown
C	aqueous chlorine	colourless to pale yellow
D	aqueous potassium iodide	colourless to brown

28 Which of the following gases **cannot** be removed from the exhaust of a petrol powered car by its catalytic converter?

A carbon dioxide
B carbon monoxide
C hydrocarbons
D nitrogen dioxide

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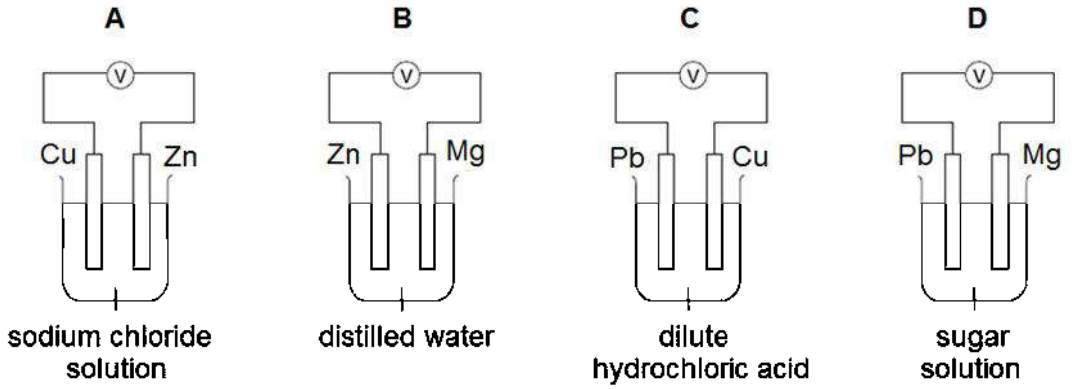
29 In an electrolytic experiment involving aqueous silver nitrate, 1.08g of silver was deposited at the cathode. What is the volume of the gas collected at the anode?

A 30 cm^3
B 60 cm^3
C 180 cm^3
D 240 cm^3

30 Which of the set-ups will produce the greatest reading on the voltmeter?



31 Pain is often felt when a piece of aluminium foil touches a dental amalgam filing in a tooth. The amalgam contains tin and an electric current momentarily flows. Which statement about what happens is **not** correct?

A The aluminium foil acts an oxidising agent.
B The current is smaller if a piece of zinc foil touches the tin amalgam.
C The electrons flow from aluminium foil to tin amalgam.
D The oxidation state of aluminium foil increases.

32 Which of the following is true about the formation of molten iron from haematite in the blast furnace?

A Coke is used as a catalyst for the process of forming molten iron.
B Haematite is made up of mainly iron(II) oxide.
C Limestone is used to remove alkaline impurities.
D Molten slag is collected above molten iron.

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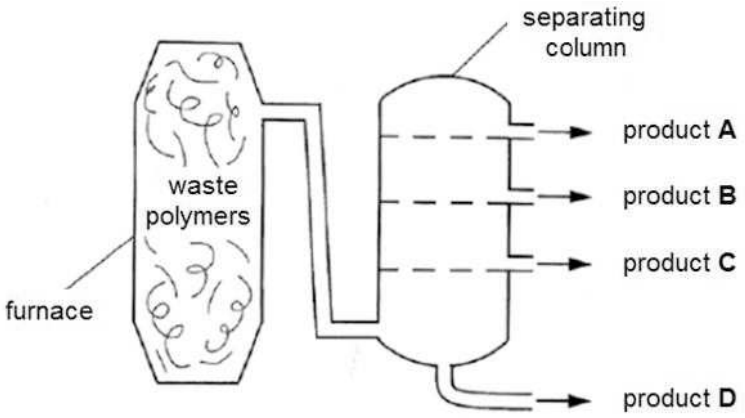
33 Waste polymers can be recycled by heating it in a furnace. The waste decomposes into a mixture of hydrocarbons which can be separated in a separating column.
Which product has the largest number of carbon atoms per molecule?



34 Which of the following is **not** true about the fractional distillation of crude oil?

A Bitumen fraction has the highest boiling point among the fractions.
B Kerosene fraction is used as fuel in aircraft.
C Naphtha fraction is used as feedstock for chemical industries.
D The different fractions obtained are pure.

35 In the presence of sunlight, methane gas and chlorine gas are mixed together in an enclosed container. After two hours, which of the following is/are present in the container?

I CH_3Cl
II CCl_4
III HCl
IV H_2

A **I** and **II**
B **I** and **III**
C **I**, **II** and **III**
D All of the above

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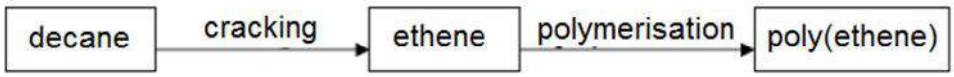
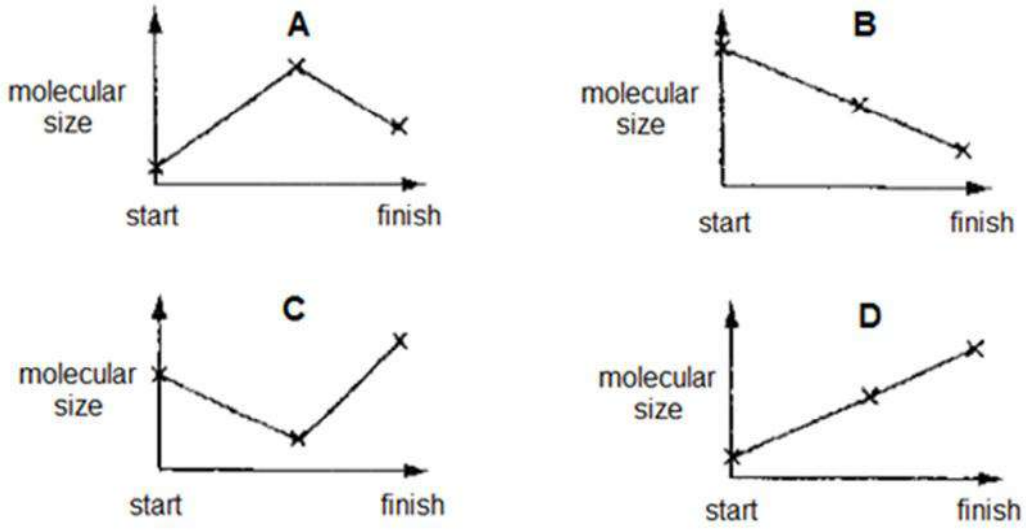
36 Poly(ethene) can be manufactured by the processes below.



Which diagram shows the correct change in molecular size during these processes?



37 When ethanol reacts with propanoic acid, the ester formed has the formula of

A $CH_3COOC_2H_5$
B $C_2H_5COOCH_3$
C CH_3COOCH_3
D $C_2H_5COOC_2H_5$

38 Which reagent **cannot** be used to distinguish methanol from methanoic acid?

A acidified potassium manganate(VII)
B aqueous bromine
C aqueous sodium carbonate
D litmus solution

39 Linoleic acid has the molecular formula, $C_{17}H_{29}COOH$. How many C = C bonds are present in one molecule of linoleic acid?

A 1
B 2
C 3
D 4

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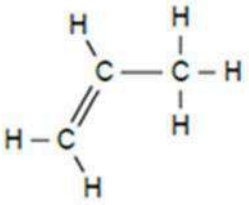
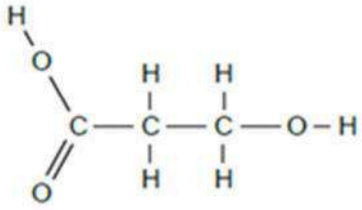
40 Which of the following monomer(s) would undergo polymerisation on their own?

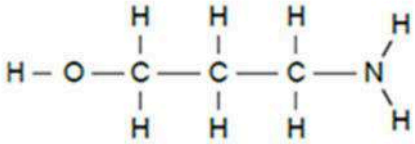
I



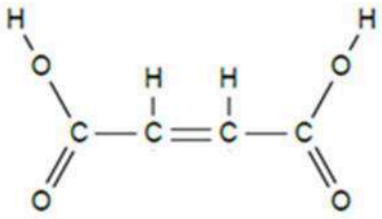
II



III



IV



A **I, II** and **III**
B **I, II** and **IV**
C **II** and **III**
D All of the above

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

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ANDERSON SECONDARY SCHOOL
Preliminary Examination 2016
Secondary Four Express & Five Normal

CANDIDATE NAME:

CLASS: /

INDEX NUMBER:

CHEMISTRY 5073/02

Paper 2

24 August 2016

1 hour 45 minutes

1100 – 1245h

No Additional Materials are required

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 a pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.

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 either/or.
Write your answers in the spaces provided on the Question Paper.

The number of marks is given in brackets [ ] at the end of each questions
A copy of the Periodic Table is printed on page **23**.

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

Section A	
Section B	
Total	

This document consists of **23** printed pages and **1** blank page.

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Section A

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

A1 A list of solutions is given below.

$Ba(NO_3)_2$	$CuSO_4$	$FeSO_4$
HC*l*	NaOH	NH_4C*l*

The solutions can be used once, more than once or not at all.

From the list, choose two solutions that will react to

(a) produce a blue precipitate,

…… and …… [1]

(b) give a pungent gas,

…… and …… [1]

(c) produce a white precipitate in a green solution.

…… and …… [1]

[total: 3]

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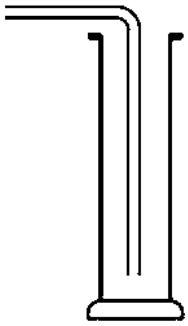
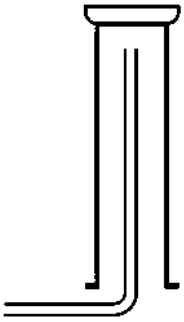
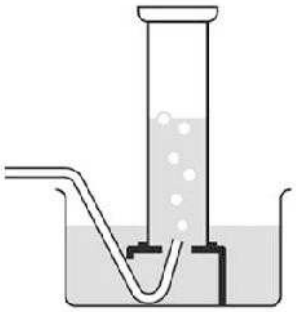
A2 Ammonia gas is an important starting material in the manufacture of fertilisers and many commercial cleaning products.

Three different methods of collecting gases in the laboratory are shown below.

method **1**	method **2**	method **3**
		

(a) Which of the methods is the most suitable for the collection of ammonia gas in the laboratory? Give reasons to support your answer by stating why the other methods are **not** suitable.

……..

……..

……..... [2]

(b) In the industry, ammonia gas is produced by the Haber process. State the optimum conditions used in this process.

……..

……..... [2]

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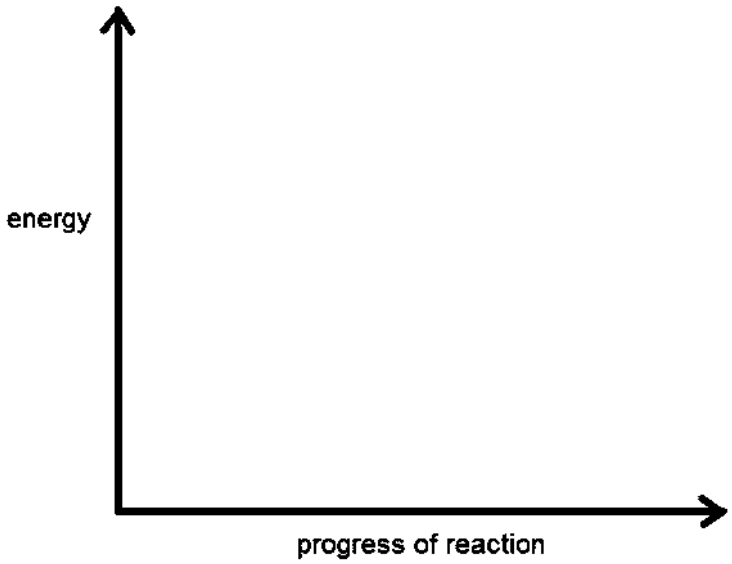
(c) Ammonium nitrate is predominantly used in agriculture as a fertiliser. When ammonium nitrate is added to water, the reaction mixture feels cold.

The reaction between solid ammonium nitrate and water can be represented as:

$$NH_4NO_3(s) \rightarrow NH_4^+(aq) + NO_3^-(aq)$$

Draw an energy profile diagram for the reaction between ammonium nitrate and water below. On the diagram, you should label the

- activation energy, E_a
- energy change for the reaction, ΔH. [3]



[total: 7]

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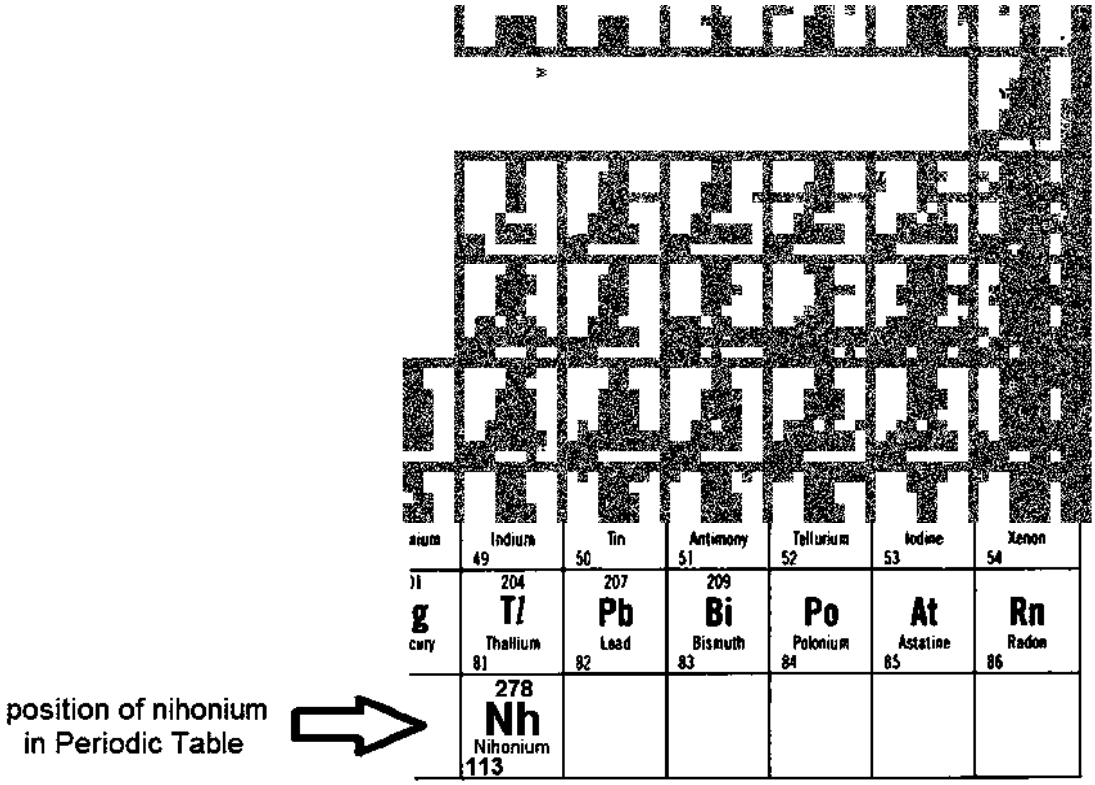
A3 Recently, the International Union of Pure and Applied Chemistry (IUPAC) has announced the proposed names for the four newest elements to be added in Period 7 of the Periodic Table.

One of the new element, with atomic number 113, the first to be discovered in an Asian country, has been christened nihonium (Nh), which borrowed its name from one of the Japanese names for Japan - nihon.

The position of nihonium in the Periodic Table is shown below.



The element was discovered by Japan's Riken Institute by colliding a thin layer of bismuth with zinc as shown in the equation below.

$$^{209}_{83}Bi + {}^{70}_{30}Zn \rightarrow {}^{278}_{113}Nh + particle\ X$$

(a) Name particle ***X***, a by-product in the synthesis of nihonium.

…….... [1]

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(b) Nihonium exists as three isotopes, nihonium-278, nihonium-282 and nihonium-285. Describe with examples, one similarity and one difference in the properties of three samples of nihonium containing nihonium-278, nihonium-282 and nihonium-285 respectively. You may refer to the samples as nihonium-278, nihonium-282 and nihonium-285 in your answers.

……..

……..

……..

……..

……..

……..... [3]

(c) Another new element, with atomic number 117, to be named as tennessine (with symbol Ts) will be placed close to nihonium in the Period Table.

(i) In which group of the Periodic Table would you expect tennessine to be found?

……..... [1]

(ii) A student made a few predictions about tennessine. Put a tick (√), in each of the correct boxes to show which of the following predictions about the properties of tennessine are true and which are false. [2]

	true	false
Tennessine is a good conductor of electricity.		
Tennessine is a solid at room conditions.		
Tennessine is green in colour.		
Tennessine is the most reactive element in its group in the Periodic Table.		

[total: 7]

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A4 An oxyacid is an acid that contains an oxygen atom bonded to a hydrogen atom and at least one other element. Sulfuric acid (H_2SO_4), phosphoric acid (H_3PO_4) and nitric acid (HNO_3) are all oxyacids.

Chlorine forms several types of oxyacids. The table below shows some properties of oxyacids of chlorine.

name of acid	chemical formula	reaction with magnesium (all acids have the same concentration)	oxidation state of chlorine
perchloric acid	HC*l*O_4	very vigorous	
hypochlorous acid	HOC*l*	only a few bubbles seen	
chloric acid	HC*l*O_3	vigorous	+5
chlorous acid	HC*l*O_2	reacts readily	+3

(a) Complete the table by filling in the oxidation state of chlorine. [2]

(b) **(i)** Arrange in ascending order the strength of these acids, starting with the weakest acid.

…..... [1]

(ii) Hence, deduce the trend in the strength of the acid with reference to the information in the table.

…..... [1]

(c) Hypochlorous acid (HOC*l*) can be made from dichlorine monoxide gas (Cl_2O). Draw a 'dot-and-cross' diagram to show the bonding in dichlorine monoxide. Show the outer electrons only. [2]

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(d) Hypochlorous acid (HOC*l*) can also be produced by reacting chlorine with water.

$$Cl_2 + H_2O \rightarrow HOCl + HCl$$

Explain, in terms of oxidation states, why the reaction shown above is a redox reaction.

……..

……..

……..... [2]

[total: 8]

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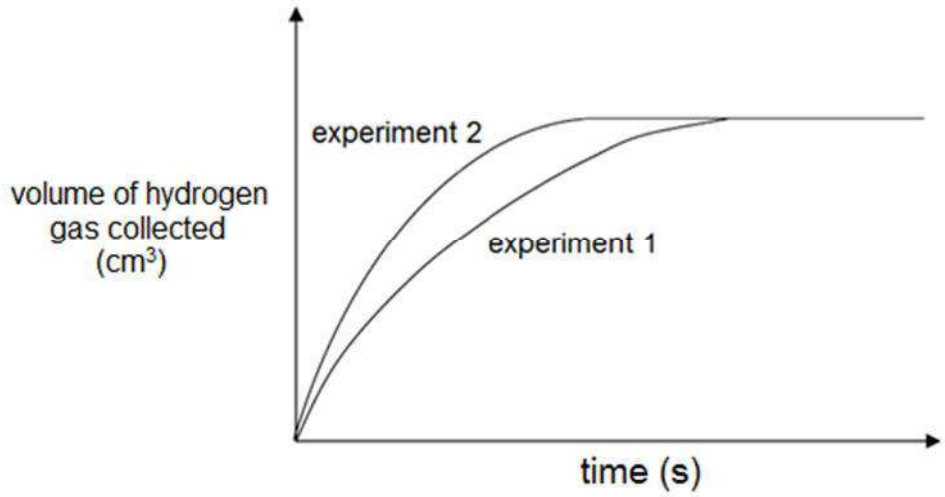
A5 A student carried out two experiments involving the reaction between zinc and dilute hydrochloric acid. Information about the experiments is given in the table below.

	experiment **1**	experiment **2**
granulated zinc	excess	excess
dilute hydrochloric acid	5.0 cm^3, 1.0 mol/dm^3	5.0 cm^3, 1.0 mol/dm^3
temperature	25°C	25°C
copper(II) sulfate solution	not added	added a few drops

The results of the experiments are shown in the graph.



(a) **(i)** Which experiment has a faster rate of reaction? How do you know?

……..... [1]

(ii) Suggest why this happens.

……..

……..... [1]

(b) Write a balanced chemical equation for the reactions in both experiments.

……..... [1]

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(c) For both experiments, zinc is used in excess. Calculate the mass of zinc that reacted.

[2]

(d) Two other experiments were performed using the following conditions. Sketch the curves using the same axes (on the previous page) to show the results of the experiments. Label your curves clearly as experiment **3** and experiment **4**. [2]

	experiment **3**	experiment **4**
granulated zinc	excess	excess
dilute hydrochloric acid	5.0 cm^3, 0.5 mol/dm^3	5.0 cm^3, 1.0 mol/dm^3
temperature	25°C	40°C
copper(II) sulfate solution	not added	added a few drops

(e) Experiment **5** was performed under the same conditions as experiment **1** but dilute sulfuric acid (5.0 cm^3 and 1.0 mol/dm^3) was added instead of dilute hydrochloric acid to zinc. The rate of reaction in experiment **5** was found to be faster than experiment **1**. Use ideas about collisions between particles to explain this observation.

……..

……..

……..

……..

……..... [2]

[total: 9]

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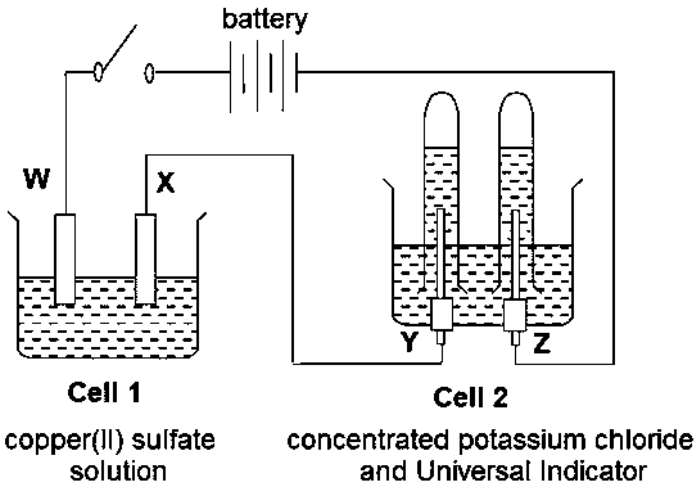
A6 An electric circuit is set up as shown below.



Electrodes ***W*** and ***X*** are made of copper while electrodes ***Y*** and ***Z*** are made of carbon. The switch is closed and some changes are observed.

(a) **(i)** State one visible change that can be observed in **Cell 1**.

…… [1]

(ii) Write the ionic half-equations for the reactions at the cathode and anode respectively in **Cell 1**. Hence, state with a reason whether there will be any change in the colour intensity of the copper(II) sulfate solution throughout the experiment in this cell.

……...

……...

……...

……..... [3]

(b) **(i)** Describe the colour change of the Universal Indicator during electrolysis of the concentrated potassium chloride solution in **Cell 2**.

…… [1]

(ii) Explain your observation in (b)(i).

……...

…… [2]

[total: 7]

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A7 This article was adapted from The Straits Times dated June 11, 2016.

> ‘Scientists find way to lock away carbon dioxide.’
>
> Scientists say they may have found a radical breakthrough to tackling climate change - by pumping heat-trapping carbon dioxide gas into the ground and turning it into stone.
>
> The research, called the *CarbFix* project and led by Columbia University, was published in American journal *Science* on Thursday (June 9).
>
> The approach involves dissolving carbon dioxide gas with water and pumping the resulting mixture - essentially, soda water - down into certain kinds of rocks, where the carbon dioxide gas reacts with the rock to form a mineral stone called *calcite. By turning the carbon dioxide gas into calcite, scientists can then lock it away permanently.
>
> **calcite has the chemical formula of $CaCO_3$*
>
> One key to the approach is to find the right kind of rocks. Volcanic rocks called basalts are excellent for the process, because basalts are rich in calcium, which react with carbon dioxide gas.
>
> The research was conducted for years in Iceland, a volcanic island made up mainly of basalt. Scientists found that the conversion yield is about 95 %; meaning that 95% of the carbon dioxide was converted into calcite. More importantly, the conversion happened relatively quickly - in less than two years, instead of ten years as previously predicted by scientists using computer.

(a) Explain the importance of the CarbFix project in protecting the environment.

……...

……...

……...

……...

……..... [2]

(b) Other than calcite, name another mineral that also contain $CaCO_3$.

……..... [1]

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(c) 'Soda water' mentioned in the article is actually weak carbonic acid. Explain what is meant by the term *weak acid*.

……

……..... [1]

(d) A researcher in the *CarbFix* project decided to investigate the presence of calcium ions in calcite. He was given the following four reagents:

dilute sulfuric acid	dilute hydrochloric acid
aqueous ammonia	aqueous sodium hydroxide

Describe the tests that he should carry out. Your answer should include

- the reactions involved using some of the given reagents,
- how the observations showed the presence of calcium ions in calcite.

……..

……..

……..

……..

……..... [3]

(e) Suggest a reason why

(i) the conversion of carbon dioxide gas into calcite happened relatively quickly in Iceland.

……..

……..... [1]

(ii) conversion yield of carbon dioxide gas into calcite may not reach 100%.

……..

……..... [1]

[total: 9]

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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.

B8 Transition metals are found in the central block of the Periodic Table.
Table 1 shows part of the central block of the Periodic Table which displays transition metals found in Periods 4, 5 and 6. The proton numbers of each of the metals are included as well.

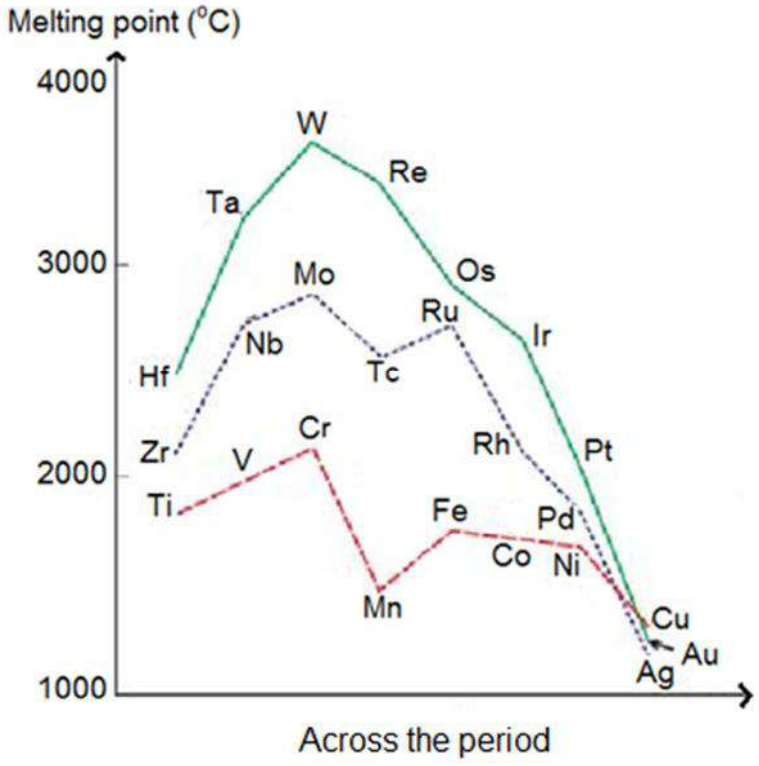
Table 1

across the period →

down the group ↓

Period	transition metals							
4	$_{22}Ti$	$_{23}V$	$_{24}Cr$	$_{25}Mn$	$_{26}Fe$	$_{27}Co$	$_{28}Ni$	$_{29}Cu$
5	$_{40}Zr$	$_{41}Nb$	$_{42}Mo$	$_{43}Tc$	$_{44}Ru$	$_{45}Rh$	$_{46}Pd$	$_{47}Ag$
6	$_{72}Hf$	$_{73}Ta$	$_{74}W$	$_{75}\mathrm{Re}$	$_{76}Os$	$_{77}Ir$	$_{78}Pt$	$_{79}Au$

The graph below shows the melting points of the transition metals of those listed in **Table 1**.



(a) Use the information above to describe the trends in melting point of transition metals

(i) down the groups,

……..... [1]

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(ii) across the periods.

……...

……...

……...

……..... [2]

(b) How does the information show that the transition metals in Period 4 are solids at room temperature and pressure?

……...

……..... [1]

(c) In an experiment to determine the relative reactivity of five transition metals (Cr, Cu, Au, Fe and Ag), small pieces of each metal were added to the aqueous nitrate solutions of the other metals. **Table 2** shows the results.

Key √ shows a reaction happened
× shows no reaction happened
- shows the experiment was not performed

Table 2

	chromium (Cr)	copper (Cu)	gold (Au)	iron (Fe)	silver (Ag)
chromium nitrate solution	-	×	×	×	×
copper(II) nitrate solution	√	-	×	√	×
gold nitrate solution	√	√	-	√	√
iron(III) nitrate solution	√	×	×	-	×
silver nitrate solution	√	√	×	√	-

(i) Place the metals in the descending order of reactivity, starting with the most reactive.

……..... [2]

(ii) Write an ionic equation, for the reaction between copper and silver nitrate solution.

……..... [1]

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(d) With reference to your answer in (c)(i) and the information from the **Table 1**, deduce the trend of the reactivity of transition metals

(i) across the periods, …… [1]

(ii) down the groups. …… [1]

(e) From **Table 1**, name the metal that is most likely to displace **only** eight other metals from their salt solutions.

…… [1]

[total: 10]

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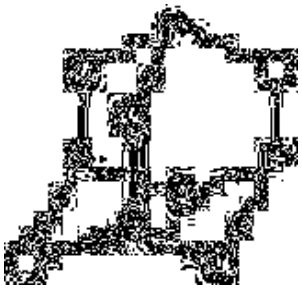
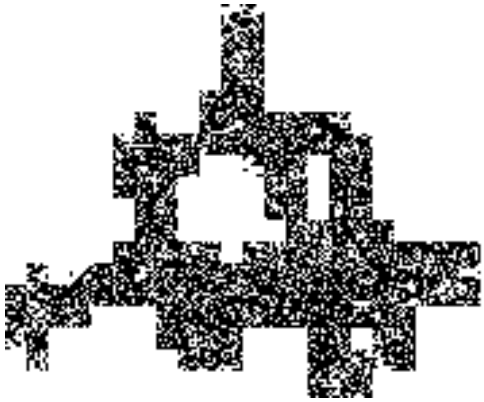
B9 The structures of phosphorus trioxide and diamond are shown below.



phosphorus trioxide



diamond

(a) Write down the molecular formula of phosphorus trioxide.

……..... [1]

(b) Based on the diagrams above, explain how it could be deduced that the structure shown for phosphorus trioxide is that of a simple molecule, while that of diamond represents only part of a macromolecule.

……...

……...

……...

……...

……...

……...

……..... [4]

(c) Explain why the melting points of phosphorus trioxide and diamond is different.

……...

……...

……..... [2]

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(d) An oxide was found to have the following composition by mass.

element	percentage by mass
phosphorus	43.7
oxygen	56.3

Deduce whether this oxide could be phosphorus trioxide by determining its empirical formula. [3]

[total: 10]

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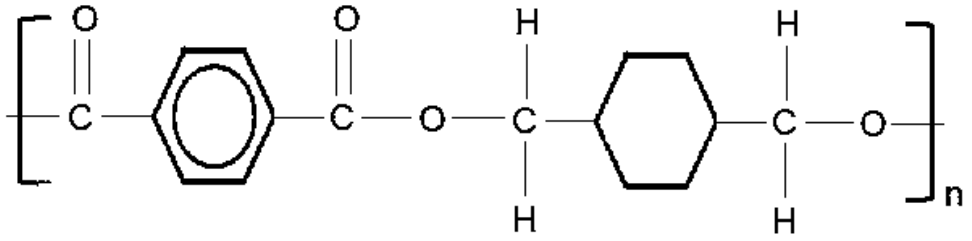
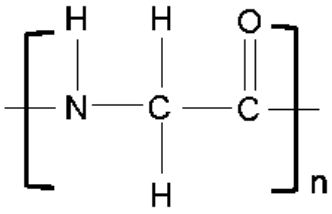
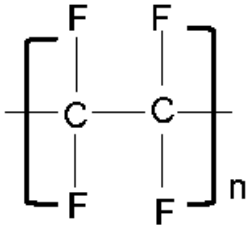
EITHER

B10 The table below shows some information regarding three polymers – Kodel©, polyglycine and Teflon©.

name	structure
Kodel©	
polyglycine	
Teflon©	

(a) Draw and name the linkage found in polyglycine. [2]

(b) Draw the structures of the two monomers used to form Kodel©. [2]

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(c) Draw the structure of the monomer used to form Teflon©. [1]

(d) The monomer shown in (c) can react with chlorine gas to form a compound that can be classified as chlorofluorocarbon (CFC).

(i) Write an equation for the reaction between the monomer of Teflon© and chlorine gas.

……..... [1]

(ii) Explain how CFCs cause ozone depletion in the upper atmosphere.

……...

……...

……..... [2]

(e) Kodel© polymers are formed in a different way from Teflon© polymers. Name both types of polymerisation involved and state one difference between them.

……...

……...

……..... [2]

[total: 10]

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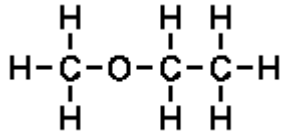
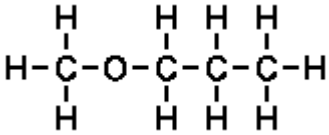
OR

B10 This question concerns the chemistry of some organic compounds.

(a) The table shows some information about the homologous series of a class of organic compounds called ethers.

name	molecular formula	structural formula
methoxy ethane	$CH_3OC_2H_5$	
methoxy propane	$CH_3OC_3H_7$	

(i) Give the name and structural formula of the next member of this homologous series. [2]

name: ……

structural formula:

(ii) Draw the full structural formula of two isomers of methoxy ethane. [2]

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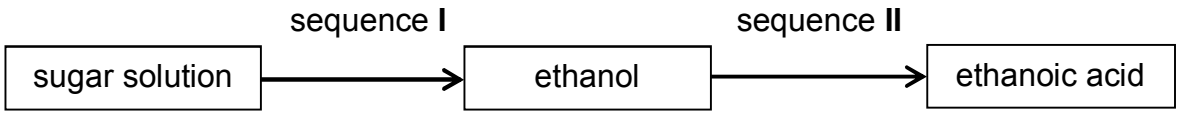
(b) Ethanoic acid can be synthesised by using various methods.
In method **1**, ethanoic acid is synthesised from methanol as shown by the following reaction sequence:

sequence	reaction
I	$CH_3OH + HCl \rightarrow CH_3Cl + H_2O$
II	$CH_3Cl + CO \rightarrow CH_3COCl$
III	$CH_3COCl + H_2O \rightarrow CH_3COOH + HCl$

In method **2**, ethanoic acid is synthesised from sugar as shown by the following reaction sequence:



(i) Name the type of reaction as shown in reaction sequence **I** in method **1**.

……..... [1]

(ii) For method **2**, state the optimum conditions needed for reaction sequence **I**.

……...

……..... [2]

(iii) For method **2**, name the reagent used for reaction sequence **II** in the laboratory.

……..... [1]

(iv) In the industry, which method provides a safer working environment?
Suggest one reason to support your answer.

……...

……..... [1]

(v) Chloromethane (CH_3Cl) can be produced from an alkane.
Write an equation to show this reaction.

……..... [1]

[total: 10]

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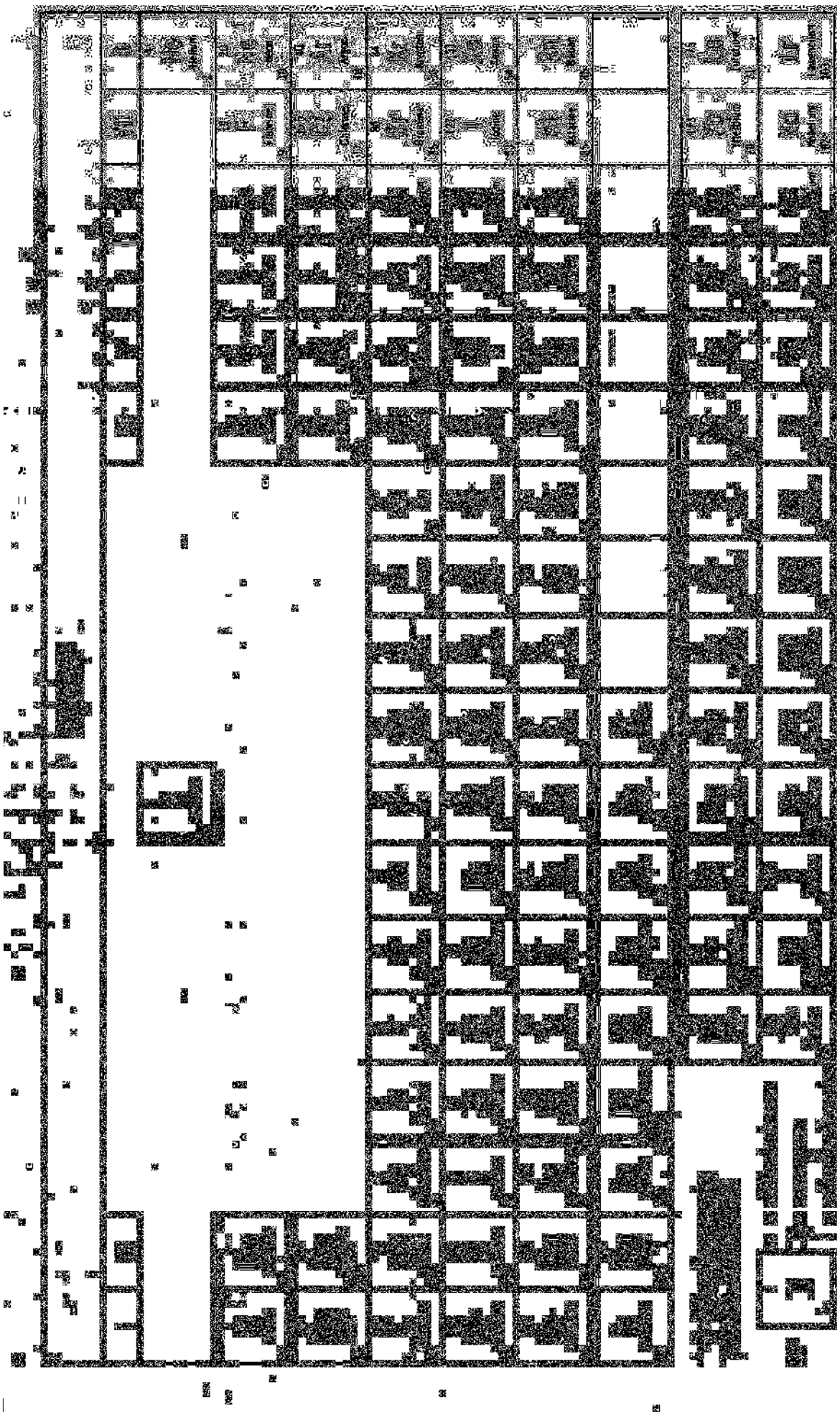

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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Answer Scheme for Chemistry 5073 Prelims 2016

Paper 1 [40 marks]

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

Paper 2 Section A [50 marks]

A1 (a) $CuSO_4$ and NaOH

(b) NaOH and NH_4Cl

(c) $Ba(NO_3)_2$ and $FeSO_4$

A2 (a) Method 2.

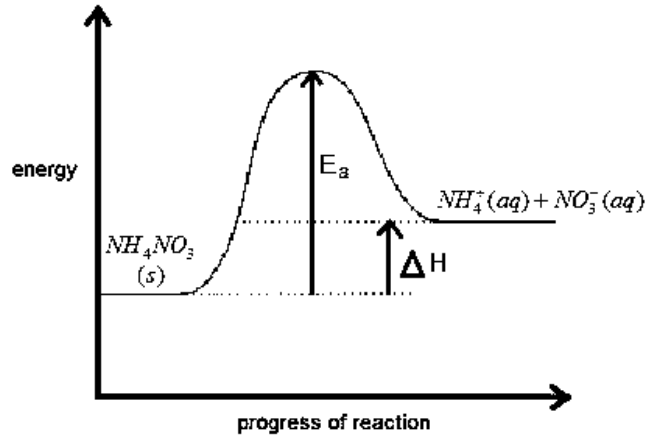
Ammonia gas is soluble in water, thus method 3 cannot be used.

Ammonia gas is less dense than air, thus method 1 cannot be used.

(b) 250 atm and 450 ^oC.

Iron as catalyst.

(c) *Refer to diagram below for marking scheme*



A3 (a) neutron

(b) All three elements will have the same chemical reactions (properties) but different physical properties.

Give one example in same chemical property such as all elements will react with chlorine to form ionic compounds.

Give one example in different physical property such as density. Nihonium-285 will has the highest density followed by nihonium-282 and nihonium-278.

(ci) group VII

(cii) Refer to table below.

	True	False
Tennessine is a good conductor of electricity.		√
Tennessine is a solid at room conditions.	√	
Tennessine is green in colour.		√
Tennessine is the most reactive element in its group in the Periodic Table.		√

A4 (a) +7 and +1

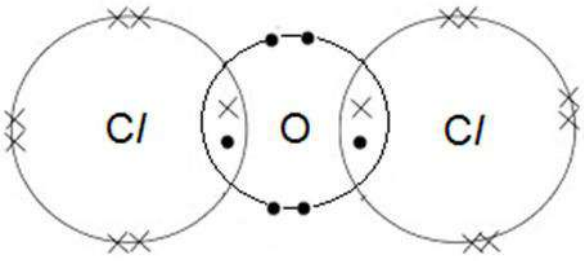
(bi) HOCl, $HClO_2$, $HClO_3$, $HClO_4$

OR hypochlorous acid, chlorous acid, chloric acid, perchloric acid

(bii) As the <u>oxidation state of chlorine</u> in the acid increases, the strength of the acid increases too. OR

As the <u>number of oxygen per molecule/in the formula</u> in the acid increases, the strength of the acid increases too.

(c) *Draw dichlorine monoxide correctly as shown below with legend*



(d) Cl_2 is reduced (OR reduction occurs) since the oxidation state of Cl decreases from 0 in Cl_2 to -1 in HCl.

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Cl_2 is oxidised (OR oxidation occurs) since the oxidation state of Cl increases from 0 in Cl_2 to +1 in HOCl.

Since both oxidation and reduction occur, this is a redox reaction.

A5 (ai) Experiment 2. It has a steeper gradient (at the start of the experiment).

(aii) Copper(II) sulfate was added to speed up the rate of reaction of experiment 2.

(b) $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

(c) number of mole of HCl used $= \frac{5}{1000} \times 1$

$= 0.005$

Based on the equation, number of mole of Zn reacted

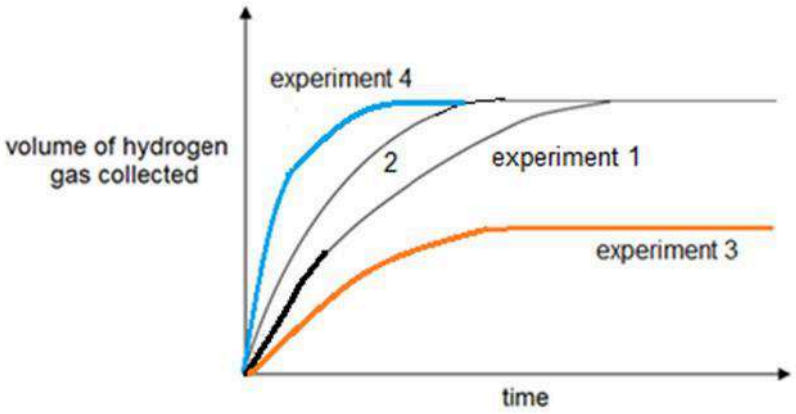
$= 0.005 \div 2$

$= 0.0025$

Thus, the mass of zinc reacted $= 0.0025 \times 65$

$= 0.163$ g

(d) *Refer to the diagram below for marking scheme*



(e) Sulfuric acid is dibasic while hydrochloric acid is monobasic.

Thus, the concentration of H^+ ions in sulfuric acid is twice of that of hydrochloric acid.

With a higher concentration, the reacting particles in experiment 5 will collide more frequently as compared to experiment 1.

As a result, there will be higher number of effective collisions per unit time in experiment 5, leading to a higher rate of reaction.

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A6 (ai) Electrode W diminishes in size. OR

Electrode X is coated with a layer of pinkish brown / brown deposit.

OR Electrode X increases in size.

(aii) At anode: $Cu(s) \rightarrow Cu^{2+}(aq) + 2e$

At cathode: $Cu^{2+}(aq) + 2e \rightarrow Cu(s)$

Since there is no change in the concentration of Cu^{2+} / copper(II) ions, the colour intensity remained in cell 1.

(bi) From green to violet

(bii) At anode / Y, the Cl^- ions is oxidised while at cathode / Z, the H^+ is reduced. OR

At anode / Y, the Cl^- ions lose electrons while at cathode / Z, the H^+ gain electrons.

Thus, the concentration of OH^- is much higher than the concentration of H^+ ions making the solution turned strongly alkaline [1], resulting in the violet colour.

OR

K^+ and OH^- ions are left behind / KOH solution is formed, resulting in a strong alkaline solution, making the solution turns violet.

A7 (a) CarbFix aims to reduce the amount of carbon dioxide in the atmosphere. By doing so, the effect of global warming can be reduced.

Carbon dioxide causes global warming which results in … → *Accept one of the following effects stated below.*

… melting of polar ice caps that causes sea level to rise. As a result, low-lying land will be flooded. /

… prolong drought that turns vegetation area into deserts. As a result, crops will be reduced. /

… rapid evaporation of seawater that lead to more carbon dioxide being released into the atmosphere. As a result, earth's average temperature will rise further.

(b) limestone

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(c) Weak acid refers to a substance that partially dissociates to form hydrogen ions when dissolved in water.

(d) Add dilute hydrochloric acid to calcite to form calcium chloride solution.

Next, add calcium chloride solution to aqueous sodium hydroxide.

White precipitate formed that is insoluble in excess aqueous sodium hydroxide will show the presence of calcium ions.

(ei) The high temperature due to the volcanoes around Iceland causes the speed of reaction / conversion to increase.

(eii) The calcite decomposes due to heating / high temperature. Thus, 100% conversion may not be achievable.

Paper 1 Section B [30 marks]

Section B

B8 (ai) Generally, down the groups, the melting point of metals increases except for the elements in the last group / except for metals Cu, Au and Ag.

(aii) Across all periods, the melting point increases for the first three metals (elements) listed before it shows a decreasing trend for the next few metals.

However, for periods 4 and 5, the 4^{th} element has a lower melting point than expected.

(b) The melting points of the metals are at least $1000^{o}C$, much higher than room temperature.

(ci) Cr, Fe, Cu, Ag, Au

(cii) $Cu(s) + 2Ag^{+}(aq) \rightarrow Cu^{2+}(aq) + 2Ag(s)$

(di) *across the period:* decreases

(dii) *down the period:* decreases

(e) cobalt

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B9 (a) P_4O_6

(b) For the phosphorus trioxide, every / all atom(s) formed the number of bonds required to achieve stable octet electronic configurations.

As shown, oxygen atoms and phosphorus atoms formed two and three covalent bonds respectively.

Carbon atoms need to form four covalent bonds to achieve stable octet electronic configurations.

For diamond, some of the carbon atoms have only formed either one or two covalent bonds / formed less than four covalent bonds.

(c) Phosphorus trioxide has a low melting point while diamond has a very high melting point.

A small amount of energy is needed to overcome the weak intermolecular forces between the molecules in phosphorus trioxide.

A very large amount of energy is needed to break all the strong covalent bonds between the (very large number of) atoms in the structure.

(d)

element	P	O
mass (g) / % by mass	43.7	56.3
number of moles	$\frac{43.7}{31} = 1.409$	$\frac{56.3}{16} = 3.518$
molar ratio	$\frac{1.409}{1.409} = 1$	$\frac{3.518}{1.409} \approx 2.5$
simplest ratio	2	5
empirical formula	P_2O_5	

Since the empirical formula of phosphorus trioxide is P_2O_3, not P_2O_5, this oxide cannot be phosphorus trioxide.

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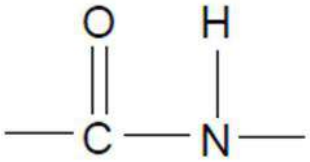
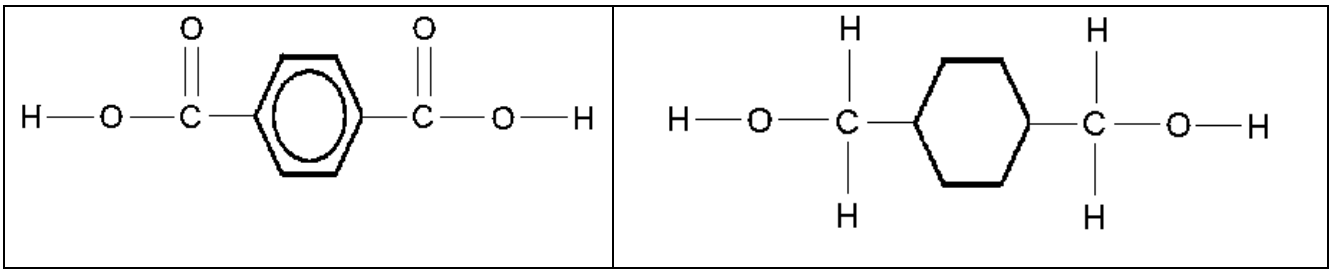
B10 Either

(a) Name of linkage: amide

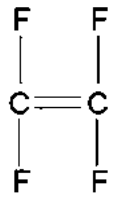
Draw structure of linkage as shown below.



(b) *Draw the monomers as shown below.*



(c) *Draw the monomer as shown below.*



(di) $C_2F_4 + Cl_2 \rightarrow C_2F_4Cl_2$

(dii) In the upper atmosphere, CFCs decomposes under ultra-violet radiation to form chlorine atoms.

The chlorine atoms react with ozone molecules to form oxygen gas and chlorine monoxide, thus causing ozone depletion.

(e) For Kodel©, it is condensation polymerisation and for Teflon©, it is addition polymerisation.

For differences, accept one of the followings or any other possible answers.

For addition, no by-product is formed / only Teflon© polymers is formed while in condensation, by-product which is a small (or simple) molecule is formed. OR

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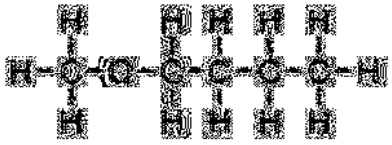
The formation of addition polymers does not involve the loss of atoms / loss of materials while in the formation of condensation polymers, small (or simple) molecule is lost. OR

The two different monomers used in condensation polymers / Kodel© have different functional groups of carboxyl and hydroxyl respectively. The monomer used in addition polymers / Teflon© has the functional group of carbon-carbon double bond.

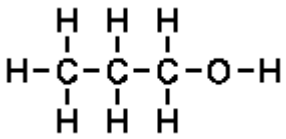
B10 OR

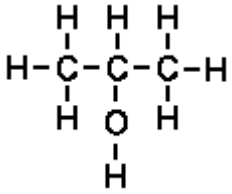
(ai) methoxy butane

Draw the structure as shown below.



(aii) *Draw the isomers as shown below.*





(bi) substitution

(bii) presence of yeast

absence of oxygen

temperature of 37^{o}C

(biii) acidified potassium manganate (VII)

(biv) Method 2 is safer since in method 1, carbon monoxide, a poisonous gas is used. OR

Method 2 is safer since in method 1, hydrogen chloride, a poisonous / acidic gas is used/produced.

(bv) $CH_4 + CI_2 \rightarrow CH_3CI + HCI$

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END OF MARKING SCHEME

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_____ ( ) Class:_____

SECONDARY 4 O LEVEL
PRELIMILARY EXAMINATION 2016

CHEMISTRY 5073

Paper 1 **31 August 2016**

1 hour

READ THESE INSTRUCTIONS FIRST

Write your name, register number, and class on the OAS sheet using a **soft pencil**.

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 correct answer and record the corresponding letter using a **soft pencil** on the OAS sheet.
Amendments may be done using a soft eraser.

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

A copy of Periodic Table is provided on page 2.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 40.

For Examiner's Use	
Total (40)	

This document consists of **16** printed pages.

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[Turn over

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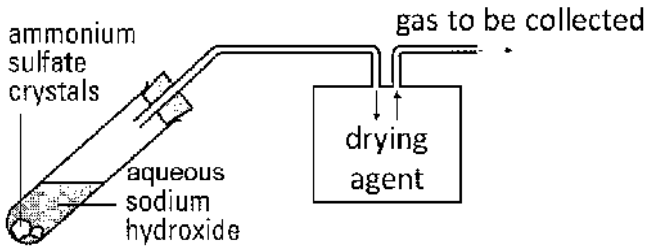
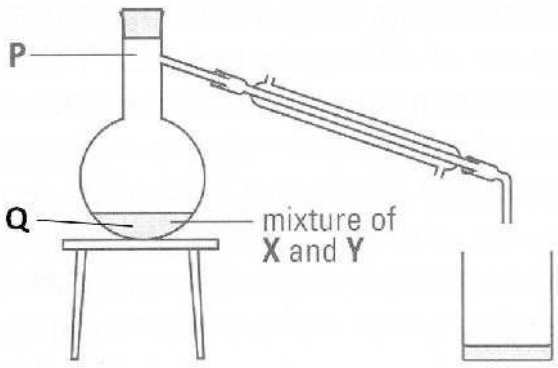
1 An excess of aqueous sodium hydroxide was added to a sample of ammonium sulfate crystals. The mixture was then heated gently, and the gas evolved was dried and collected using a suitable method.



What is the most suitable drying agent and gas collection method for the gas evolved?

	Drying agent	Gas collection method
A	Anhydrous calcium chloride	Water displacement
B	Concentrated sulfuric acid	Downward delivery
C	Anhydrous calcium chloride	Upward delivery
D	Concentrated sulfuric acid	Upward delivery

2 The diagram below shows the partial set-up of a simple distillation experiment used to separate two substances, **X** (boiling point of 70°C) and **Y** which is soluble in **X** (boiling point of 535°C).



At which position, **P** or **Q**, should the bulb of a thermometer be placed at and what temperature should the thermometer show when the first distillate is collected.

A At **P** and at 70°C
B At **P** and at 535°C
C At **Q** and at 70°C
D At **Q** and at 535°C

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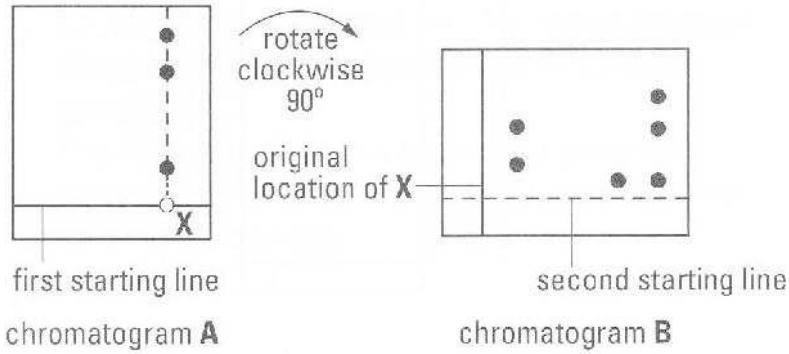
3 An experiment was carried out to determine the different types of sugar present in a sample of mixture **X**.

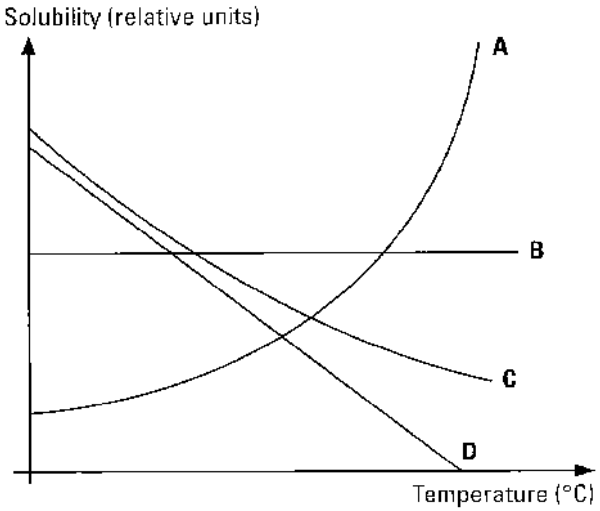
Chromatogram **A** shows the separation of sugars using water as a solvent. Chromatogram **A** is then removed, rotated clockwise and then placed inside another solvent, ethanol. The final results are shown in chromatogram **B**.



How many different types of sugars are present in mixture **X**?

A 3
B 4
C 5
D 6

4 The solubility curves of four different substances **A** to **D** in water are shown below:



Which substance is the most suitable to be collected by crystallization from its hot saturated aqueous solution?

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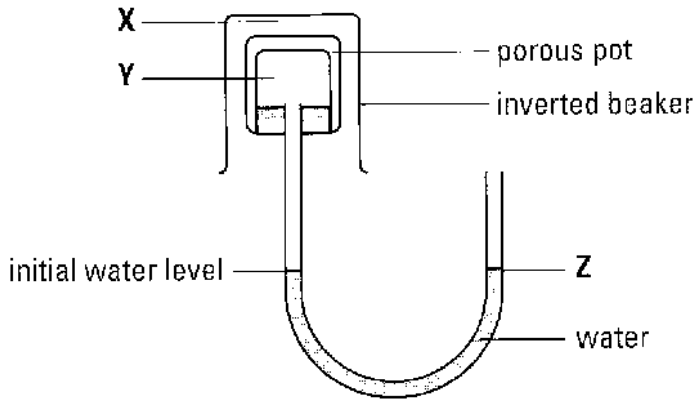
5 Which of the following best describes the arrangement of particles present in dilute aqueous ammonia?

	NH_3 molecules	OH^- ions
A	Not present	Close together
B	Not present	Far apart
C	Close together	Close together
D	Far apart	Far apart

6 The diagram below is a set up involving two gases **X** and **Y**.



After some time, the water level at **Z** rises. What could be the identities of gas **X** and **Y**?

	X	Y
A	Fluorine	Neon
B	Ethane	Nitrogen dioxide
C	Air	Methane
D	Sulfur dioxide	Propene

7 The melting and boiling points of three substances are given below.

Substance	Melting point/ °C	Boiling point/ °C
Argon	-189	-186
Nitrogen	-210	-196
Oxygen	-218	-183

At what temperature would one of the above substances exist as a solid, another one as a liquid and the third as a gas?

A -184°C
B -188°C
C -192°C
D -214°C

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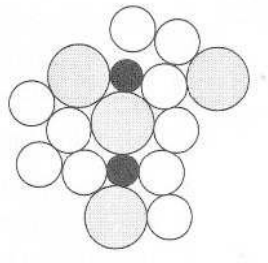
8 Which of the following pairs consists of two mixtures?

A Petrol and air
B Sugar and bronze
C Steel and hydrogen chloride
D Petroleum and sulfur dioxide

9 The diagram below shows the structure of a substance.



Which of the following statements about the substance is true?

A The substance is a compound.
B The substance melts over a range of temperature.
C The substance has a fixed composition of its constituents.
D The substance can be broken down into simpler forms by chemical means.

10 The following particles has different number of nucleons and electrons.

Particle	Nucleon number	Number of electrons
Atom **L**	26	12
Ion $\mathbf{M^{2+}}$	24	10

Which of the following statements about the particles is true?

A Atoms **L** and **M** have different number of protons.
B Atoms **L** and **M** have different number of electrons.
C Atoms **L** and **M** have the same number of neutrons.
D Atoms **L** and **M** have similar chemical properties, but different physical properties.

11 An imaginary element has two isotopes:

- The first has 15 protons and a relative abundance of 80%
- The second isotope has 16 neutrons.

If the relative atomic mass of the imaginary element is 30.2, determine the number of neutrons in the first isotope.

A 15
B 16
C 30
D 31

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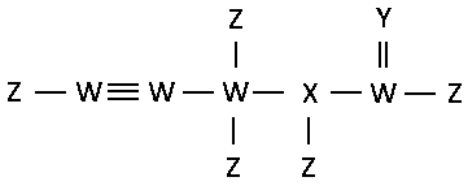
12 Study the molecule below:

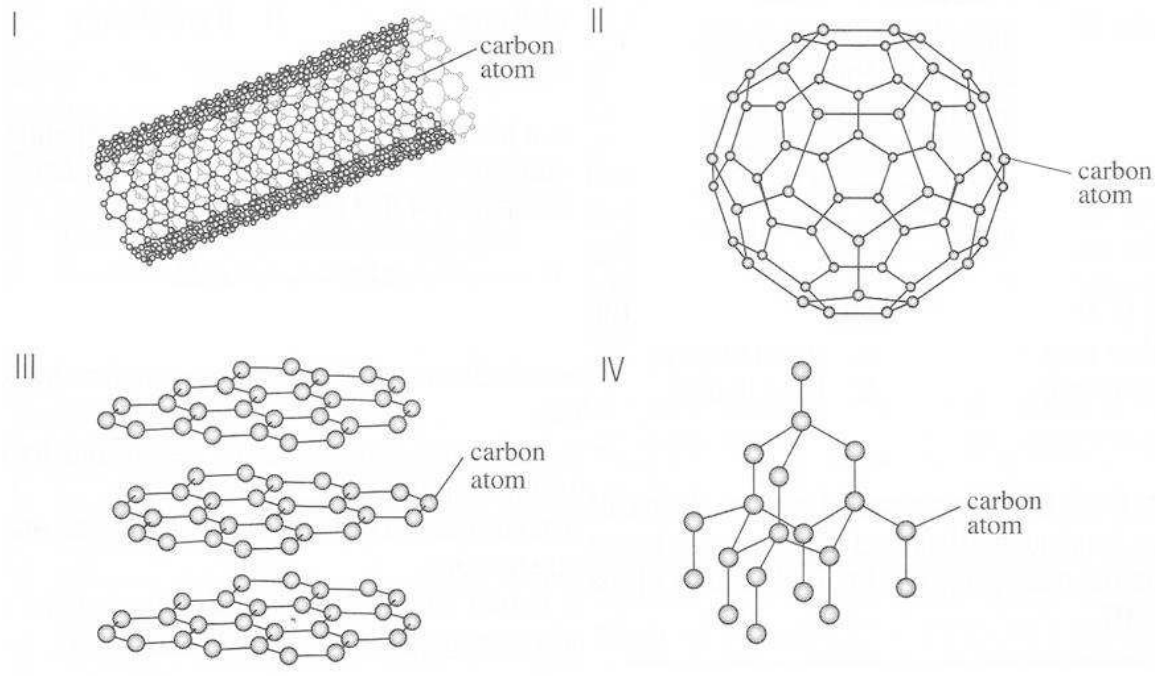


Suggest which Group of elements **W**, **X**, **Y** and **Z** could be from.

	W	**X**	**Y**	**Z**
A	Group III	Group V	Group VI	Group I
B	Group IV	Group III	Group VI	Group VII
C	Group III	Group V	Group II	Group I
D	Group IV	Group V	Group VI	Group VII

13 Answer questions **13** and **14** using the diagram below.

Carbon can form different structures as shown:



Which structure(s) is/are likely to be electrical conductors?

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

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14 Using the diagram on question **13**, identify which structure(s) has/have a simple covalent structure.

A II only
B I and II only
C I, II and III only
D None of the above

15 The table below gives some information on four substances

Substance	Melting point /°C	Boiling point /°C	Electrical conductivity		Solubility in water
			As solid	As liquid	
W	17	118	Poor	Poor	Soluble
X	455	1547	Poor	Good	Insoluble
Y	1064	2970	Good	Good	Insoluble
Z	3550	4830	Poor	Poor	Insoluble

Which of the following statements is likely to be true?

A **W** has a simple covalent structure.
B **X** has a giant metallic structure.
C **Y** is a polymer.
D **Z** is held together by electrostatic forces between oppositely charged ions.

16 Which of the following substances contains the largest number of atoms at room temperature and pressure?

A 72 dm^3 of argon
B 2 moles of bromine
C 24 g of carbon
D 3×10^{23} carbon dioxide

17 The percentage composition of hydrogen in a hydrocarbon is 11.1%. If 1 mole of the hydrocarbon combusts completely to form 3 moles of water, what could be the relative mass of the compound?

A 14
B 27
C 54
D 56

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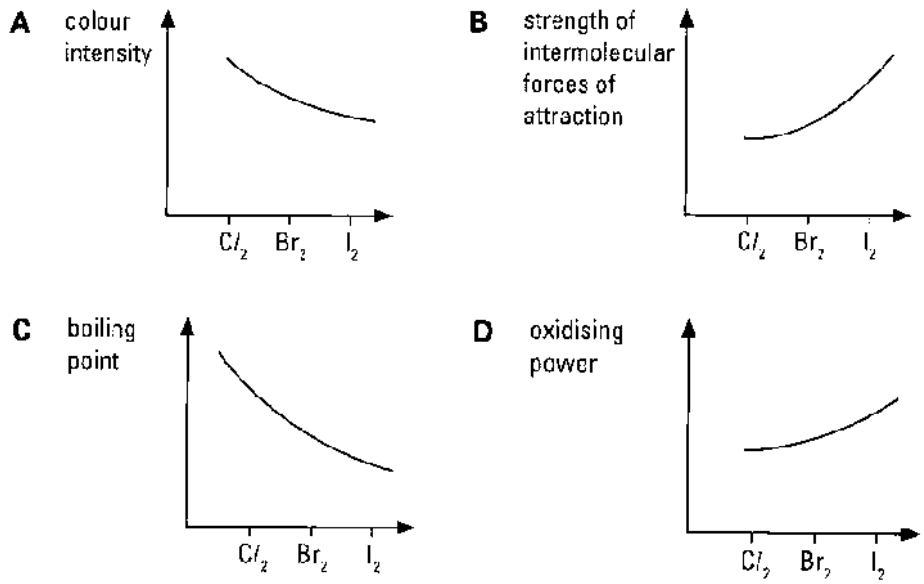
18 3.0 g of impure magnesium is added to 150 cm^3 of 2.0 mol/dm^3 dilute hydrochloric acid. What is the percentage purity of magnesium if only 2.4 dm^3 of hydrogen gas was produced at the end of the reaction.

A 40.0%
B 62.5%
C 80.0%
D 83.3%

19 Which of the following statements about Group I metals is **incorrect**?

A Reactivity increases down the group.
B Melting point decreases down the group.
C All Group I metals can react with cold water and the resultant solution turns red litmus paper blue.
D When Group I metals are exposed to air, they react to form a grey metal oxide that is insoluble in water.

20 Which graph correctly describes a trend down Group VII?



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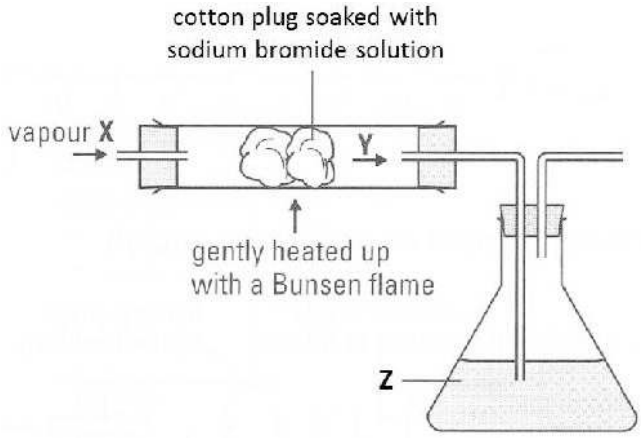
21 Vapour **X** was passed through a tube containing a cotton plug saturated with aqueous sodium bromide. The tube was warmed gently. The gas **Y** leaving the tube was then bubbled into **Z**.



What are the possible identities of substance **X** and **Z**, with the correct corresponding observations?

	X	**Z**	Observation
A	Fluorine	Liquid hexene	Brown vapour **Y** decolourised when in contact with **Z**
B	Chlorine	Aqueous potassium iodide	No colour change at **Z**
C	Iodine	Liquid octene	Brown vapour decolourised when in contact with **Z**
D	Iodine	Aqueous potassium chloride	**Z** turned greenish-yellow

22 A substance $Na\mathbf{X}O_4$ undergo a chemical reaction with hydrogen peroxide, according to the following equation:

$$2Na\mathbf{X}O_4 + 3H_2O_2 \rightarrow 2\mathbf{X}O_2 + 2NaOH + 2H_2O + 3O_2$$

What is the role of hydrogen peroxide in the above reaction?

A It acts as a catalyst.
B It is a reducing agent.
C It is an oxidizing agent.
D It is a dehydrating agent.

23 When acidified aqueous potassium iodide is added to iron(III) sulfate solution, what will be observed?

A No visible change.
B Pale yellow solution turns brown.
C Pale green solution turns brown.
D Pale yellow solution turns pale green.

57
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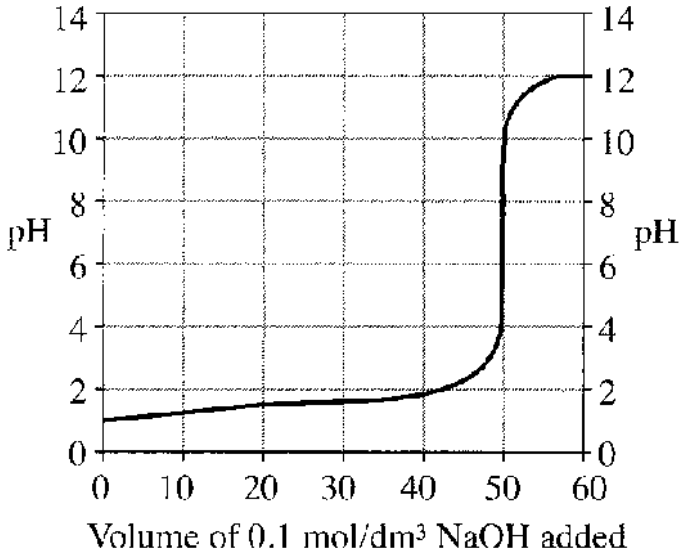
24 Which of the following statements about strong and weak acids is true?

A There are no mobile OH^- ions present in all types of aqueous acids.
B A weak dibasic acid will always have a faster rate of reaction as compared to a strong monobasic acid of the same concentration.
C For the same basicity and concentration, weak acids have a lower pH than strong acids.
D Regardless of strength, monobasic acids of the same concentration and volume require the same number of moles of aqueous sodium hydroxide for complete neutralization.

25 The chart below shows the colours of three indicators at different pH values:

Indicator	Colour change Low pH → high pH	pH which colour change takes place
Methyl orange	Red → yellow	4.0
Bromothymol blue	Yellow → blue	6.5
Phenophthalein	Colourless → pink	9.0

Titration is carried out between aqueous sodium hydroxide and dilute hydrochloric acid. The pH change is plotted onto the graph shown below.



Which indicator(s) can be used to identify the end point of this titration?

A Methyl orange only
B Bromothymol blue only
C Bromothymol blue and phenolphthalein only
D Methyl orange, bromothymol blue and phenolphthalein

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26 Which of the following salts can be prepared using the same method?

A Zinc chloride, calcium sulfate
B Potassium iodide, lead(II) iodide
C Copper(II) sulfate, lead(II) nitrate
D Ammonium chloride, magnesium nitrate

27 When aqueous lead(II) nitrate was added into an unknown solution, a white precipitate was formed. Subsequently, dilute nitric acid was added dropwise to the resultant mixture, till in excess. Effervescence was observed and the white precipitate dissolved completely.

Based on the observations, suggest what could be present in the unknown solution.

A Zinc chloride
B Ammonium iodide
C Aluminium sulfate
D Sodium carbonate

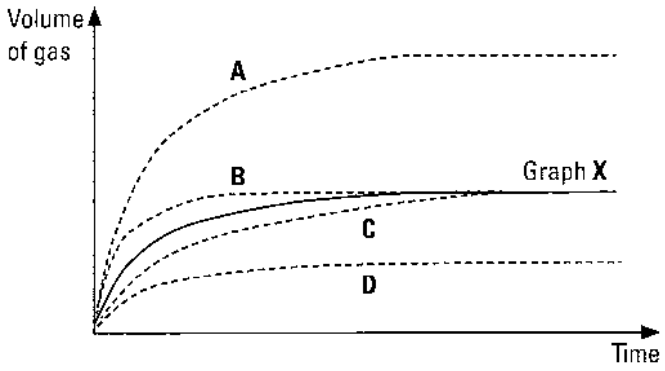
28 In experiment 1, one mole of ethane undergoes complete combustion to form carbon dioxide and water only. In experiment 2, one mole of butane is combusted completely instead. How will the activation energy and enthalpy change of experiment 2 be different from experiment 1?

	Activation energy	**Enthalpy change**
A	Unchanged	Unchanged
B	Increase	Unchanged
C	Unchanged	Increase
D	Increase	Increase

29 0.0100 mol of zinc powder is added to 100 cm^3 of 0.100 mol/dm^3 dilute hydrochloric acid at 25°C. The volume of gas produced is plotted against time as shown by **Graph X** below.

The experiment is then repeated using 0.0100 mol of **granulated** zinc with 100 cm^3 of 0.200 mol/dm^3 dilute hydrochloric acid at 50°C.

Which of the following graphs could be obtained for the second experiment?



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30 Which gases can be removed by factories using moist calcium carbonate?

A NO, NO_2, SO_2
B HCl, NO, CH_4
C CO, NO_2, CH_4
D HCl, NO_2, SO_2

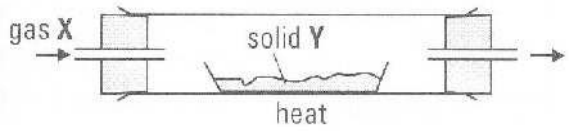
31 The table below provides information on the chemical properties of four metals and some of their compounds.

Metal	Metal + Steam	Metal oxide + Coke	Metal carbonate heated strongly
W	H_2 gas evolved	Oxide reduced	CO_2 evolved
X	H_2 gas evolved	No visible change	No visible change
Y	No visible change	Oxide reduced	CO_2 evolved
Z	H_2 gas evolved	No visible change	CO_2 evolved

Which of the following shows the correct order of reactivity of the metals?

	Most reactive →			least reactive
A	**Y**	**W**	**Z**	**X**
B	**X**	**Z**	**W**	**Y**
C	**Z**	**X**	**W**	**Y**
D	**W**	**X**	**Y**	**Z**

32 An unknown gas **X** is passed over heated solid **Y**, as shown below.



Which of the following pairs of reactants will undergo a reaction?

	Gas **X**	Solid **Y**
A	Carbon monoxide	magnesium oxide
B	Carbon dioxide	Zinc oxide
C	Hydrogen	Iron(III) oxide
D	Steam	Lead

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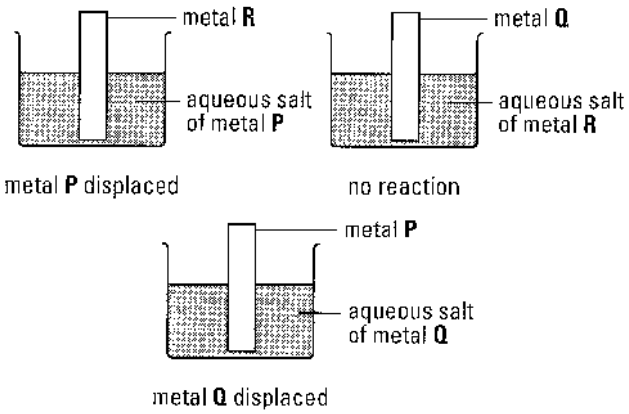
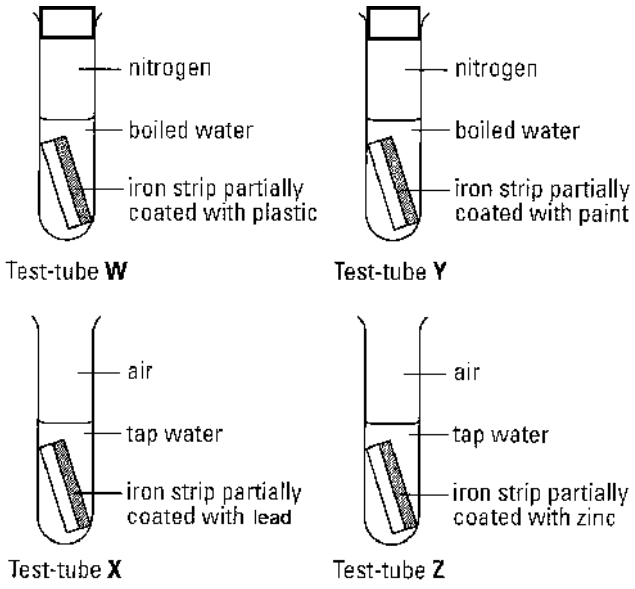
33 Three metals were added into three aqueous salts as shown.



Which one of the following gives the correct order of metal reactivity?

	Least reactive →		Most reactive
A	**P**	**Q**	**R**
B	**P**	**R**	**Q**
C	**Q**	**P**	**R**
D	**Q**	**R**	**P**

34 Four iron nails are placed in separate test tubes and subjected to different conditions as shown below.



After some time, which of the above iron nails will rust?

A **X** only
B **Z** only
C **X** and **Z** only
D **W** and **X** only

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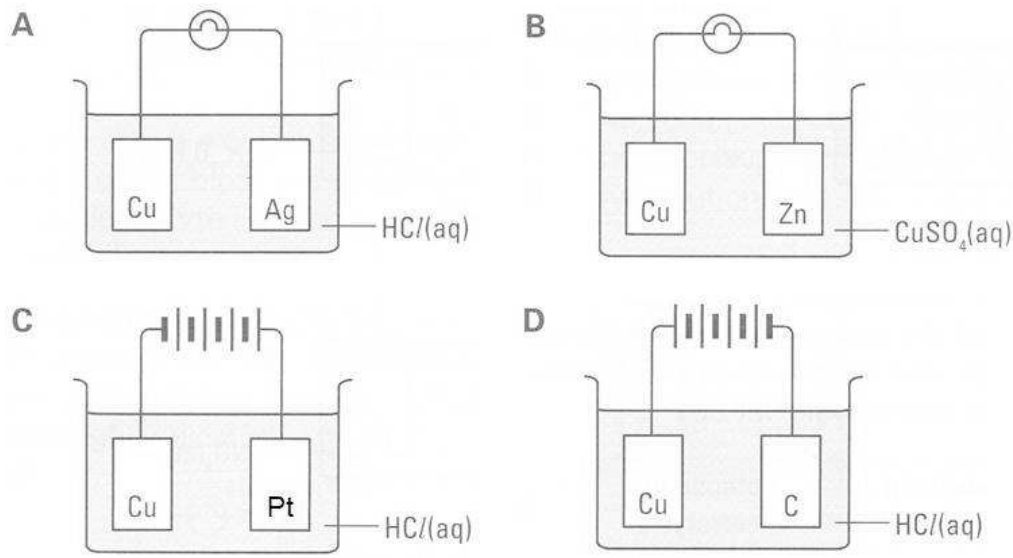
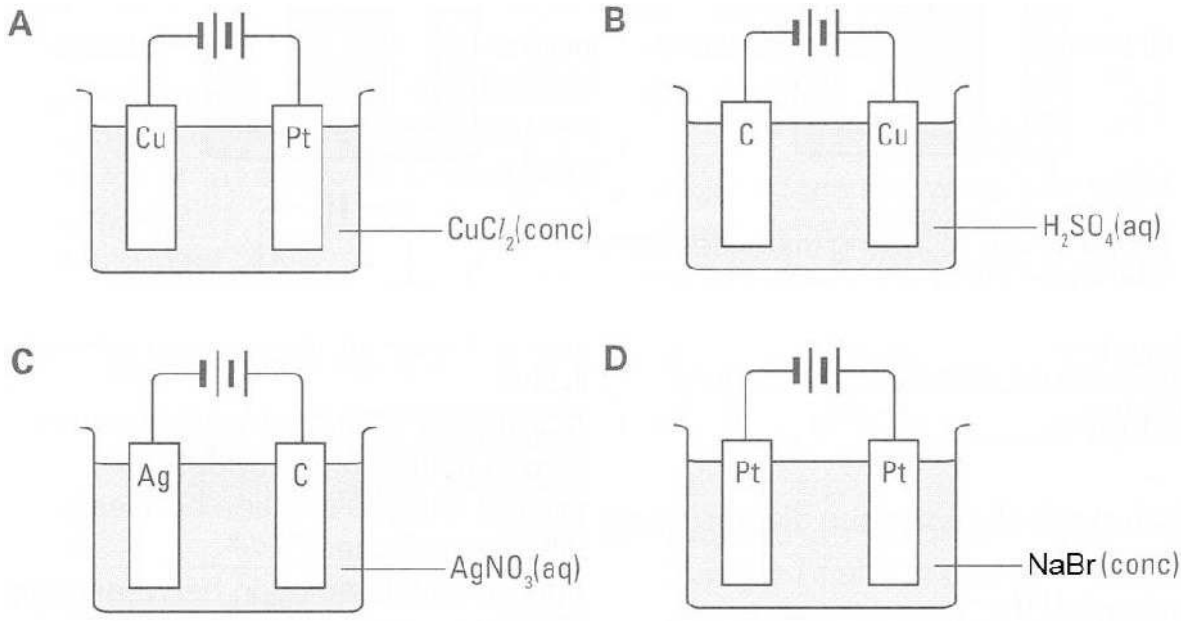
35 Four experimental set ups are shown below. Which set up will produce bubbles of colourless, odourless gas around the copper electrode?



36 Four electrolytic cells are shown below. After a short period of time, which set up will the pH of electrolyte decreases the most significantly?



37 Which of the following statements describing naphtha and lubricating oil is true?

A Naphtha is more flammable than lubricating oil.
B Both naphtha and lubricating oil have sharp boiling points.
C Naphtha consists of larger hydrocarbons than lubricating oil.
D Naphtha is obtained below lubricating oil in a fractionating column.

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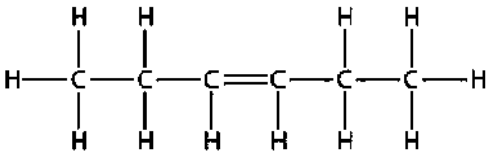
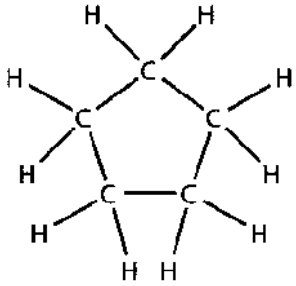
38 The structures of molecules **X** and **Y** are shown below.



Molecule **X**

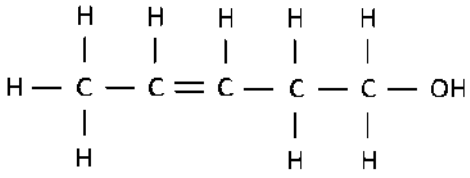


Molecule **Y**

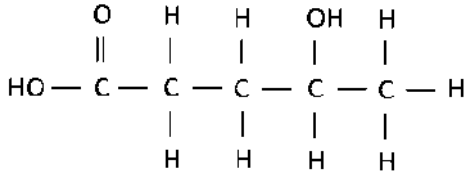
Which of the following statements about the two molecules is true?

A They are isomers of each other.
B They have different empirical formula.
C They have the same percentage composition.
D They are from the same homologous series since their general formula is the same.

39 The labels on the containers of substances **X** and **Y** have been mixed up.



Substance **X**

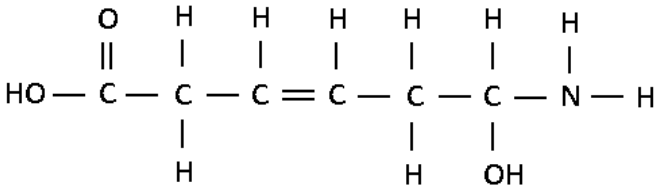


Substance **Y**

Which chemical test can be used to distinguish between substances **X** and **Y**?

A Adding copper metal
B Aqueous sodium carbonate
C Bromine under ultraviolet light
D Warm acidified potassium manganate(VII) solution

40 The diagram below shows an organic molecule.



How many different types of polymer can be formed using the monomer above?

A None
B One
C Two
D Three

End of Paper 1

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Answers to Section A: Circle the most appropriate answer to each question.

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

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_____ ( ) Class:_____

SECONDARY 4 O LEVEL
PRELIMILARY EXAMINATION 2016

CHEMISTRY 5073

Paper 2 **22 August 2016**

1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, register number, and class 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 highlighters, glue, correction fluid or correction tape.

Answer **all** questions.
Write all answers in the answer space provided.
If working is needed for any question it must be shown with the answer.
Give non-exact numerical answers correct to 3 significant figures unless a different level of accuracy is specified in the question.
The use of a scientific calculator is expected, where appropriate.
You are reminded of the need for clear presentation in your answers.

A copy of Periodic Table is provided on page 2.

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

The total number of marks for this paper is 80.

For Examiner's Use	
Section A (50)	
Section B (30)	
Total (80)	

This document consists of **19** printed pages.

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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 following substances have different physical properties as shown below:

Substance	Melting point/ °C	Boiling point/ °C	Solubility in water
W	-114	78	soluble
X	-6	300	insoluble
Y	801	1413	soluble
Z	Sublimes at 338°C		soluble

When these substances are mixed, physical methods of separating them may include:

filtration	sublimation	simple distillation	fractional distillation
chromatography	separating funnel	crystallisation	evaporation to dryness

(a) Select from the above list, the best method(s) by which each of the following mixtures at room temperature may be separated, assuming that the components do not dissolve in each other.

You may use a method once, more than once or not al all.

(i) A mixture of **W** and **X**: _____ [1]

(ii) A mixture of **X** and **Y**: _____ [1]

(iii) A mixture of **Y** and **Z**: _____ [1]

(iv) A mixture of **W**, **X** and **water**: [2]

1. _____

2. _____

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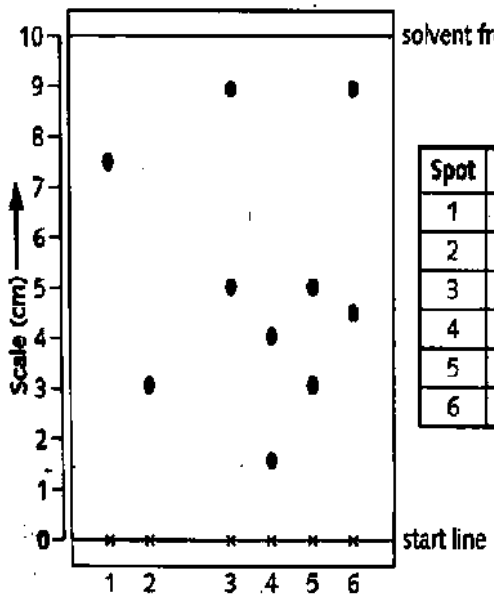
(b) Chromatography is used by 'Horse Racing Forensic Laboratory' to test for the presence of illegal drugs in racehorses.

Concentrated samples of urine from racehorses are spotted onto chromatography paper on the start line. Alongside this, two known illegal drugs such as winstrol and dermorphin are spotted. The chromatogram is run using **methanol** as the solvent. When finished, the chromatogram is analysed by placing under ultra-violet light.

A chromatogram of urine from four racehorses is shown below:



Spot	Description
1	wintstrol
2	demorphin
3	urine sample horse A
4	urine sample horse B
5	urine sample horse C
6	urine sample horse D

(i) Calculate the R_f value of winstrol? [1]

_____

(ii) Will the R_f value of winstrol change if water, instead of methanol, was used as the solvent? Explain your answer. [1]

_____

_____

(iii) State which horse was fed an illegal drug and name the drug used. [1]

_____

(iv) What is the purpose of ultra-violet light, when used to analyse the chromatogram? [1]

_____

[9 Marks]

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A2 Tin is a Group IV element. At room temperature, tin has a silvery white appearance and can conduct electricity. When cooled to low temperatures, the appearance of tin turns grey and the structure of tin transforms into one that resembles diamond.

(a) In terms of bonding and structure, briefly explain why tin can conduct electricity at room temperature. [2]

_____

_____

(b) State whether tin can conduct electricity at low temperatures. Explain your answer using bonding and structure. [2]

_____

_____

_____

(c) **(i)** Silicon is above tin in the Periodic Table. Silicon only has a structure similar to diamond and it reacts with oxygen to form silicon(IV) oxide, which is acidic in nature. [1]

Tin can also react with oxygen to form tin(IV) oxide. The tin(IV) oxide formed can undergo two reactions as shown below:

SnO_2 (s) + 2NaOH (aq) + $2H_2O$ (l) → $Na_2[Sn(OH)_6]$ (aq)
SnO_2 (s) + $2H_2SO_4$ (aq) → $Sn(SO_4)_2$ (aq) + $2H_2O$ (l)

Suggest the nature of tin(IV) oxide.

_____

(ii) Hence, describe the trend of one chemical property for Group IV elements down the group. [1]

_____

_____

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(d) Describe the procedures required to obtain pure, dry silicon(IV) oxide from a mixture of silicon(IV) oxide and tin(IV) oxide. [3]

_____

_____

_____

_____

[9 Marks]

A3 The strength of an acid can be indicated by its dissociation constant. The larger the dissociation constant value, the stronger the acid. The dissociation constant for some acids are given below.

Type of Acid	Acid	Dissociation constant, K_a
Inorganic	Hydrochloric acid, HCl	1.3×10^{6}
	Nitric acid, HNO_3	2.5×10^{1}
Organic	Methanoic acid, HCOOH	1.8×10^{-4}
	Ethanoic acid, CH_3COOH	1.75×10^{-5}
	Propanoic acid C_2H_5COOH	1.34×10^{-5}
	Oxalic acid, HOOCCOOH	5.9×10^{-2}

(a) (i) Using the table above, compare and comment on the general difference in the dissociation constants of organic and inorganic acids. Explain the difference in values with reference to the extent of dissociation. [2]

_____

_____

(ii) Referring to the K_a values of methanoic acid, ethanoic acid and propanoic acid, describe the trend in strength within the carboxylic acid homologous series. [2]

_____

_____

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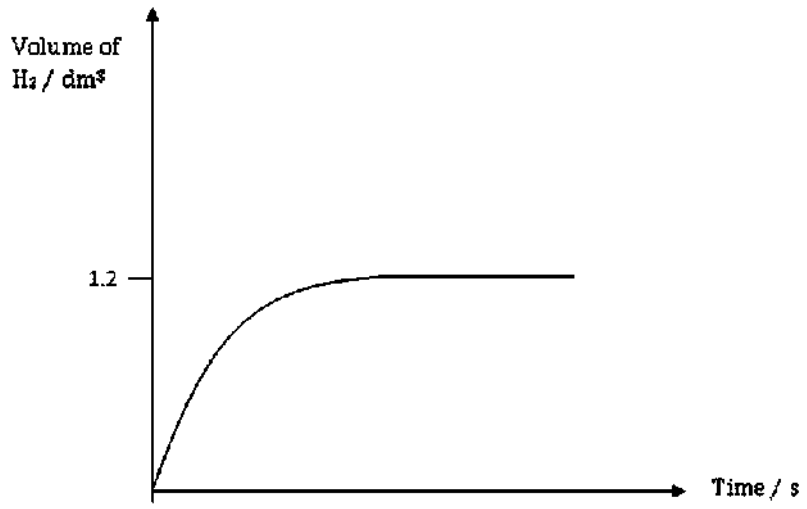
(b) Excess magnesium was added to 100 cm^3 of 1 mol/dm^3 aqueous methanoic acid. The time taken for the metal to produce hydrogen gas was measured and a graph was plotted as shown below.



This experiment was then repeated using different dilute acids, but **keeping all the other conditions the same.**

(i) On the same diagram, sketch a graph of the reaction when propanoic acid is used. Label this graph as **A**. [2]

(ii) On the same diagram, sketch another graph of the reaction using nitric acid. Label this graph as **B**. [2]

(iii) On the same diagram, sketch another graph of the reaction using oxalic acid. Label this graph as **C**. [2]

(iv) Another student carried out the experiment with magnesium and oxalic acid dissolved in methylbenzene. Write down the observation. Explain your answer. [2]

_____

_____

[12 Marks]

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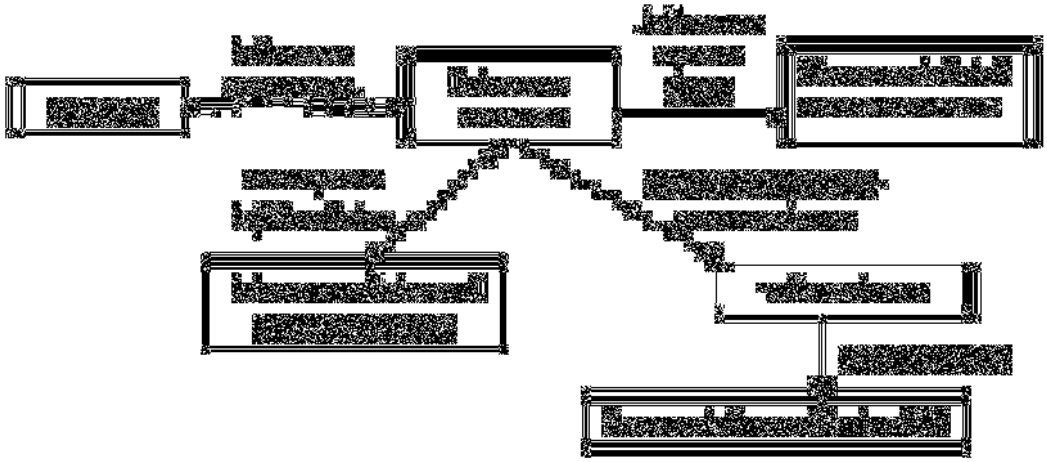
A4 **a** The flow chart below shows a series of chemical tests involving substances **A** to **E**.



Give the chemical formula of substances **A** to **E**. [5]

A: **B**: **C**:

D: **E**:

b Write down the ionic equation for the formation of precipitate **C.** [1]

_____

[6 Marks]

A5 **a** When 3.10 g of copper(II) carbonate is added to 100 cm^3 of 49.0 g/dm^3 dilute sulfuric acid, calculate the maximum volume of carbon dioxide that can be produced, measured at room temperature and pressure. [2]

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b If only 400 cm^3 of carbon dioxide is obtained from the reaction in part **a**, what is the percentage yield of the reaction? [1]

c Using the collision theory, explain how an increase in temperature will affect the rate of reaction in part **a**. [2]

_____

_____

_____

[5 Marks]

A6 **a** Pure titanium is extracted from its ore, rutile - TiO_2.
Rutile is first reacted with chlorine at 1000°C to produce titanium(IV) chloride and oxygen gas. The titanium(IV) chloride formed is then cooled and collected.

(i) Construct the chemical equation for the reaction above. [1]

_____

(ii) Which is the oxidizing agent in the reaction above? Explain your answer using oxidation states. [2]

_____

_____

_____

b Titanium(IV) chloride is then reacted with magnesium at 1100°C in a sealed reactor which is filled with argon gas. Titanium is then obtained at the end.

(i) Name the type of reaction that occurred in part **b**. [1]

_____

(ii) Other than magnesium, suggest another metal which could be used in part **b**. [1]

_____

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(iii) Why is argon gas used to fill the sealed container instead of air? [2]

_____

_____

_____

c Aluminium can also be added into titanium to form an alloy to increase the overall strength of the metals.
In terms of structure, explain how the addition of aluminium strengthens titanium. [2]

_____

_____

[9 Marks]

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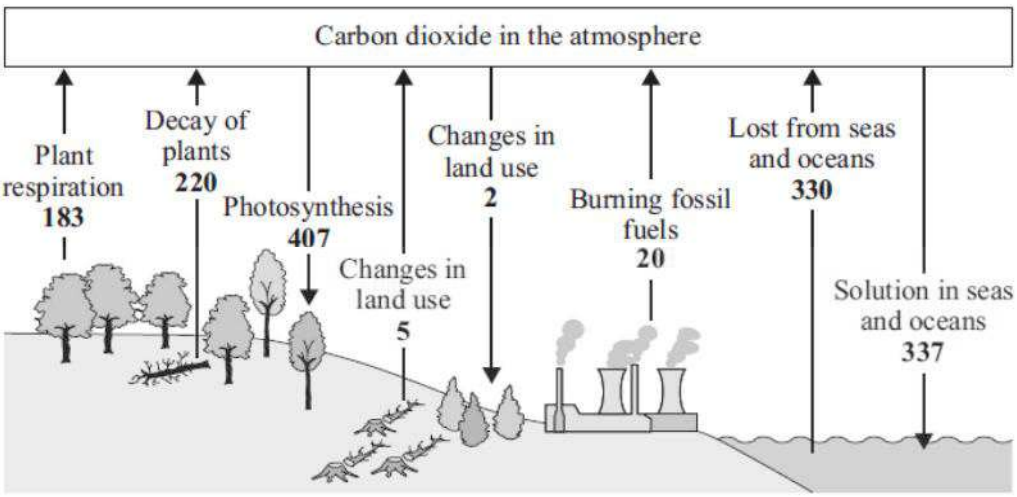
Section B

Answer all the **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 Below shows a schematic diagram of the carbon cycle. The diagram contains environmental features such as plants, factories and oceans which contribute to the removal and release of carbon dioxide to the atmosphere. The amount of carbon dioxide removed or released are represented by numerical values on the diagram. The changes are measured in **billions of tonnes of carbon dioxide per year**.



(a) **(i)** Sources of carbon dioxide contributors are not only limited to the features shown above. Suggest another source of carbon dioxide emission which is **not included** in the carbon cycle diagram. [1]

_____

(ii) A carbon sink is an environmental feature that has a tendency to trap and store large amounts of carbon.

From the numerical data above, identify an environmental feature that is the most effective carbon sink **on land**. Explain your answer using values from the diagram. [2]

_____

_____

_____

(iii) Write a chemical equation to show how the environmental feature in part **(a)(ii)** trap and store carbon. [1]

_____

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(b) Ocean acidification is one of the top environmental issues today. Ocean acidification refers to a decrease in the pH of the ocean over an extended period of time.

(i) Using numerical data from the carbon cycle diagram, explain how oceans are being acidified. [2]

_____

_____

_____

(ii) The burning of fossil fuels such as coal also releases another gas that contributes to ocean acidification. Name this gas. [1]

_____

(iii) What chemical can be used by factories to remove the gas in **(b)(ii)**? [1]

_____

(iv) Write the chemical equation for the reaction in **(b)(iii)**. [1]

_____

(c) Many marine organisms produce calcium carbonate structures and use them as a form of shelter. Suggest how ocean acidification will affect these organisms. [1]

_____

[10 Marks]

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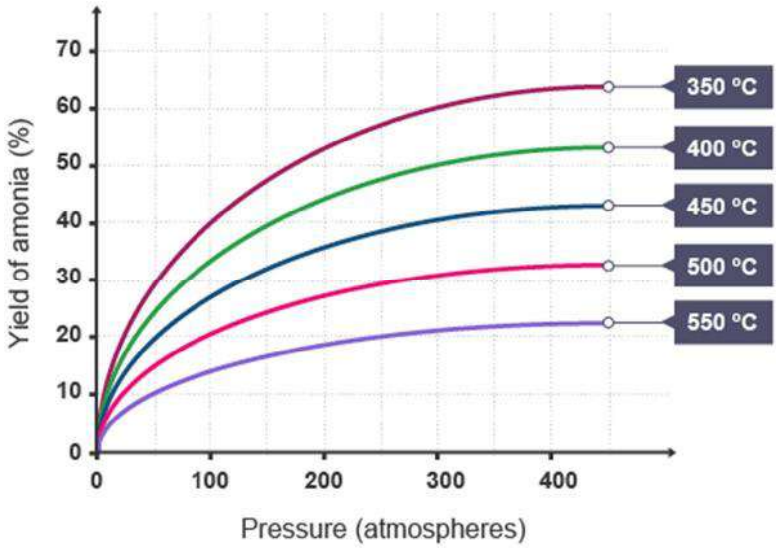
B8 The Haber process produces ammonia from the reaction between nitrogen and hydrogen.

It be carried out at various temperature and pressure to obtain different yields of ammonia as shown in the graph below.



(a) From the graph, describe the relationship between temperature, pressure and the yield of ammonia. [2]

_____

_____

(b) **(i)** Calculate the enthalpy change for the Haber process using the bond energies given below. [2]

Type of bond	Bond energy (kJ/mol)
H-H	432
N-H	391
N-N	160
N=N	418
N≡N	941

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(ii) From the answer in **b(i)**, explain why the reaction is exothermic or endothermic in terms of bond breaking and bond formation. [2]

_____

_____

(c) **(i)** State the conditions commonly used by industries to carry out the Haber process. [1]

_____

(ii) With the aid of a labelled energy profile diagram, explain how a catalyst affects the rate reaction in the Haber process. [3]

_____

_____

_____

[10 Marks]

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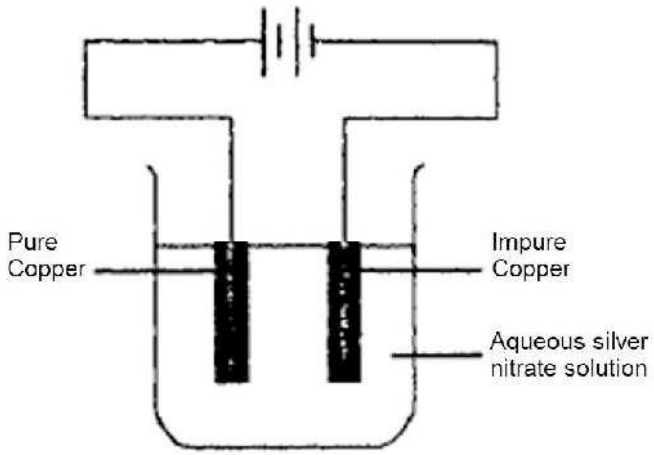
EITHER

B9 Copper extracted from the blast furnace can be further purified or refined using electrolysis. A student tried to carry out this process and set up an experiment as shown below.



(a) **(i)** The student failed to extract copper from the impure copper. State two changes that have to be made to the set up above for the purification process to be carried out properly. [2]

_____

_____

(ii) If the anode in the **student's set-up** is changed to graphite, what will be observed at the anode and what happens to the pH of the electrolyte after some time? [2]

_____

_____

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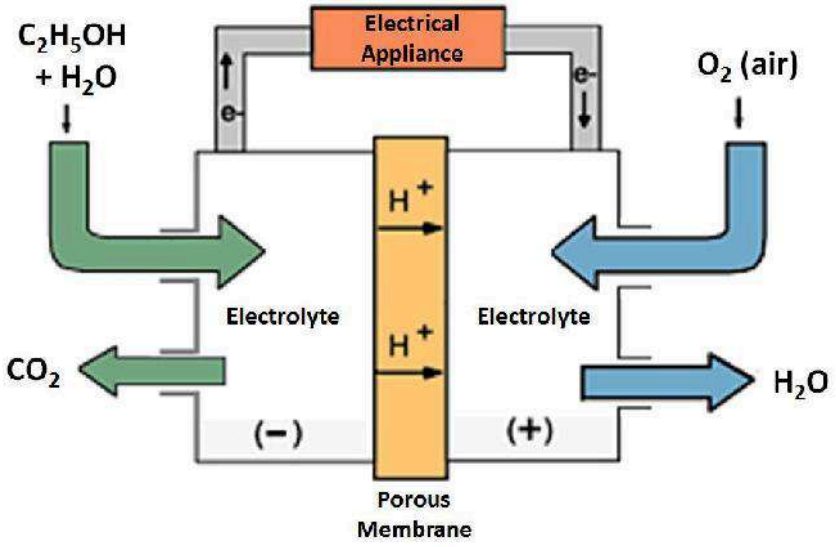
(b) There are various forms of cells that can be used to generate electricity. Below shows the schematic diagram of a direct ethanol fuel cell (DEFC):



The half equation at the anode is:
$C_2H_5OH + 3H_2O \rightarrow 12H^+ + 12e^- + 2CO_2$

The half equation at the cathode is:
$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$

(i) Construct the overall equation for the reaction occurring in a DEFC. [2]

_____

(ii) If 4.00 moles of electrons flow through the electrical appliance, what is the maximum volume of carbon dioxide gas, at room temperature and pressure, that can be produced by the DEFC? [2]

(c) Hydrogen can also be used in a fuel cell, state one advantage and one disadvantage of using hydrogen instead of ethanol in a fuel cell. [2]

_____

_____

_____

[10 Marks]

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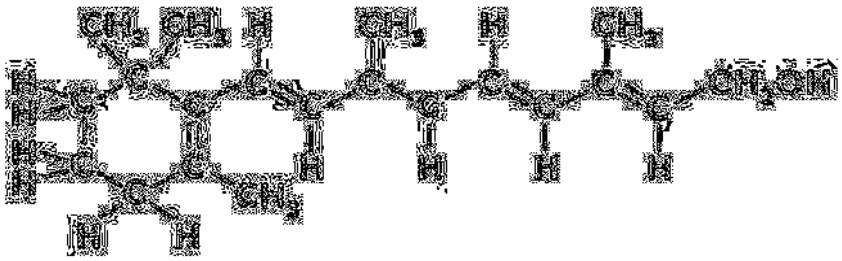
OR

B9 Vitamin A, also known as retinol, is important for eye health and vision. Retinol has the following structure:



(a) **(i)** How many moles of aqueous I_2 can react completely with 1 mol of Vitamin A in the dark? [1]

_____

(ii) Vitamin A (Retinol) is oxidized in the body to form retinoic acid, which helps to maintain skin health and bone growth.

Describe a chemical test that could be used to distinguish retinol from retinoic acid. State the corresponding observations. [2]

_____

_____

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(b) Organic compound **P** has the general formula C_nH_{2n}. It can undergo a series of chemical reaction to form compound **Z** as shown in the chart below. [7]

(i) Identify and draw the full structural formulae of compounds **P**, **Q**, and **R**. [3]

P:

Q:

R:

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(ii) What is reagent **A**? [1]

_____

(iii) If compound **S** and compound **X** can react together to form a sweet smelling liquid, what is the name of reagent **B**? [1]

_____

(iv) What is the name of the sweet smelling liquid formed from compound **S** and compound **X**? [1]

_____

(v) Using information from the flow chart, write down the structural formula of compound **Y**. [1]

_____

[10 Marks]

End of Paper 2

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Mark scheme for Sec 4 Prelim 2016 Paper 2

Section A (50 marks)

A1	**ai**	Separating funnel
	aii	Filtration
	aiii	Sublimation
	aiv	1. Separating funnel, 2. Fractional distillation
	bi	0.75
	bii	Yes, **X** has different solubility in different solvents,
	biii	Horse C / Horse 5 Dermorphin / Demorphin
	biv	To make the spots visible/seen. OR reveal/locate or identify the position of the spots.
A2	**a**	Tin has giant metallic structure/has metallic bonds. consists of cations in a sea of delocalized electrons The electrons are mobile
	b	Each tin atom uses all 4 of its valence electrons / all valence electrons used for covalent bonds/bonding no mobile electrons to conduct electricity
	ci	Amphoteric
	cii	Down group IV, the elements become more metallic in character. Down group IV, the elements turn from non-metal to metal. Down group IV, the elements reducing property increases. Down group IV, the oxides formed turn from acidic to amphoteric. Down group IV, the oxides formed become more basic.
	d	Add excess Aq or dilute nitric acid/sulfuric acid/hydrochloric Filter the mixture to obtain the residue Wash the residue with distilled water (if wash with wrong solution, do not award) Dry between sheets of filter paper
A3	**ai**	Inorganic acids have larger dissociation constants than organic acids. OR Organic acids have K_a values that are less than 1 [0.5] Inorgannic acids have K_a values that are more than 1 [0.5] Inorganic/strong acids dissociates completely

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		Organic/weak acids dissociates partially
	aii	As the number of C atoms increases within the series or down the series the acids become weaker / strength decreases. Because K_a value decreases
	bi	Gentler initial slope, volume of H_2 at 1.2 dm^3
	bii	Steeper initial slope, volume of H_2 at 1.2 dm^3
	biii	Steeper initial slope than methanoic acid but gentler than initial slope of nitric acid, max volume of H_2 at 2.4 dm^3
	biv	No visible change/no gas evolved/no effervescence (no reaction not accepted) Oxalic acid does not ionize in methylbenzene OR only ionizes in water to form mobile H^+ ions Hence it does not display acidic properties / does not behave like an acid
A4	**a**	**A**: HCl **B**: $FeCl_2$ **C**: $Fe(OH)_2$ **D**: AgCl **E**: I_2
	b	$Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2$
A5	**a**	No of mol of $CuCO_3$ = 3.1 / 124 = 0.0250 mol No of mol of H_2SO_4 = 49/98 x 0.100 = 0.0500 mol $CuCO_3$ is the limiting reagent No of mol of carbon dioxide formed = 0.0250 mol Volume of carbon dioxide formed = 0.6 dm^3
	b	% yield = 0.4/0.6 x 100% = 66.7%
	c	Particles will have more kinetic energy, Proportion of particles with energy equal to or more than E_a increases. Greater frequency of collisions Greater frequency of effective collisions Faster rate of reaction
A6	**ai**	$TiO_2 + 2Cl_2 \rightarrow TiCl_4 + O_2$
	aii	Cl_2 is the oxidising agent. The oxidation state of chlorine decreased from 0 in Cl_2 to -1 in $TiCl_4$. Therefore, Cl_2 is reduced.
	bi	Displacement / Redox
	bii	Any metal above Mg in the reactivity series
	biii	Argon is a noble gas/noble gas configuration. It is inert (unreactive not accepted)

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		Prevents Ti from oxidizing back into TiO_2 OR Prevents Ti from reacting with air or O_2 OR Prevents the more reactive metal from reacting with air or O_2
	c	Different sized atoms Disrupts the regular arrangement Layers unable to slide over each other ("layers" must be included)

Section B (30 marks)

B7	**ai**	Any 1 of the following: Combustion of fuel in cars/aircrafts Animal Respiration Decay of dead animals
	aii	Plants take in 407 but give out 183 and 220 billions of tonnes. OR Overall, plants absorb 4 (award 0m only if ans is 224) billions of tonnes.
	aiii	$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ If $6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6O_2 + 12H_2O$, minus 1/2m (not balanced)
	bi	Oceans take in 337 but only give out 330 billions of tonnes. OR Overall, oceans absorb 7 billions of tonnes. Carbon dioxide is acidic / form carbonic acid
	bii	Sulfur dioxide
	biii	CaO, $Ca(OH)_2$, $CaCO_3$
	biv	$CaCO_3 + SO_2 \rightarrow CaSO_3 + CO_2$ OR $CaO + SO_2 \rightarrow CaSO_3$ OR $CaCO_3 + H_2SO_3 \rightarrow CaSO_3 + CO_2 + H_2O$ OR $Ca(OH)_2 + SO_2 \rightarrow CaSO_3 + H_2O$
	c	Acids can react with/corrode/remove/destroy the carbonate structures

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B8	**a**	The <u>higher the temperature</u>, the <u>lower the yield</u> The <u>higher the pressure</u>, the <u>higher the yield</u>
	bi	941 + 3(432) OR (+2237) -6(391) = OR (-2346) -109 kJ/mol
	bii	The <u>energy absorbed</u> to <u>break bonds</u> (used or required = 0m) Is <u>less</u> than the <u>energy released</u> to <u>form bonds</u> (used or required = 0m) Hence, energy is given out to the surroundings/ the reaction is exothermic OR hence ΔH is negative
	ci	Iron, 400°C, 200 atm
	cii	Correctly labelled axis Correctly drawn and labelled reactants and products Correctly drawn and labelled E_a (catalyzed) and E_a (uncatalysed) Correctly drawn curves (2 curves) Provides an alternative pathway With lower activation energy
B9 Either	**ai**	Switch the polarity of the battery OR swap the positions of the electrodes Change the electrolyte to aqueous copper(II) nitrate/chloride/sulfate
	aii	<u>Effervescence</u> is observed. pH of the electrolyte <u>decreases/</u> become <u>more acidic</u>
	bi	$C_2H_5OH + 3H_2O \rightarrow 12H^+ + 12e^- + 2CO_2$ $3O_2 + 12H^+ + 12e^- \rightarrow 6H_2O$ $C_2H_5OH + 3H_2O + 3O_2 \rightarrow 2CO_2 + 6H_2O$ $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$
	bii	Max no of mol of CO_2 formed = 4 / 12 x 2 = 0.6667 mol Max vol of CO_2 formed = 0.6667 x 24 = 16.0 dm^3
	c	The only product of the hydrogen fuel cell is <u>water</u> Ethanol fuel cell <u>produces CO_2</u> <u>Hydrogen gas needs to be liquefied</u>
B9 OR	**ai**	4 mol
	aii	<u>Warm and acidified</u> <u>potassium manganate (VII) solution</u> will turn from <u>purple</u> to <u>colourless</u> when added to <u>retinol</u> <u>Effervescence</u> OR colourless gas <u>Water</u> when a reactive metal (must state the metal eg <u>Zn, Mg, etc</u>)

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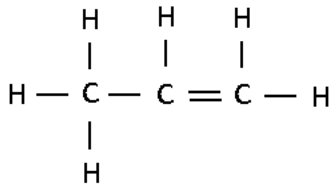
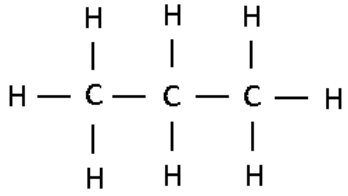
		OR aqueous sodium carbonate is added to retinoic acid.

bi

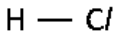
P:



Q:



R:



	bii	Hydrogen gas or H_2
	biii	Acidified Aqueous potassium manganate(VII)
	biv	Propyl propanoate
	bv	$CH_3CH_2NH_2$ OR $C_2H_5NH_2$

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Name:		Index Number:		Class:	

CATHOLIC HIGH SCHOOL
Preliminary Examination 3
Secondary 4

CHEMISTRY 5073/01

Paper 1 Multiple Choice

19 September 2016

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, pencil clips, glue or correction fluid.
Write your name, index number and class on the Answer Sheet in the spaces provided.

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 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 in this booklet.
A copy of the Periodic Table is given on page **19**.
The use of an approved scientific calculator is expected, where appropriate.

For examiner's use only:

Paper 1	/ 40
Total	**/ 40**

This document consists of **19** printed pages and **1** blank page.

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1. Hydrogen chloride gas is very soluble in water, whereas chlorine gas is only slightly soluble in water. Which diagram below shows the correct method to obtain dry chlorine gas from damp chlorine gas containing a small amount of hydrogen chloride gas?

A

B

C

D

2. **J**, **K**, **L**, **M** and **N** are five different mixtures of amino acids.
The diagram shows a chromatogram of these five different mixtures.

A protein is made up of all the amino acids found in these five mixtures. How many different amino acids are present in the protein?

A 0
B 4
C 5
D 12

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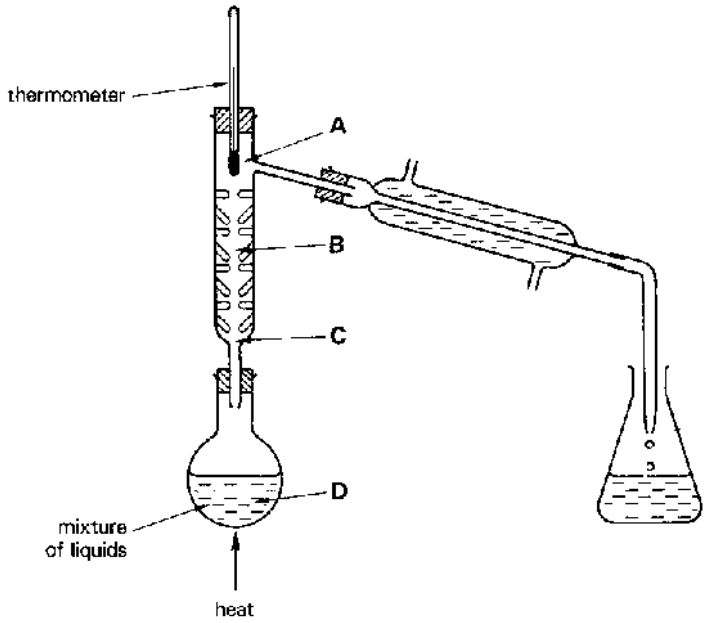
3. A mixture containing equal volumes of hexane (boiling point, 68°C) and heptane (boiling point, 98°C) is separated using the apparatus shown below.



When the temperature first shows a steady reading, at which labelled point will there be a highest proportion of hexane?

4. Solid samples of ammonium chloride, lead(II) chloride and potassium chloride were accidentally mixed together. Which of the following outline the best method to obtain the pure dry sample for each substance?

A dissolving, filtration, sublimation, crystallisation
B dissolving, filtration, sublimation, evaporation
C sublimation, dissolving, filtration, crystallisation
D sublimation, dissolving, filtration, evaporation

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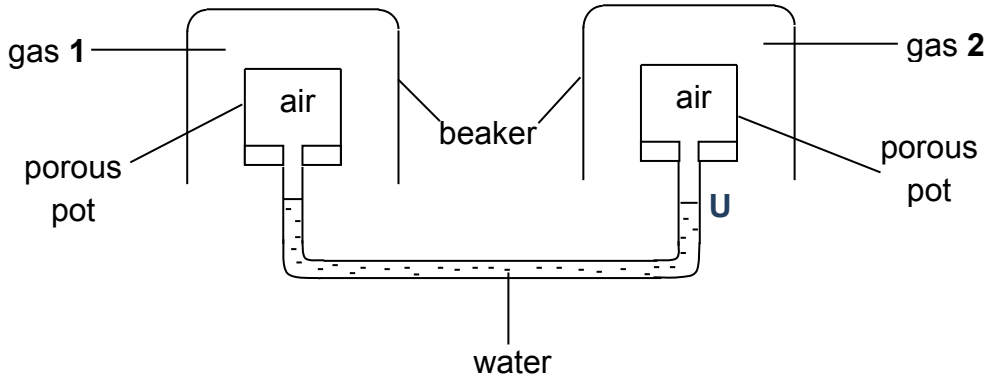
5. The apparatus is set up, using different gases in the two inverted beakers.



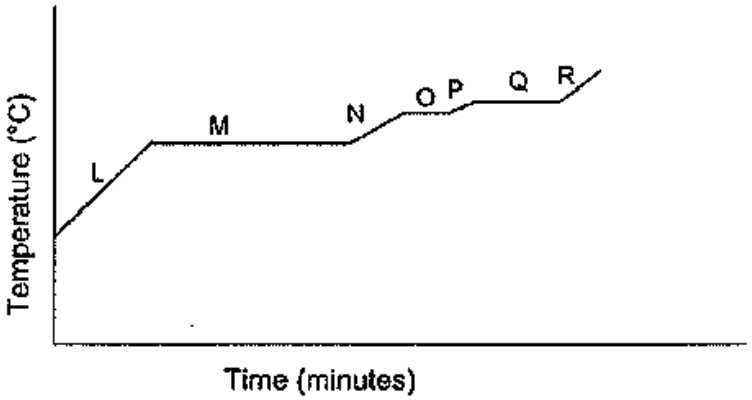
Which pair of gases would cause an upward movement of the water level at **U**?

	gas **1**	gas **2**
A	N_2	F_2
B	N_2	H_2
C	Cl_2	F_2
D	Cl_2	H_2

6. The three main components of liquid air are nitrogen, oxygen and argon. Their respective boiling points are:

Nitrogen -196°C
Oxygen -183°C
Argon -186°C

Liquid air can be separated into its three main components by fractional distillation. The graph shows the temperature of a liquid air mixture as it is heated.



In section **N** of the graph, the mixture remaining consists of

A liquid oxygen only.
B liquid nitrogen only.
C liquid argon and oxygen only.
D liquid argon and nitrogen only.

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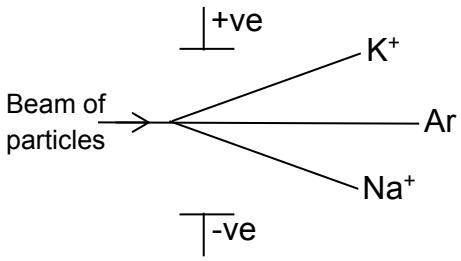
7. When chocolate is heated, it softens and melts over a range of temperatures. Which statement explains this behaviour of chocolate?

A It is a mixture.
B It is a macromolecule.
C It expands before melting.
D It forms other substances when heated.

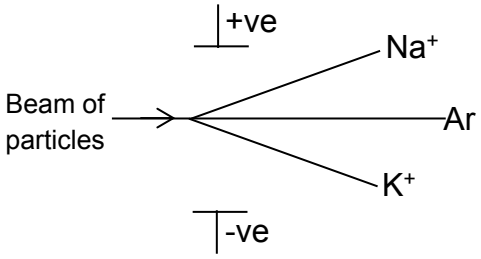
8. A beam of particles contains Na^+, K^+ and Ar. The beam is passed between charged plates.

Which diagram shows how the particles are affected by the plates?

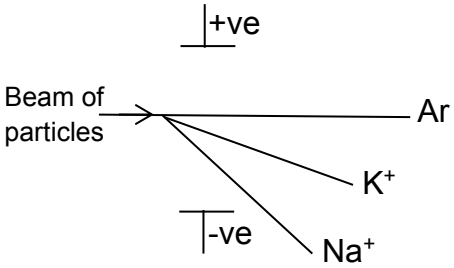
A



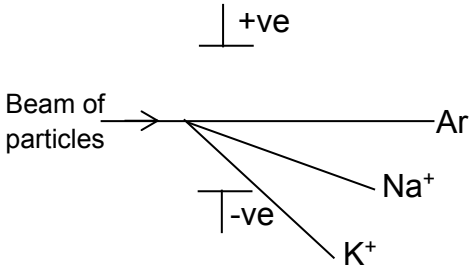
B



C



D



9. An element **Q** has **x** neutrons and **y** protons. Which of the following symbol can be used to represent the ion of **Q** if it belongs to group VI?

A $^{x+y}_{y}\mathbf{Q}^{2+}$

B $^{x}_{y}\mathbf{Q}^{2+}$

C $^{x+y}_{y}\mathbf{Q}^{2-}$

D $^{x}_{y}\mathbf{Q}^{2-}$

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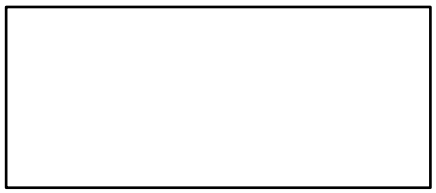
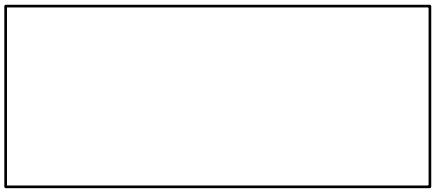
10. Which of the following diagrams correctly represent a mixture of element(s) and compound(s)?

A

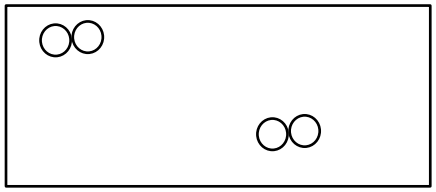
B



C



D



11. Which of the following correctly shows the colour change when sulfur dioxide is bubbled into acidified KI and acidified $KMnO_4$?

	effect on KI	effect on $KMnO_4$
A	remains colourless	changes from purple to colourless
B	remains colourless	changes from colourless to purple
C	changes from colourless to brown	changes from purple to colourless
D	changes from brown to colourless	changes from colourless to purple

12. Ethanoyl chloride has the following structure.

What is the total number of electrons not used for bonding?

A 10
B 14
C 16
D 26

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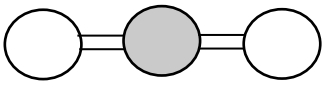
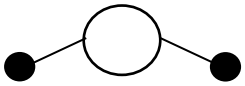
13. Element **C**, **D** and **E** are three consecutive members in the Periodic Table. Given that **C** is in group VII of the Periodic Table, which of the following statement is true for the compound formed between **C** and **E**?

A The compound formed is soluble in ethanol.
B The compound formed has a simple molecular structure.
C The compound formed has a high melting point and boiling point.
D The compound formed can conduct electricity due to mobile electrons.

14. The models and formulae for some molecules are shown below.



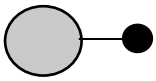
XY_2



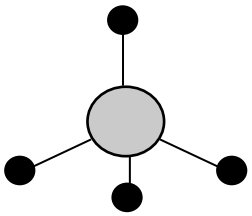
YZ_2

Which is the correct model for a molecule of the compound formed between **X** and **Z**?

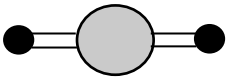
A



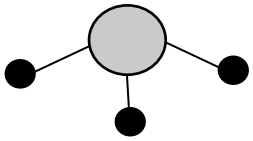
B



C



D



15. **X** is a metal which reacts with cold water and its oxide is stable to heat. Which of the following methods is most suitable to extract **X** from its ores?

A electrolysis of its molten chloride
B reduction of its oxide with carbon
C electrolysis of its aqueous chloride solution
D displacement from its aqueous chloride solution with iron

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16. An oxide has the following properties:

- insoluble in water
- reacts with acids
- does not react with alkalis

Which of the following elements forms an oxide with these properties?

A copper
B sodium
C sulfur
D zinc

17. The table gives information about the solubilities of the hydroxides, carbonates and sulfates of calcium, sodium and zinc.

	hydroxide	carbonate	sulfate
calcium	slightly soluble	insoluble	slightly soluble
sodium	soluble	soluble	soluble
zinc	insoluble	insoluble	soluble

What is the best way of making zinc carbonate?

A Shake solid zinc hydroxide with aqueous sodium hydroxide and pass in carbon dioxide.
B Shake solid zinc sulfate and solid calcium carbonate with water.
C Shake solid zinc sulfate with water and add aqueous sodium carbonate.
D Shake aqueous zinc sulfate with solid calcium hydroxide and pass in carbon dioxide.

18. The labels fell off from two bottles each containing a colourless solution, one of which was aqueous lead(II) nitrate and the other was aqueous aluminium nitrate. Which of the following tests could be used to distinguish between the two solutions?

1 addition of dilute hydrochloric acid
2 addition of aqueous sodium sulfate
3 addition of aqueous potassium iodide
4 addition of aqueous sodium hydroxide

A 1 and 2
B 2 and 3
C 3 and 4
D 1, 2 and 3

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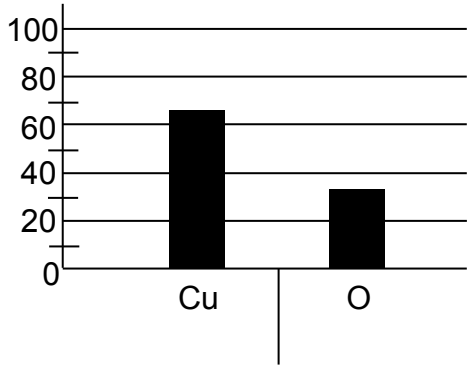
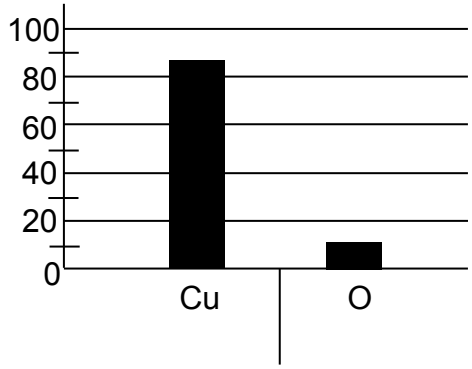
19. A 100g sample of copper oxide was analysed. The results of the analysis are shown in the following graphs.



Percentage proportion of atoms



Percentage proportion by mass

These data suggests that the formula for copper oxide is _____.

A CuO
B Cu_2O
C CuO_2
D Cu_2O_3

20. Which of the following contains the same number of ions as the value of Avogadro's constant?

A 0.25 mol Na_3PO_4
B 0.50 mol CO
C 0.50 mol Cs_2O
D 1.00 mol CaO

21. Which of the following statement(s) correctly describes the information necessary for finding the concentration of an unknown monobasic acid by titration with KOH?

1 The concentration of the base.
2 The volume of acid.
3 The volume of the base used to reach the end-point.

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

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22. The formula of a nitride of element **X** is $\mathbf{X}_3\mathrm{N}_2$.
23.8 g of $\mathbf{X}_3\mathrm{N}_2$ contains 4.5 g of **X**.
How many moles of **X** does 4.5 g of the element contain?

A $\frac{19.3}{14} \times \frac{2}{3}$ **B** $\frac{19.3}{14} \times \frac{3}{2}$

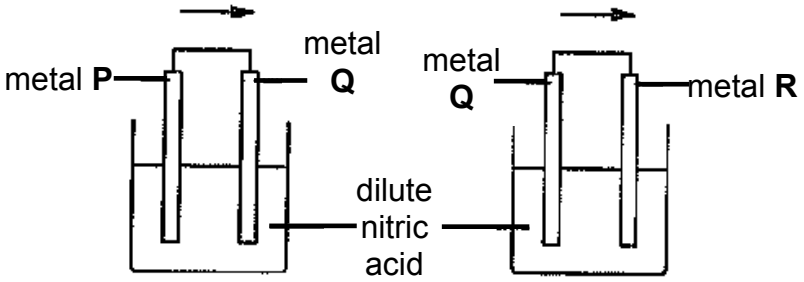
C $\frac{23.8}{14} \times \frac{2}{3}$ **D** $\frac{23.8}{14} \times \frac{3}{2}$

23. In an electrolysis experiment, the same amount of charge deposited 14 g of iron and 6.875 g of manganese. The charge on the iron ion was 2+.
[A_r: Mn, 55; Fe, 56]

What was the charge on the manganese ion?

A 1+
B 2+
C 3+
D 4+

24. Two cells were set up as shown in the diagram. The arrow shows the direction of electron flow in the external circuit.



Which set of metals would give the electron flows in the direction shown?

	metal **P**	metal **Q**	metal **R**
A	Ag	Cu	Zn
B	Ag	Zn	Cu
C	Cu	Zn	Ag
D	Zn	Cu	Ag

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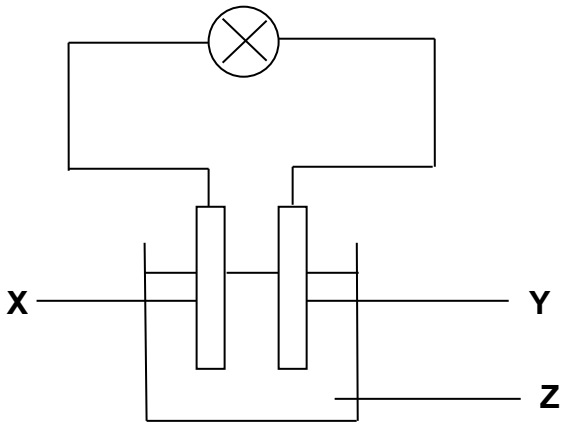
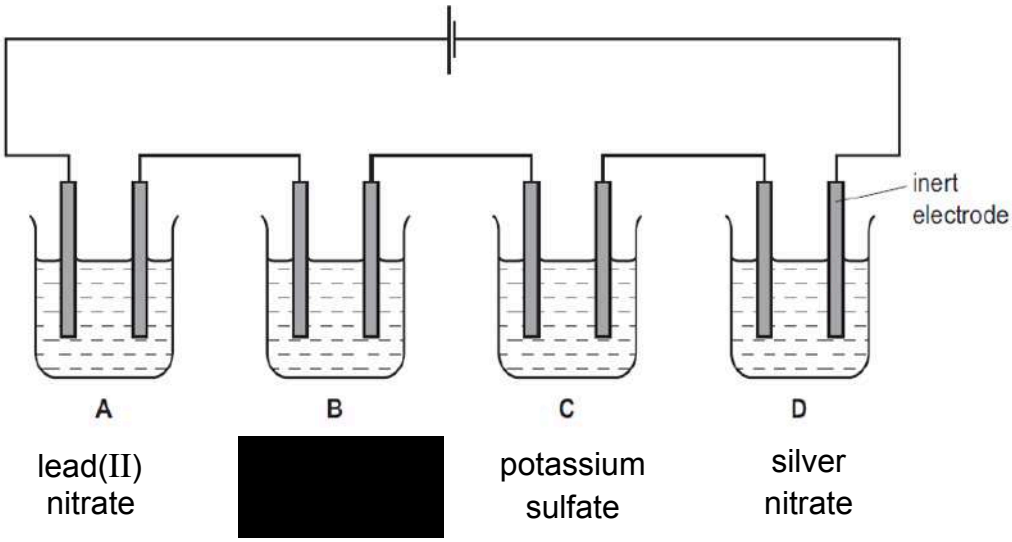
25. A simple cell was set up to light up a bulb, as shown in the diagram.



What should **X**, **Y** and **Z** be for the bulb to light up the brightest?

	X	Y	Z
A	lead	zinc	dilute salt solution
B	lead	iron	dilute sugar solution
C	silver	zinc	dilute salt solution
D	silver	iron	dilute sugar solution

26. When electrolysed using inert electrodes, which dilute solution would produce the greatest increase in mass of the cathode?
[A_r: Pb, 207; Cu, 64; K, 39; Ag, 108]



27. Which substance is **not** an essential raw material in the extraction of iron in a blast furnace?

A air
B coke
C limestone
D sand

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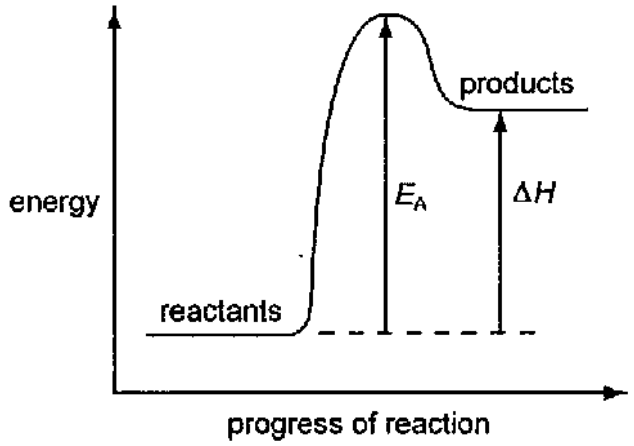
28. Commercially available 'cold packs' and 'heat packs' use reactions to cause a change in temperature.

One type of pack consists of two bags; an inner bag containing water, and an outer bag containing ammonium nitrate. When the inner bag of water is broken by squeezing the package, water that is released dissolves the ammonium nitrate. When this occurs, the temperature of the solution decreases.

Based on the information provided, ammonium nitrate is used in a

A cold pack because it undergoes an exothermic dissolution process.
B cold pack because it undergoes an endothermic dissolution process.
C heat pack because it undergoes an exothermic dissolution process.
D heat pack because it undergoes an endothermic dissolution process.

29. The diagram shows the energy profile for a chemical reaction.



What is the effect of a catalyst on E_A and ΔH?

	E_A	ΔH
A	decreases	decreases
B	decreases	no change
C	no change	decreases
D	decreases	increases

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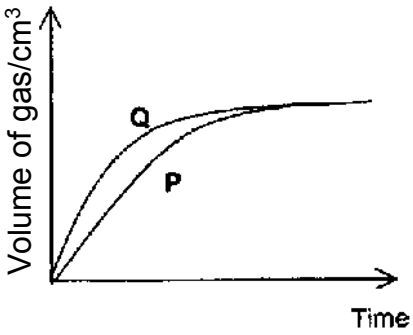
30. The effect of temperature and concentration on the rate of reaction between excess solid zinc carbonate and dilute nitric acid was investigated. The table below shows the conditions used for the two experiments, **P** and **Q**.

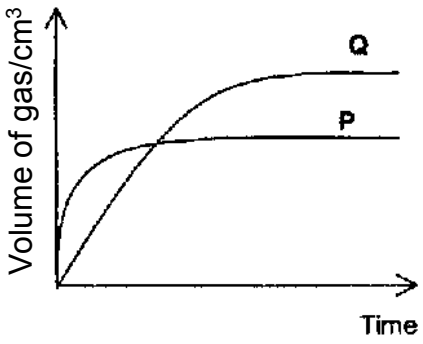
experiment	temperature /^{o}C	concentration of acid /moldm^{-3}	volume of acid used /cm^{3}
P	35	2.00	50
Q	25	1.00	150

The volume of gas given off was plotted against time. Which one of the following graphs shows correctly the results obtained in experiments **P** and **Q**?

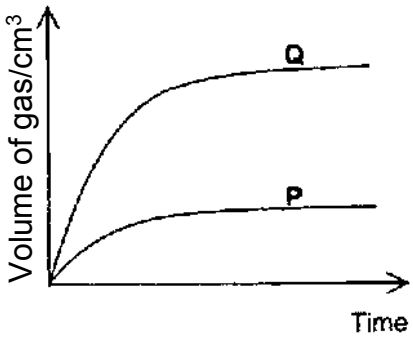
A



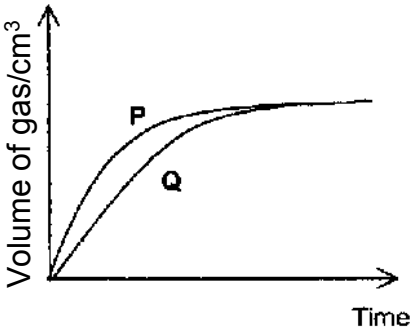
B



C



D



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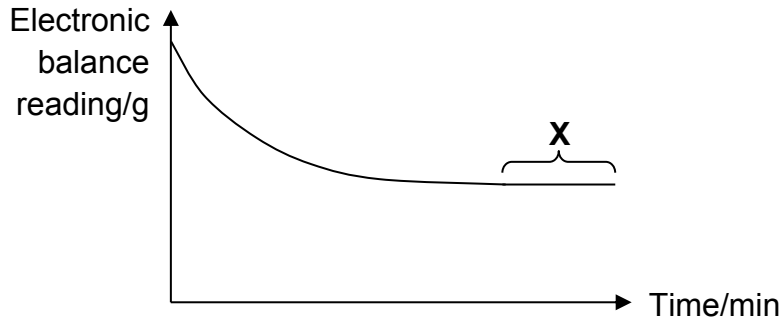
31. A little powdered limestone is added to excess hydrochloric acid in a beaker and the mass is recorded at various times. The graph below shows the result.



Which statement about the section of graph labelled **X** is correct?

A No more gas is being produced.
B Half the limestone has been used up.
C Half the hydrochloric acid has been used up.
D The rate of reaction has reached its maximum.

32. Germanium (Ge) is in the same group of the Periodic Table as carbon and silicon. Which is the correct formula for its chloride, hydride and oxide?

	chloride	hydride	oxide
A	$GeCl$	GeH	GeO
B	$GeCl$	GeH_4	GeO_2
C	$GeCl_4$	GeH	GeO
D	$GeCl_4$	GeH_4	GeO_2

33. Part of the Periodic Table is shown. The letters are not the symbols of the elements.

Period	Group								
	I	II		III	IV	V	VI	VII	0
1									
2	**V**	**W**						**X**	
3	**Y**							**Z**	

Which statement is correct?

A **V** is more reactive than **Y**.
B **W** has more metallic character than **V**.
C **Y** has a lower melting point than **V**.
D **Z** is more reactive than **X**.

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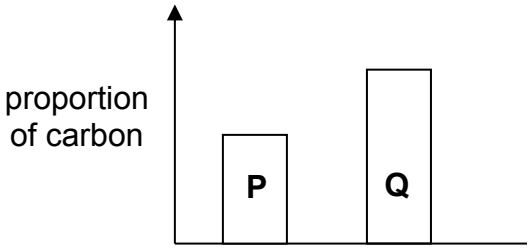
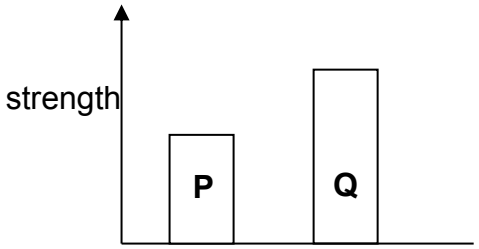
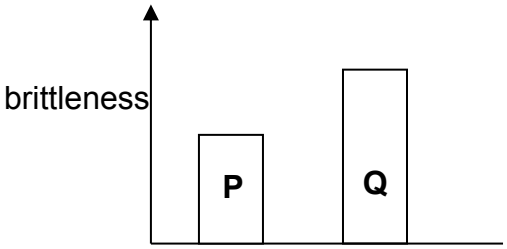
34. The diagram compares the proportion of carbon in two steels, **P** and **Q**.



Which two diagrams correctly compare the strength and brittleness of **P** and **Q**?

A





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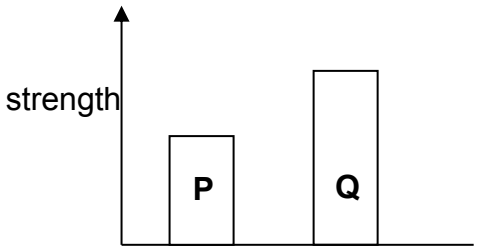

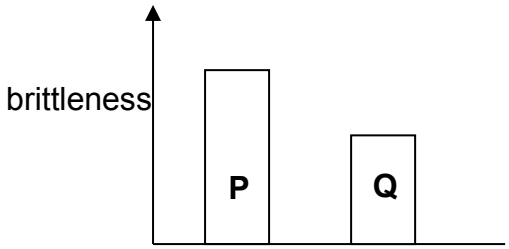

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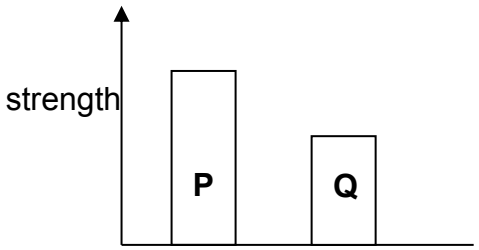
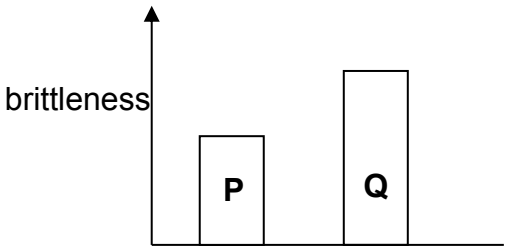
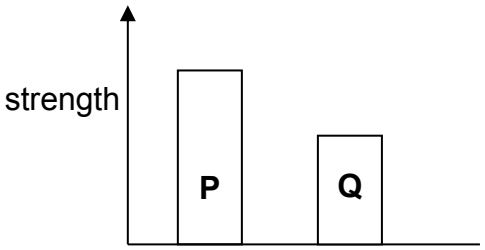
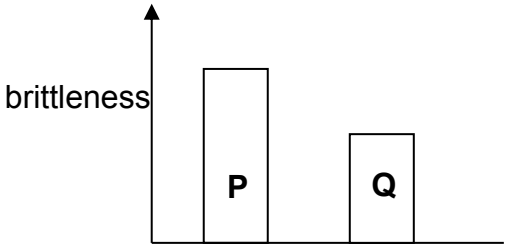




D





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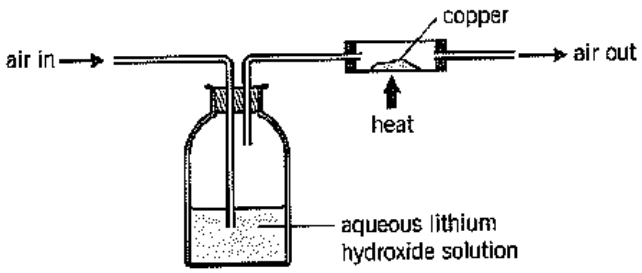
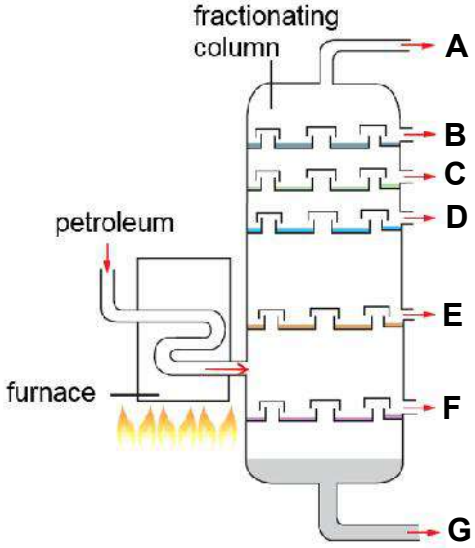
35. A sample of air is slowly passed through aqueous lithium hydroxide and then over heated copper as shown below.



Which substances will **not** be found in the composition of air after passing through this experimental setup?

A oxygen and nitrogen
B oxygen and carbon dioxide
C water vapour and nitrogen
D water vapour and carbon dioxide

36. The diagram shows a fractionating column used for the separation of crude oil.



Which of the following statement is correct?

A **A** burns less easily than **D**.
B **B** has a higher viscosity than **E**.
C **C** has a higher boiling point than **F**.
D **D** is more flammable than **G**.

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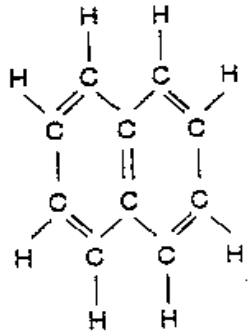
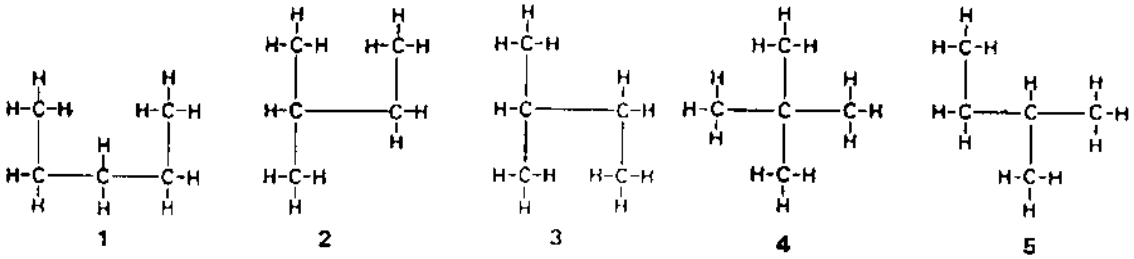
37. Mothballs are small balls of chemical pesticide and deodorant used when storing clothing and other articles susceptible to damage from mould or moth larvae. The main ingredient of traditional mothballs is naphthalene which has the following structure.



Which of the following about naphthalene is likely to be **incorrect**?

A It is an unsaturated hydrocarbon.
B It can be represented by the empirical formula C_5H_4.
C It undergoes complete combustion to form carbon dioxide and water.
D When it boils, the carbon-carbon and carbon-hydrogen bonds are broken.

38. Five structural formulae are shown below.



Which of the compounds are isomers?

A 1 and 4 only
B 4 and 5 only
C 1, 2 and 4 only
D All of the above

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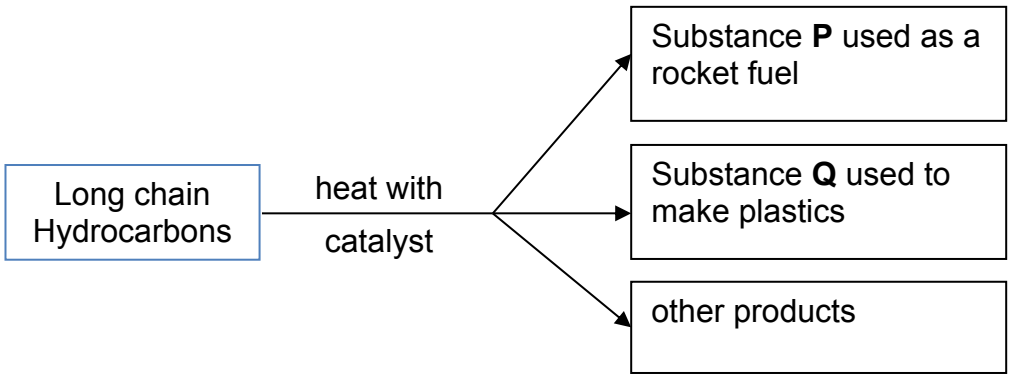
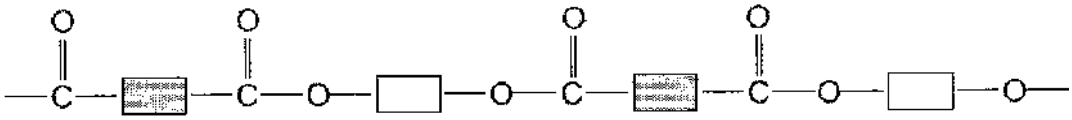
39. The diagram shows how useful products can be obtained by cracking long chain hydrocarbons.



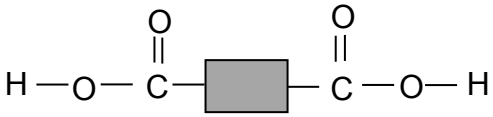
	substance **P**	substance **Q**
A	ethanol	ethane
B	ethanol	ethene
C	hydrogen	ethane
D	hydrogen	ethene

40. Part of a polyester chain is shown below:

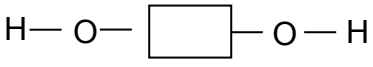


Which compound, when added to the reactants during polymerization, would stop the polymer chain from becoming too long?

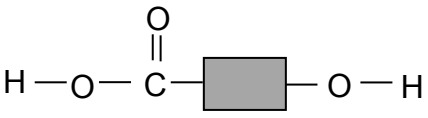
A



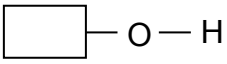
B



C



D



- End of Paper 1 -

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Name:		Index Number:		Class:	

CATHOLIC HIGH SCHOOL
Preliminary Examination 3
Secondary 4

A

CHEMISTRY

5073/02

Paper 2

15 September 2016
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 on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

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

For examiner's use only:

Questions	Marks
A1	/3
A2	/9
A3	/9
A4	/4
A5	/7
A6	/12
A7	/6
Total	/50

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 13.

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

This document consists of **13** printed pages and **1** blank page.

[Turn over]

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Section A

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

A1 The table shows the name of some compounds and their reactions with a few drops of aqueous sodium hydroxide and acidified barium nitrate.

Formula of compound	**Colour of aqueous solution**	**Reaction of aqueous solution with a few drops of**	
		aqueous sodium hydroxide	**acidified barium nitrate**
		blue precipitate	white precipitate
$Fe(NO_3)_2$	pale green		
KI			no precipitate

[3]

Complete the table by filling in the missing blanks above.

[Total: 3]

A2 The manufacture of sulfuric acid is described below.

step 1: Sulfur in burnt in excess air to form sulfur dioxide.

$$S(s) + O_2(g) \rightarrow SO_2(g)$$

step 2: Sulfur dioxide reacts with more oxygen to form sulfur trioxide.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H = -196kJ/mol$$

step 3: Sulfur trioxide is dissolved in concentrated sulfuric acid to form oleum, $H_2S_2O_7$.

$$H_2SO_4(l) + SO_3(g) \rightarrow H_2S_2O_7(l)$$

step 4: Oleum can then react safely with water to produce concentrated sulfuric acid.

$$H_2S_2O_7(l) + H_2O(l) \rightarrow 2H_2SO_4(l)$$

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(a) Is **step 3** a redox reaction? Use ideas about **oxidation states** to explain your answer.

……...

……..

…….. [1]

(b) State one factor which can increase the rate of reaction for **step 1**. Using the idea of collisions between reacting particles, explain how this factor increases the rate of reaction.

……..

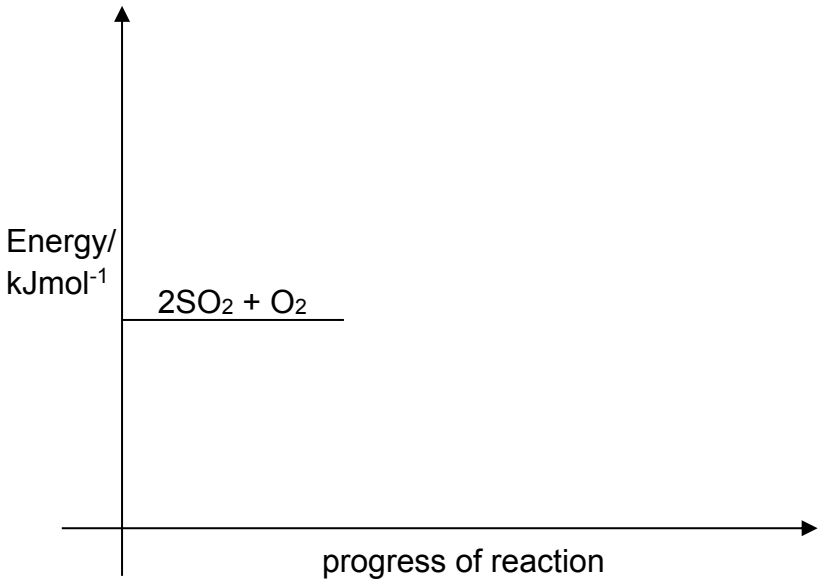
……..

……..

…….. [3]

(c) **(i)** Complete the energy profile diagram below for the reaction of sulfur dioxide and oxygen to produce sulfur trioxide. The activation energy for this reaction is 2200 kJ/mol.

Label clearly the **reaction enthalpy change** and the **activation energy**.



[3]

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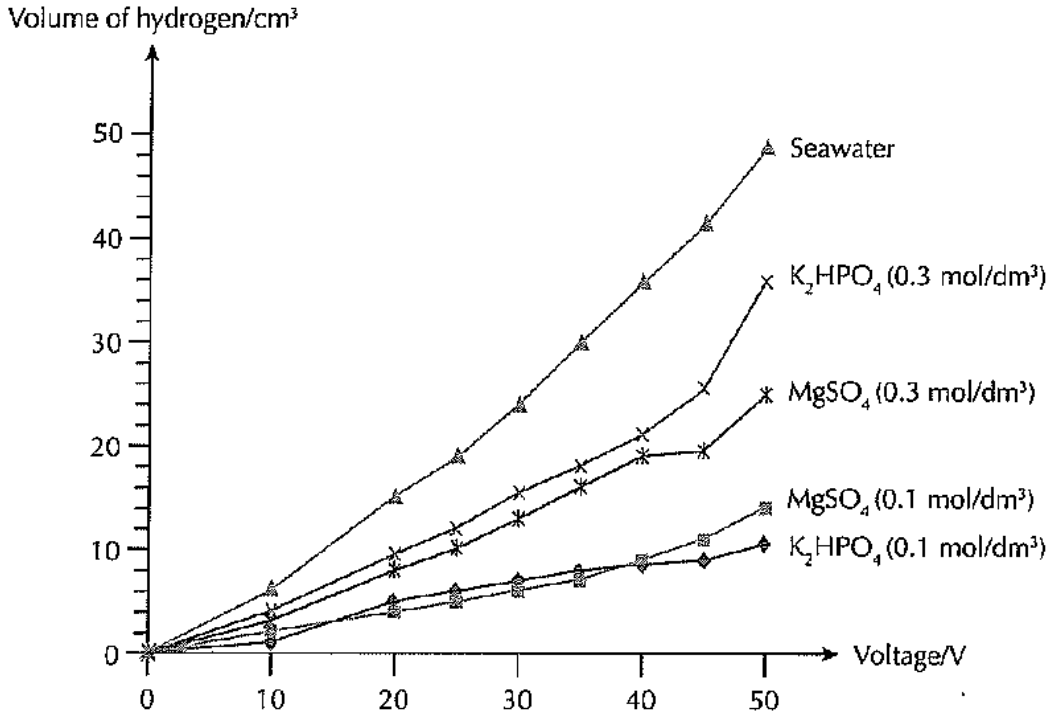
(ii) State the values of the enthalpy change and the activation energy of the reverse reaction.

ΔH = …….kJ/mol

E_a = …….. kJ/mol [2]

[Total: 9]

A3 During the electrolysis of some aqueous salt solutions using inert electrodes, hydrogen gas is produced at the cathode. The graph below shows the volume of hydrogen gas collected in 1 hour at different voltages when different solutions were used.



(a) Using the graph above, state the relationship between the concentration of the solution and the volume of hydrogen gas produced.

……...

……... [1]

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(b) **(i)** Write the half equations for the electrolysis of aqueous magnesium sulfate.

cathode: .....

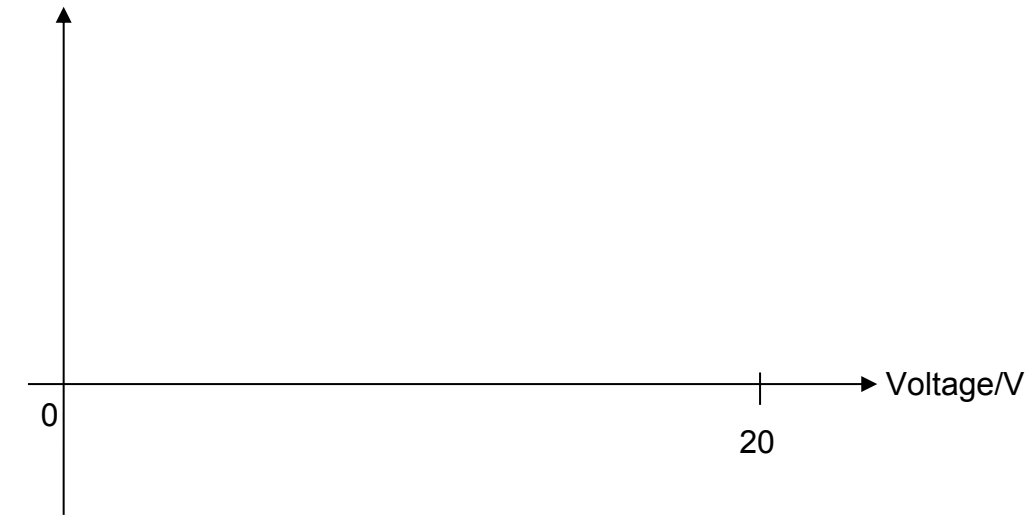
anode: ..... [2]

(ii) Use the information from the graph to calculate the volume of gas formed at the **anode** at room temperature and pressure when the electrolysis was carried out at 40 V using 0.3 mol/dm^3 aqueous magnesium sulfate.

[3]

(c) A student conducted another electrolysis experiment using distilled water at different voltages.

(i) Sketch a graph of the volume of hydrogen against voltage for the electrolysis of distilled water.



[1]

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(ii) Explain your answer in **c(i)**.

……

…… [2]

[Total: 9]

A4 Chlorofluorocarbons (CFCs) are organic compounds that contain only carbon, fluorine and chlorine. When CFC molecules diffuse high up into the atmosphere, they destroy the ozone molecules which are present in the stratosphere, a layer of atmosphere at about 20-50 km above the Earth.

A list of some CFCs in current use and their possible replacements is given.

	formula	code number	potential for destroying the ozone layer (scaled)
compounds in current use	CCl_3F	11	1.00
	CCl_2F_2	12	1.00
possible replacement compounds	$CHClF_2$	22	0.05
	CF_3CCl_2H	123	0.02
	CF_3CH_2F	134a	0.00
	CH_3CCl_2F	141b	0.12
	CH_3CHF_2	152a	0.00

(a) The most common form of CFCs is dichlorodifluoromethane, CCl_2F_2.

(i) CCl_2F_2 can be produced from methane. What type of reaction is used in the production process?

……..…….. [1]

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(ii) Draw a 'dot-and-cross' diagram to show the bonding in a molecule of dichlorodifluoromethane.

You only need to show outer shell electrons.

[2]

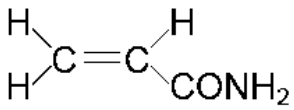
(b) Suggest a reason for the difference in the potential for destroying ozone between compounds 134a and 152a and compounds 22, 123 and 141b.

……..

…… [1]

[Total: 4]

A5 **(a)** Researchers in Europe and the United States have found acrylamide in certain foods that were heated to a temperature above 120 °C. Potato chips and french fries were found to contain higher levels of acrylamide compared to other foods. The World Health Organisation and the Food and Agriculture Organisation of the United Nations stated that the levels of acrylamide in foods pose a risk to human health. Acrylamide has the following structure.



(i) Acrylamide readily polymerises to polyacrylamide. Draw the structural formula of the polymer formed.

[1]

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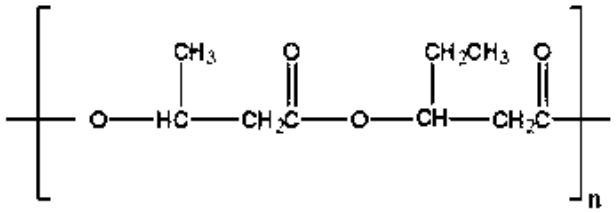
(ii) Foods are commonly stored in food containers. One common polymer used for such purpose is poly(3-hydroxybutyrate-*co*-3-hydroxyvalerate), commonly known as PHBV. It is a type of polyester that is obtained from renewable sources and is biodegradable. The structure of this polymer is shown below.



Draw the structural formulae of the **two** monomers used to make PHBV.

[2]

(iii) Describe two differences between addition and condensation polymerization.

……..……..

……..……..

……..……..

……..…….. [2]

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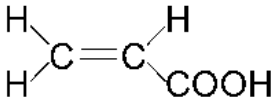
(b) Acrylamide hydrolyses to form acrylic acid. The structural formula of acrylic acid is shown below.



(i) What is observed for the reaction between acrylic acid and aqueous bromine?

……..

…….. [1]

(ii) Write the equation for the above reaction, showing the structural formulae of the organic compounds.

[1]

[Total: 7]

A6 30 cm^3 of 1 mol/dm^3 hydrochloric acid is added to four different test tubes containing substances **A** to **D**. The results are recorded in the table below.

Substance	Appearance of substance	Gas produced	Colour of solution formed
A	green solid	gas formed white precipitate with limewater.	pale blue
B	silvery solid	gas extinguished a lighted splint with a 'pop' sound.	colourless
C	black solid	no gas produced	pale blue
D	reddish brown solid	no visible change	

(a) Suggest the name of substance **A** and write down a balanced chemical equation for the reaction between **A** and dilute hydrochloric acid.

……..……

……..…… [2]

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(b) **(i)** Substance **D** is a metal. State two observations when **B** is added to a chloride solution of **D.**

……

…… [2]

(ii) Use the information in the table to explain why these changes occur.

……

……

…… [2]

(c) Substance **C** is impure copper(II) oxide. The mass of **C** in the test tube is 3 g. To test for the purity of substance **C**, the following is carried out. It is assumed that the impurities do not react with dilute hydrochloric acid.

(i) The excess hydrochloric acid that did not react with **C** was titrated with 1 mol/dm^3 of dilute sodium hydroxide. The average volume of sodium hydroxide required for the titration was 10.00 cm^3. Calculate the number of moles of excess hydrochloric acid and hence, calculate the number of moles of hydrochloric acid that has reacted with substance **C**.

[3]

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(ii) The reaction between copper(II) oxide and hydrochloric acid is given by the equation below.

$$CuO + 2HCl \rightarrow CuCl_2 + H_2O$$

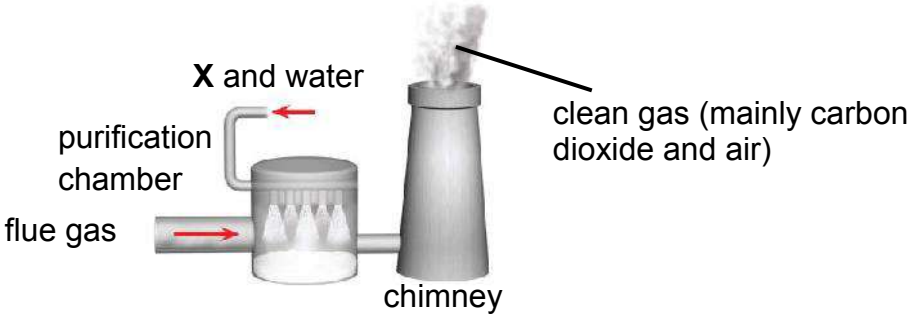
Calculate the percentage purity of **C** in the test tube.

[3]

[Total: 12]

A7 Coal-burning power stations generate large amount of heat from the combustion of coal to convert water into steam which in turn drives turbine generators to produce electricity. Flue gas that is produced contains sulfur dioxide and oxides of nitrogen. These two gases cause acid rain.

Sulfur dioxide can be removed from the flue gas by several methods. One method uses a 'scrubber' that contains wet compound **X**.



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(a) Identify compound **X** that is added to the purification chamber to remove sulfur dioxide and write a chemical equation to represent the reaction between **X** and sulfur dioxide.

……..

…….. [2]

(b) Oxides of nitrogen generally consist of a mixture of nitrogen monoxide and nitrogen dioxide. In flue gas, nitrogen monoxide is the main component in the oxides of nitrogen produced. Explain how nitrogen monoxide cause acid rain even though it is a neutral oxide.

……...

……...

……... [2]

(c) Acid rain impacts farming greatly as it often causes the soil to be overly acidic and results in the leaching of nutrients. In order to alleviate the effects of acid rain, a farmer has been advised to treat the soil to reduce the acidity.

The table below gives the solubility of some calcium compounds.

	calcium hydroxide	**calcium oxide**	**calcium carbonate**
Solubility in water (g per 100ml of water)	0.173	immediately reacts with water on contact to form an alkaline solution	6.17×10^{-4}

Using the information in the table given, suggest why calcium carbonate is less effective at reducing acidity than calcium hydroxide and calcium oxide.

……...

……...

……...

……...

……... [2]

[Total: 6]

- End of Section A -

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Name:		Index Number:		Class:	

CATHOLIC HIGH SCHOOL
Preliminary Examination 3
Secondary 4

B

CHEMISTRY

5073/02

Paper 2

15 September 2016
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 on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

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

For examiner's use only:

Question	Marks
B8	/10
B9	/10
B10 either/or	/10
Total	/30

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 11.

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

This document consists of **11** printed pages and **1** blank page.

[Turn over]

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Section B

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

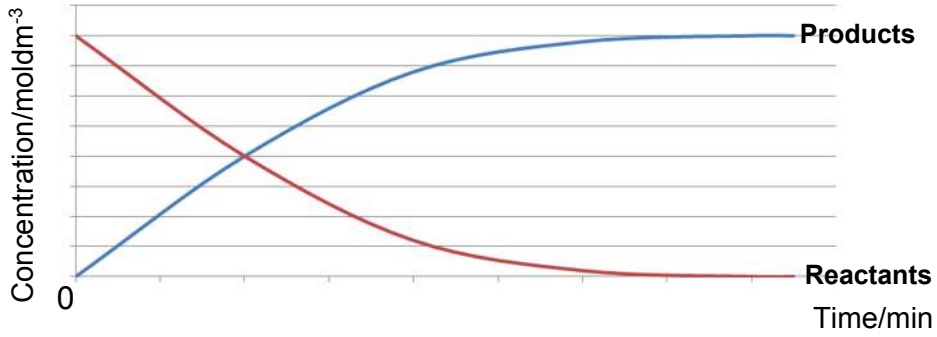
The last question is in the form of an either/or and only one of the alternatives should be attempted.

B8 Reactions can be classified as reversible or irreversible reactions.

Graph 1 shows how the concentration of reactants and products change with time for irreversible reactions.

Reactants → Products

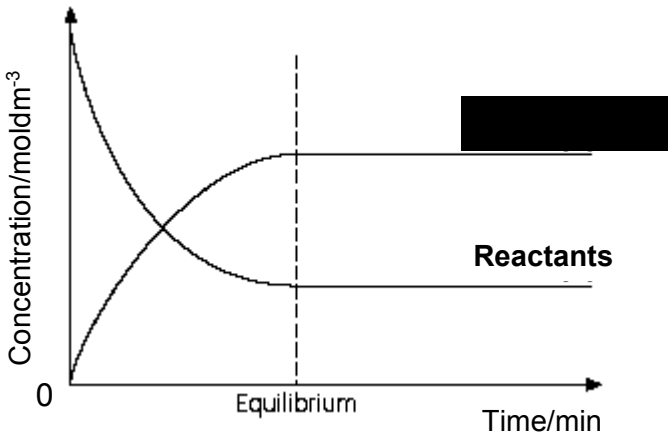
Graph 1



Graph 2 shows how the concentration of reactants and products change with time for reversible reactions.

Reactants ⇌ Products

Graph 2



Many chemical reactions are reversible. An example of a reversible reaction is the Haber process:

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ $\Delta H = -92kJ/mol$

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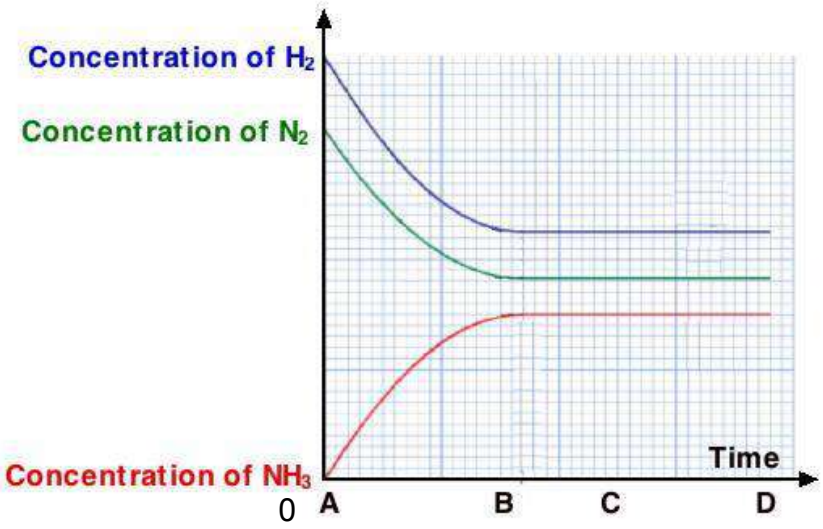
If the above reaction takes place in a closed system (i.e. one whereby there is no exchange of matter between the reaction mixture and its surroundings), a dynamic equilibrium is reached when the rate of the forward reaction (reactants $\rightarrow$ products) is the same as the rate of the backward reaction (products $\rightarrow$ reactants). The concentrations of nitrogen, hydrogen and ammonia remain constant when the system is in dynamic equilibrium.

Graph 3 shows how the concentration of N_2, H_2 and NH_3 changes with time.

Graph 3



Le Chatelier's Principle states that when the system in dynamic equilibrium is subjected to a **change** in conditions such as **temperature, pressure** and **concentration**, the system will respond in a way to **counteract** the effect of change and re-establish the equilibrium.

For example, in a system that is in dynamic equilibrium, when the concentration of nitrogen is increased, the position of the equilibrium will **shift to the right** to favour the **forward reaction**. This results in an **increase in the concentration of ammonia** at equilibrium while **decreasing the concentration of the nitrogen and hydrogen**.

(a) Using **Graph 1** and **Graph 2**, state and explain one difference between reversible and irreversible reactions.

……...

……..…..

……..…..

……..….. [2]

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(b) **(i)** On **Graph 3**, sketch a graph showing only the concentration of NH_3, to illustrate what happens when the reaction is carried out at a lower temperature- Label this graph **I**. [2]

(ii) Explain the shape of graph **I** in terms of the position of equilibrium and the rate of reaction.

……

……

……

……..…..

……..….. [3]

(iii) State the temperature used in the Haber process and explain how this optimal temperature is selected.

……

……

……

……

……. [3]

[Total: 10]

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B9 Properties of elements across Period 3.

Table 1 shows the properties of the oxides formed by elements in Period 3.

Table 1

Element	Formula of oxide	Melting point of oxide/°C	Boiling point of oxide/°C
Na	Na_2O	1132	1950
Mg	MgO	2852	3600
Al	Al_2O_3	2072	2977
Si	SiO_2	1600	2230
P	P_4O_6	24	173
	P_4O_{10}	340	360
S	SO_2	-72	-10
	SO_3	17	45
Cl	Cl_2O	-121	2
	Cl_2O_7	-92	82

(a) (i) Describe the general trend in the melting points of the oxides formed by elements in Period 3.

……

……

…… [1]

(ii) Explain the trend in terms of structure and bonding.

……

……

……

……

……

……

……

…… [3]

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(b) Suggest a reason for the difference in the melting and boiling points between the two oxides of sulfur.

……

……

…… [2]

(c) **Table 2** shows the variation of atomic and ionic radius across Period 3.

Table 2

Element	Atomic radius/nm	Simple ion	Ionic radius/nm	Number of shells of electrons in simple ion
Na	0.191	Na^+	0.102	
Mg	0.160	Mg^{2+}	0.072	
A*l*	0.130	Al^{3+}	0.054	
Si	0.118	*	-	-
P	0.110	P^{3-}	0.212	
S	0.102	S^{2-}	0.184	
C*l*	0.099	Cl^-	0.181	
Ar	0.095	-	-	-

* Si does not form simple ions and thus the data is omitted from the table.

(i) Complete the table to show the number of shells of electrons in the **ions** of period 3 elements. [2]

(ii) Use the information from **table 2** to explain why the radii of cations are generally smaller than that of anions in the same period.

……

……

…… [1]

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(iii) Suggest why there is no value stated for the ionic radius of argon.

……..……..

……

……. [1]

[Total: 10]

Either

B10 The table below shows a study of a precipitation reaction between dilute sulfuric acid and aqueous calcium hydroxide.

Test tubes **1** to **6** contain different volumes of calcium hydroxide and dilute sulfuric acid as stated in the table. To each test tube, two drops of methyl orange indicator is added. Precipitation occurs in all the test tubes and after 10 minutes, the height of the precipitate in each test tube is measured and recorded.

Test tube	**1**	**2**	**3**	**4**	**5**	**6**
volume of 0.50 mol/dm^3 of calcium hydroxide/cm^3	5.0	5.0	5.0	5.0	5.0	5.0
volume of 1.00 mol/dm^3 of sulfuric acid/cm^3	1.0	1.5	2.0	2.5	3.0	3.5
height of precipitate/cm	2.5	3.0	3.5	4.0	4.0	

(a) Write a balanced chemical equation, including state symbols, to represent the precipitation reaction between aqueous calcium hydroxide and dilute sulfuric acid.

…… [2]

(b) State the colour of methyl orange indicator in

test tube 1: ……..…….

test tube 5: ……..……. [1]

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(c) Predict the height of the precipitate collected in test tube 6 after 10 minutes. Explain your answer with the aid of calculation.

Prediction …… cm

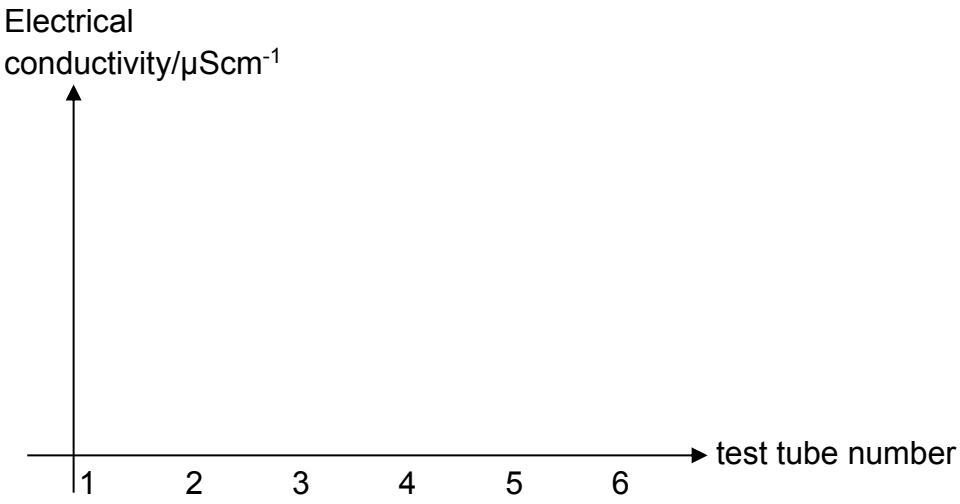
Explanation ……..

……

……

…… [3]

(d) **(i)** The electrical conductivity of the mixture in each test tube was measured. Sketch a graph of electrical conductivity against the test tube number.



[1]

(ii) Explain your graph in **(d)(i)**.

……

……

……

……

…… [3]

[Total: 10]

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Or

B10 Sulfamic acid, SO_3NH_3, is a strong monobasic acid which melts at 205 ^oC before decomposing at higher temperatures.

Although acids speeds up corrosion of iron, they are also often used as cleaning agents to remove rust. Sulfamic acid is commonly used as a replacement for hydrochloric acid in removing rust. It does not react with hypochlorite based products such as bleach to produce chlorine gas, unlike hydrochloric acid. In general, the sulfamate salts of iron and calcium formed are water-soluble.

The table shows the comparison between using hydrochloric acid and sulfamic acid to remove rust and limescale.

	hydrochloric acid	sulfamic acid
relative corrosivity on aluminium	5.3	1
relative corrosivity on copper	6.7	1
relative corrosivity on steel	4.2	1
cost per tonne	US $200	US $500

* Relative corrosivity refers to the relative ease of corroding the metal.

(a) Describe what happens to the **arrangement** and **movement** of the particles in sulfamic acid when dissolved in water.

……

……

……

…… [2]

(b) One student explains that sulfamic acid is a strong acid because there is a high concentration of hydrogen ions present. Do you agree with this statement? Explain your reasoning.

……..……..

……..…….. [1]

(c) **(i)** Explain why aqueous sulfamic acid can be used to remove rust.

……

……. [2]

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(ii) One way of protecting underground iron pipes from rusting is through the use of sacrificial protection. Describe how sacrificial protection works.

……

……

…… [2]

(d) Use the information provided to discuss the advantage(s) and disadvantage(s) of using sulfamic acid to replace hydrochloric acid in the removal of rust.

……

……

……

……

…… [3]

[Total: 10]

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The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	64 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	– Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I Iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La lanthanum 57 *	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	– Po polonium 84	– At astatine 85	– Rn radon 86
– Fr francium 87	– Ra radium 88	– Ac actinium 89 †															

*58-71 Lanthanoid series

†90-103 Actinoid series

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	– Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	162 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	– Pa protactinium 91	238 U uranium 92	– Np neptunium 93	– Pu plutonium 94	– Am americium 95	– Cm curium 96	– Bk berkelium 97	– Cf californium 98	– Es einsteinium 99	– Fm fermium 100	– Md mendelevium 101	– No nobelium 102	– Lr lawrencium 103

Key: a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

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

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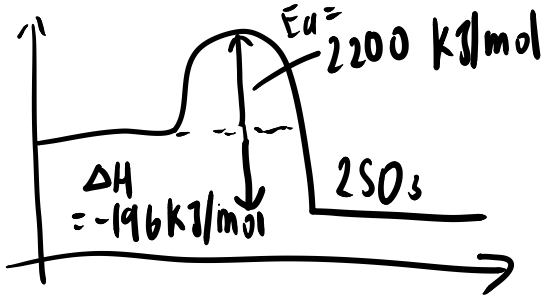
Marking Scheme for 2016 Sec 4 Prelim 3

Paper 1

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

Section A

A1			$CuSO_4$; Blue Green precipitate; No precipitate Colourless; No precipitate	[1] [1] [1]
A2	(a)		No. The **<u>oxidation state</u>** of S, O and H **<u>remains the same</u>** at +6, -2 and +1 respectively in both reactants and products.	[1]
	(b)		Use **<u>powdered sulfur</u>**. There are **<u>larger surface area</u>** for the particles to collide on, thus **<u>frequency of effective collision increase</u>**. OR **<u>Increase the pressure</u>**. There will be **<u>more particles per unit area</u>**, thus **<u>frequency of effective collision increase.</u>** OR **<u>Increase the temperature</u>**. The **<u>particles move faster</u>** and **<u>more particles</u>** have **<u>energy greater or equal to the activation energy</u>**, thus **<u>frequency of effective collision increase.</u>**	[1] [1] [1] [1] [1] [1] [1] [1] [1]
	(c)	(i)		[3]

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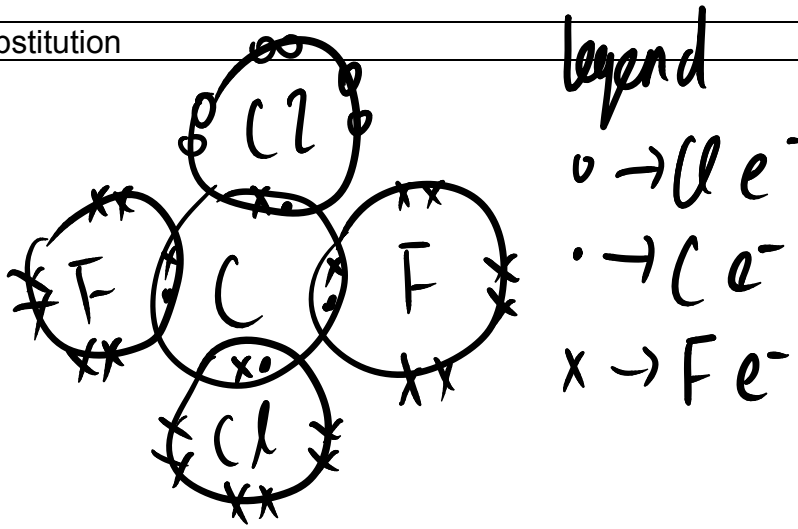
		(ii)	ΔH = **+196** kJ/mol E_a = **2396** kJ/mol	[1] [1]
A3	(a)		As the **concentration increases**, the **volume of hydrogen produced increases**.	[1]
	(b)	(i)	Cathode: $2H^+$ (aq) + 2e → H_2(g) Anode: $4OH^-$ (aq) → $2H_2O$ (*l*) + O_2 (g) + 4e	[1] [1]
		(ii)	Mol of H_2 produced = 0.02/24 = 0.0008333 mol Mol of e = 0.0008333*2 = 0.001667 mol Mol of O_2 = 0.001667/4 = 0.0004167 mol Vol of O_2 = 0.0004167*24 = 0.0100 dm^3 or 10.0cm^3 Can accept (18 to 20 cm^3) Ans: 9.00cm^3 to 10.0 cm^3	[1] [1] [1]
	(c)	(i)	Vol of H_2 = 0 cm^3 (horizontal line)	[1]
		(ii)	Distilled water **contains very few ions/no mobile ions** and thus is a poor conductor of electricity. Hence, **no electrolysis occur** and thus no hydrogen gas is produced. /No discharge of H^+ ions.	[1] [1]
A4	(a)	(i)	Substitution	[1]
		(ii)		[2]
	(b)		Compounds 134a and 152a **do not contain chlorine** atoms which react with ozone molecules.	[1]

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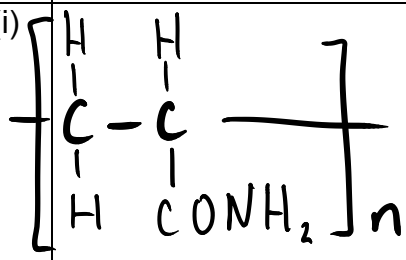
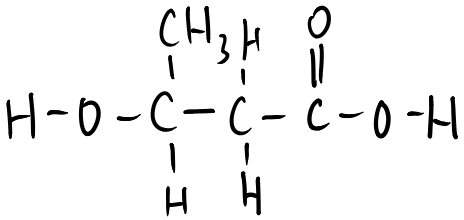
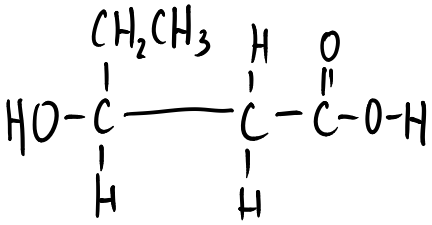
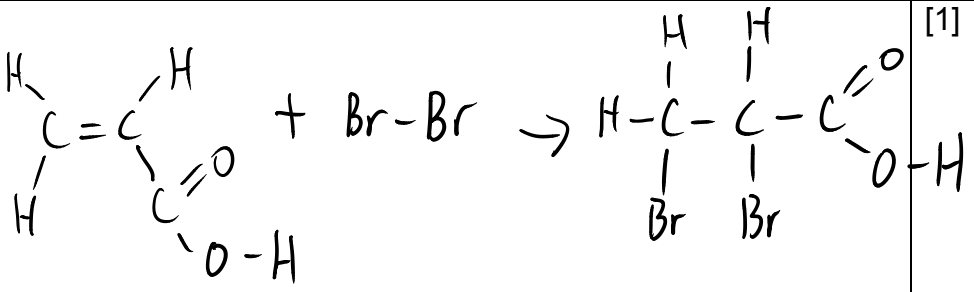
A5	(a)	(i)		[1]
		(ii)		[1]
				[1]
		(iii)	**By products** such as water is produced during condensation polymerisation, but there is only **one product** in addition polymerisation. Condensation polymer is made up of **monomers containing 2 functional groups** (-COOH and -OH group) while addition polymer is made up of **monomer with 1 functional group** (C=C).	[1] [1]
	(b)	(i)	The aqueous bromine changes from **reddish brown** to **colourless.**	[1]
		(ii)		[1]
A6	(a)		Copper(II) carbonate $CuCO_3 + 2HCl \rightarrow CuCl_2 + H_2O + CO_2$	[1] [1]

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	(b)	(i)	**Reddish brown solid** formed. Colour of solution changes from **blue** to **colourless**.	[1] [1]
		(ii)	Since **B** can react with acid but not **D**, **B** is **more reactive** than **D**. Thus **B can displace D from its aqueous solution**, forming **D** which is a reddish brown solid and a chloride solution of **B**.	[1] [1]
	(c)	(i)	$NaOH + HCl \rightarrow NaCl + H_2O$ Mol of NaOH = 10/1000*1 = 0.01 mol Mol of HCl = 0.01 mol Mol of HCl added initially = 30/1000*1 = 0.03 mol Mol of HCl that react with $CuCO_3$ = 0.03 – 0.01 = 0.02mol	[1] [1] [1]
		(ii)	Mol of CuO = 0.02/2 = 0.01 mol Mass of CuO = 0.01 * 80 = 0.8 g % purity = 0.8/3*100 = 26.7%	[1] [1] [1]
A7		(a)	$CaCO_3$/ calcium carbonate $CaCO_3 + SO_2 \rightarrow CaSO_3 + CO_2$	[1] [1]
		(b)	NO will be **oxidised by oxygen in the air** to form nitrogen dioxide. Nitrogen dioxide will then react with oxygen and water in the air to form nitric acid which causes acid rain.	[1] [1]
		(c)	Calcium carbonate is very much less soluble, with a solubility of 6.17×10^{-4} g/100ml than calcium oxide (dissolves to give alkaline solution) and calcium hydroxide (0.173g/100ml) Thus $CaCO_3$ reacts slowly with acid/effective only in reducing acidity on soil/surface in contact/ cannot penetrate soil to neutralise acid deeper down [1].	[1] [1]

Section B

B8	(a)		For irreversible reactions, **concentration of reactants becomes zero**(used up) eventually, while for reversible reactions, there will **still be reactants left** (concentration of reactants do not react zero concentration) OR For irreversible reaction, limiting reactant is used up but reversible reaction there will be a mixture of reactants and products at all time. This is because **irreversible reaction goes to completion** while reversible reaction **does not go to completion**.	[1] [1]

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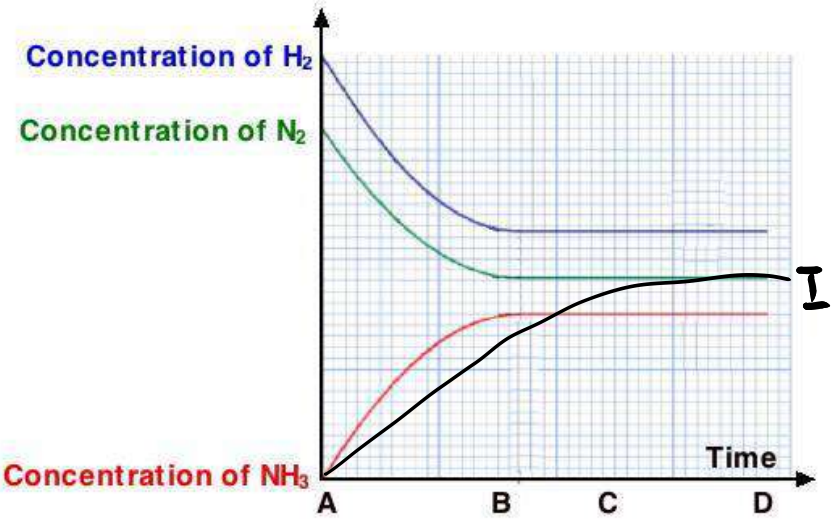
			OR For reversible reaction, products are constantly converted back to reactants as reactants react to form product.	
	(b)	(i)	 1m for slower speed 1m for higher conc of ammonia	[2]
		(ii)	**Concentration of NH_3** in the equilibrium mixture **increases** as the position of equilibrium is **shifted to the right** to **favour the forward exothermic reaction to increase the temperature**/counteract the change. The graph is **less steep** as the **rate of reaction is decreased** as **temperature decreases**.	[1] [1] [1]
		(iii)	The lower the temperature, the **higher the yield of ammonia** as the **forward reaction is favoured**. However, a lower temperature also results in a **slower reaction**. Thus a temperature of **450°C** is chosen.	[1] [1] [1]
B9	(a)	(i)	The melting and boiling points **show an increase from Na to Mg**, then **decrease from Mg to Cl**.	[1]
		(ii)	Na_2O, MgO and Al_2O_3 has a **giant ionic lattice structure**. Thus **large amount of energy** is needed to overcome the **strong electrostatic FOA** between the **ions**. SiO_2 has a **giant molecular structure**. **Large amount of energy** is needed to overcome the **strong covalent bond** between the **atoms**.	[1] [1] [1]

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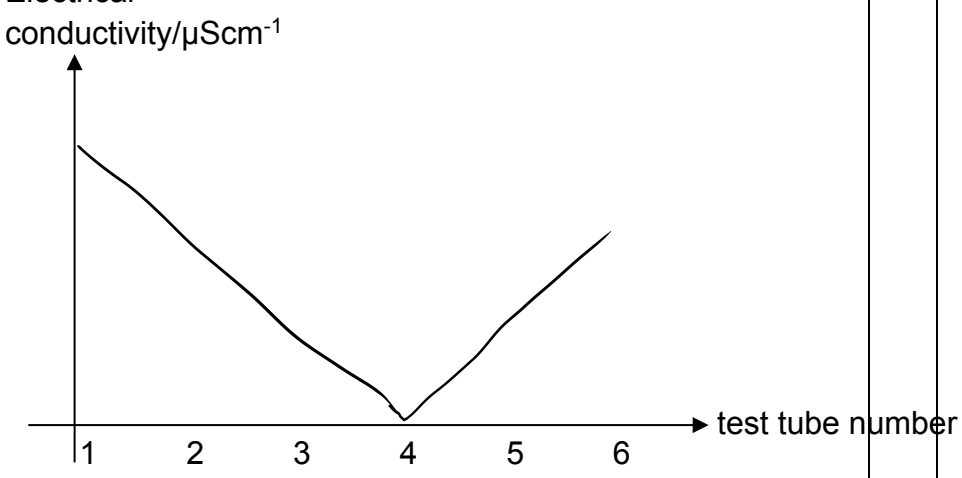
			Oxides of P, S and Cl have a **simple molecular structure**. **Small amount of energy** is needed to overcome the **weak intermolecular FOA**.	
	(b)		SO_3 has a higher melting and boiling point compared to SO_2 because it has a **relative molecular mass/ larger surface area/more electrons**. Thus the **intermolecular forces of attraction is stronger**. More energy is needed to overcome it.	[1] [1]
	(c)	(i)	2;2;2; 3;3;3	[1] [1]
		(ii)	anions consist of **1 more electron shells** compared to cations, thus radius of cations are generally smaller.	[1]
		(iii)	Argon has a **stable electronic configuration** and thus do **not form ions**.	[1]
B10 (E)	(a)		$Ca(OH)_2$ (aq) + H_2SO_4(sq) → $CaSO_4$(s) + $2H_2O$(l)	[2]
	(b)		Test tube 1: yellow Test tube 5:red	[1]
	(c)		4cm Mol of calcium hydroxide = 0.5*0.005 = 0.0025mol Mol of sulfuric acid = 1*0.0035 = 0.0035 mol Since mol ratio of calcium hydroxide: sulphuric acid = 1:1, Calcium hydroxide is the limiting reagent.	[1] [1] [1]
	(d)	(i)		[1]
		(ii)	The electrical conductivity **decreases** from test tube 1 and reaches 0 at test tube 4 because **$CaSO_4$ is being precipitated** out and **thus ions decreases**.	[1] [1]

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			In test tube 4, all the reactants have been used up and thus there is **no ions left** in the mixture. The electrical conductivity **increases** from reaction tube 4 to 6 as now **sulfuric acid is in excess**, thus there is an **increase in the number of mobile ions** as sulphuric acid is being added.	[1]
B10 (or)	(a)		The particles changes from **vibrate about fixed position** to **moving freely throughout the liquid**. The particles changes from **pack closely together** in an **orderly arrangement** to **slightly further apart in disorderly arrangement**.	[1] [1]
	(b)		No, It is a strong acid as it **dissociate completely in water** and **not** due to it having high concentration of hydrogen ions.	[1]
	(c)	(i)	Acid can **react with Fe_2O_3** which is a **basic oxide** to give **soluble salt and water**.	[1] [1]
		(ii)	**Attach a more reactive metal** such as zinc to the underground pipes. It will **corrode in place of iron**, thus protecting iron from rusting.	[1] [1]
	(d)		Advantages: - Sulfamic acid will **corrode the metals** that it is cleaning to a **smaller extend** compared to hydrochloric acid as the corrosivity of HCl on steel is 4.2 times that of sulfamic acid. - It is **safer** to use sulfamic acid as it **will not react with bleach to produce Cl_2 which is toxic.** Disadvantage: - It is **2.5 times more expensive** than HCl.	[1] [1] [1]

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CENTRE NUMBER					INDEX NUMBER			

CHEMISTRY

5073/01

Paper 1 Multiple Choice

12 August 2016

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, class and index number on the Question Paper and Answer Sheet in the spaces provided.

There are **forty** questions in this paper. Answer **all** questions. For each question, there are four possible answers, **A**, **B**, **C**, **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 2.
The use of an approved scientific calculator is expected, where appropriate.

This question paper consists of 20 printed pages

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DATA SHEET
The Periodic Table of the Elements

Group																	
I	II										III	IV	V	VI	VII	0
							1 H Hydrogen 1									4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4										11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12										27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															
		140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71		
		232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103		

*58-71 Lanthanoid series
†90-103 Actinoid series

Key: a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

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

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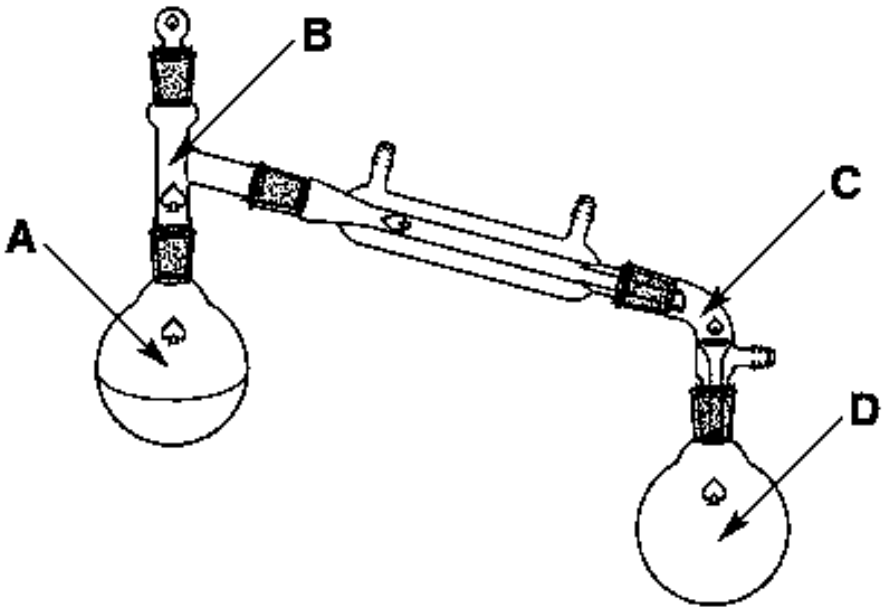
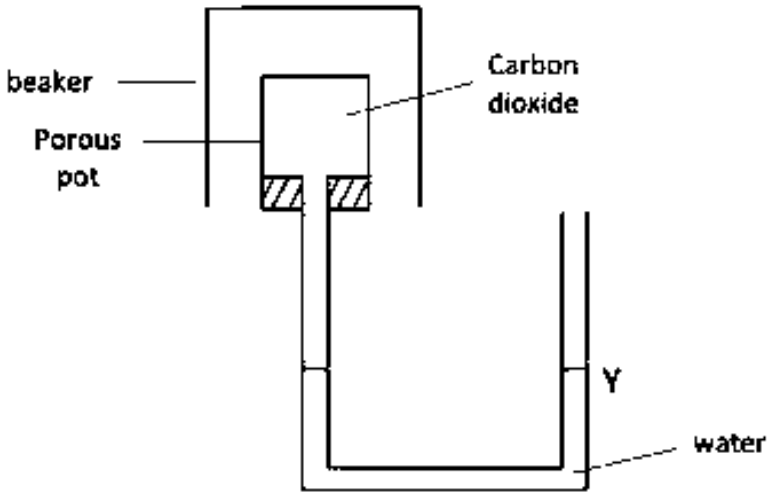
1 A student is distilling a mixture of iodine in ethanol (boiling point of ethanol= 78^{o}C). She has just begun to collect the distillate in the receiving flask. At which position in the experimental set-up will the temperature be 78 ^{o}C?



2 A beaker containing gas **X** is placed over a porous pot filled with carbon dioxide gas as shown. The level of water at Y rises after a short time. What is a possible identity of gas **X**?



A Chlorine
B Oxygen
C Nitrogen dioxide
D Sulfur dioxide

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3 The atomic number of element **X** is 16. Which statement(s) concerning **X** is/are correct?

I. X can react with calcium to form an ionic compound.
II. The oxide of X dissolves in water to form an acidic solution.
III. X can conduct electricity in its molten state.

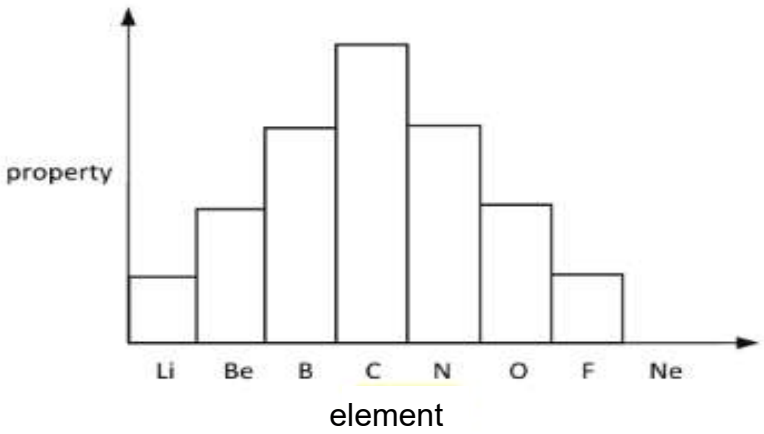
A I and II only
B I and III only
C II and III only
D I, II and III

4 **T** is an element. It can form a cation $\mathbf{T^{2+}}$, which has an electronic arrangement 2.8.8. Which statements about T are correct?

I. T is a strong oxidising agent.
II. T is in Period 4 of the Periodic Table.
III. T burns in oxygen to form a white solid.

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

5 The bar chart shows the variation of a specific property of elements in Period 2 from lithium to neon. Which property of these elements is shown in the chart?



A The number of electrons used in bonding
B The number of shells holding electrons
C The melting point
D The atomic radius

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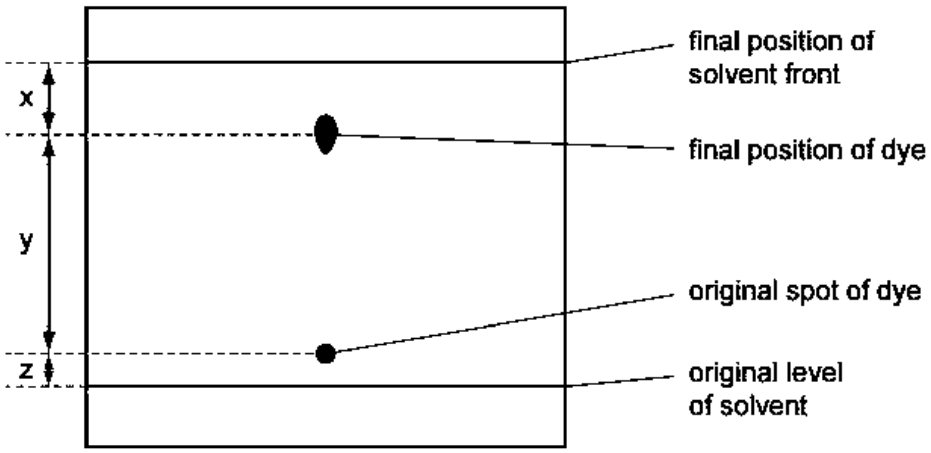
6 The diagram shows the chromatogram obtained by analysis of a single dye. Three measurements are shown.



How is the R_f value of the dye calculated?

A $\frac{x}{x+y}$

B $\frac{y}{x+y}$

C $\frac{x}{x+y+z}$

D $\frac{y}{x+y+z}$

7 Silicon carbide, SiC, has a structure similar to diamond. Boron nitride, BN, has a structure similar to graphite. Bronze is an alloy of copper and tin. Which statements about silicon carbide, boron nitride and bronze are correct?

I. All are bonded covalently.
II. All except silicon carbide conduct electricity when solid.
III. All have high melting points.

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

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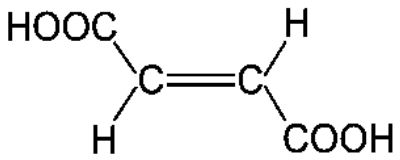
8 The diagram shows the structure an organic compound.



Which of the following statements is **false** for the compound?

A It is immiscible in water.
B It reacts with alcohol under suitable conditions.
C It decolorises aqueous bromine rapidly.
D It reacts with steam.

9 The atmosphere of Venus contains mainly oxygen, argon and nitrogen. The melting and boiling points of these gases are shown in the table below.

Gas	Melting point/ ^{o}C	Boiling point/ ^{o}C
Oxygen	-219	-183
Argon	-189	-186
Nitrogen	-210	-196

If only liquid oxygen is to be obtained, what temperature should the sample of air be decreased to?

A -180^{o}C
B -185^{o}C
C -187^{o}C
D -198^{o}C

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10 In an experiment, 4.0 cm^3 of 1.0 mol/dm^3 aqueous copper(II) sulfate was mixed with 8.0 cm^3 of 1.0 mol/dm^3 aqueous sodium carbonate. The equation for the reaction is as shown below.

$$CuSO_4 + Na_2CO_3 \rightarrow Na_2SO_4 + CuCO_3$$

What did the reaction vessel contain when the reaction was completed?

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

11 A 10.00 g sample of a compound containing only carbon, hydrogen and oxygen forms 23.98 g CO_2 and 4.91 g H_2O upon complete combustion. What is the empirical formula of the compound?

A C_2HO
B C_3H_3O
C $C_6H_3O_2$
D C_6H_6O

12 Carbon monoxide reacts with oxygen according to the equation shown below.

$$2CO(g) + O_2(g) \rightarrow 2CO_2(g)$$

If all volumes of gases are measured at the same temperature and pressure, what is the total volume of the resulting gas(es), after 50 cm^3 of carbon monoxide reacts with 50 cm^3 of oxygen?

A 100 cm^3
B 75 cm^3
C 50 cm^3
D 25 cm^3

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13 Silver ions react with chloride ions as follows:

$$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$$

It is found that 5 cm^3 of a 0.1 mol/dm^3 solution of the chloride of metal X needs 10 cm^3 of 0.1 mol/dm^3 silver nitrate for complete reaction. What is the formula of the chloride?

A XCl_4
B XCl_2
C XCl
D X_2Cl

14 An aqueous solution of the organic compound methylamine has a pH greater than 7. Which one of the following statements about methylamine is correct?

A It neutralises an aqueous solution of sodium hydroxide.
B It reacts with copper(II) carbonate to give carbon dioxide.
C It reacts with hydrochloric acid to form a salt.
D It turns blue litmus red.

15 Which equation describes the most suitable reaction for making lead(II) sulfate?

A $Pb + H_2SO_4 \rightarrow PbSO_4 + H_2$
B $PbCO_3 + H_2SO_4 \rightarrow PbSO_4 + CO_2 + H_2O$
C $Pb(NO_3)_2 + H_2SO_4 \rightarrow PbSO_4 + 2HNO_3$
D $Pb(OH)_2 + H_2SO_4 \rightarrow PbSO_4 + 2H_2O$

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16 The table below shows the properties of some elements, **W**, **X**, **Y** and **Z** in Period 3.

	W	**X**	**Y**	**Z**
Appearance at room temperature	Silvery grey solid	Yellow solid	Silvery grey solid	Yellowish-green gas
Reaction with cold water	Extremely violent reaction	No reaction	No reaction	Slow reaction
Nature of oxide	Reacts with acids	Reacts with bases	Reacts with acids and bases	Reacts with bases

Which of the following shows the arrangement of these elements in the Periodic Table in **increasing** order of group number, from the smallest to the largest?

A W, X, Y, Z
B W, Y, X, Z
C Y, W, X, Z
D Z, X, Y, W

17 Three experiments are carried out to determine the reactivity of three unknown halogens. The ionic equations of the three experiments are shown below.

$Z^-(aq) + Y_2(aq) \rightarrow$ no reaction

$X^-(aq) + Z_2(aq) \rightarrow$ no reaction

$2Y^-(aq) + X_2(aq) \rightarrow 2X^-(aq) + Y_2(aq)$

Predict the reactivity of the halogens in **decreasing** order.

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

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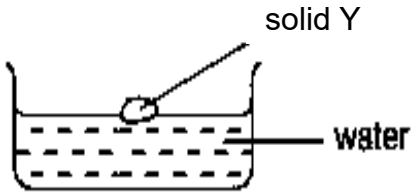
18 When heated, solid X gives off gas. When this gas is bubbled through limewater, a white precipitate is formed. The residue after heating solid X reacts with dilute acid and also with aqueous alkali. What is X?

A Magnesium carbonate
B Aluminium oxide
C Calcium hydroxide
D Zinc carbonate

19 When solid Y reacts with water, a solution and a gas are produced.



The universal indicator changed from green to purple and the gas extinguished a lighted splint with a 'pop' sound.

What is the identity of solid Y and the explanation for the test for the gas formed?

	Identity of solid Y	**Is gas flammable?**
A	Calcium	Yes
B	Calcium	No
C	Sodium	No
D	Sodium	Yes

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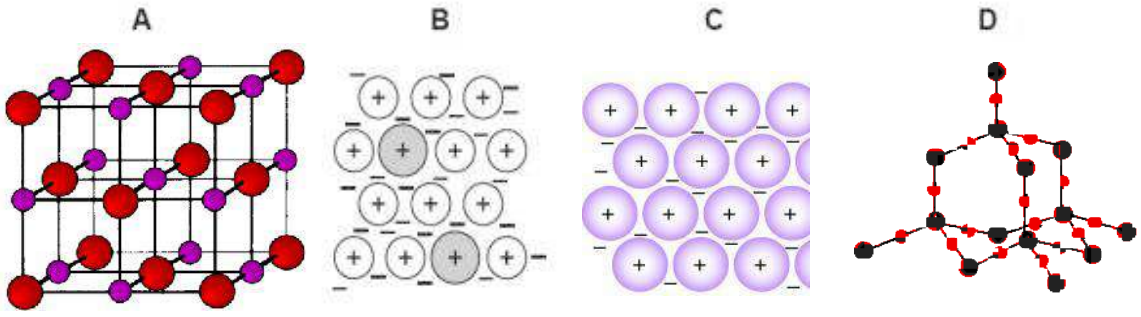
20 The red colour in some pottery glazes may be formed as a result of the reactions shown.

$$CuCO_3 \xrightarrow{\text{heat}} CuO + CO_2$$
$$CuO + SnO \longrightarrow Cu + SnO_2$$

These equations show that …….**1**…… is oxidised and …….**2**…… is reduced.
Which substances correctly complete gaps **1** and **2** in the above sentence?

	1	**2**
A	CO_2	SnO_2
B	$CuCO_3$	CuO
C	CuO	SnO
D	SnO	CuO

21 Which diagram represents the structure of an alloy?



22 An element has the following properties.

- It forms coloured compounds.
- It acts as a catalyst.
- It melts at 1539°C.

In which Period is the element likely to be found?

A Period 1
B Period 2
C Period 3
D Period 4

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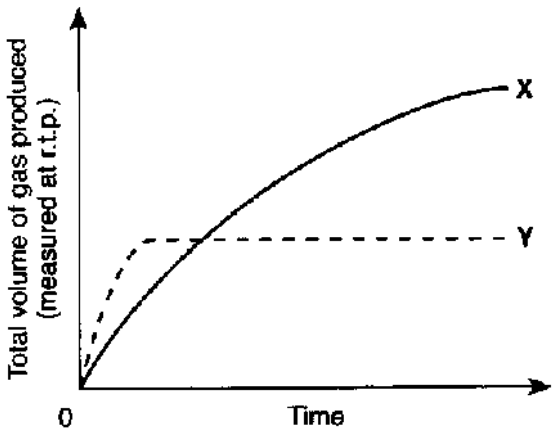
23 Calcium carbonate reacts with dilute hydrochloric acid as shown:

$$CaCO_3(s) + 2HCl\ (aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

Which option shows the correct effect on the rate of the reaction when a factor is changed?

	Factor changed	Rate of reaction
A	Particle size of calcium carbonate increased	Increased
B	Concentration of hydrochloric acid increase	Increased
C	Pressure of carbon dioxide increased	Increased
D	Temperature increased	Decreased

24 In the graph shown below, curve **X** represents the results of the reaction between 2g of zinc granules and excess acid at 25°C. Which of the following changes would produce curve **Y**?



A Using 1 g of zinc powder at 25°C
B Using 2 g of zinc powder at 30°C
C Using 1 g of zinc granules at 25°C
D Using 2 g of zinc granules at 30°C

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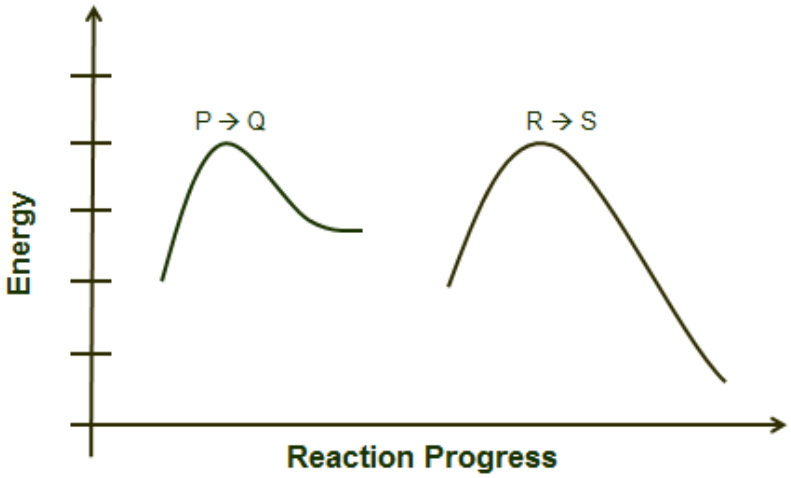
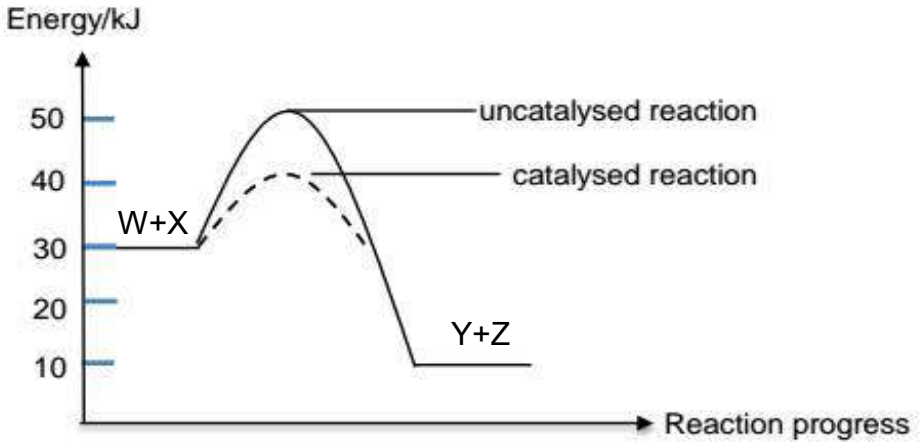
25 From the energy profiles for the two reactions below, how will the rates of the two reactions compare if the temperature of each reaction is increased from 25°C to 75°C?



A The rate of reaction P → Q will increase more than the rate of R → S.
B The rate of P → Q will decrease but the rate of R → S will increase.
C The rate of reaction R → S will increase more than the rate of P → Q.
D The rates of the two reactions will increase by the same amount.

26 A reversible reaction is represented by the equation W + X ⇌ Y +Z.

The energy profiles for the reversible reaction under catalysed and uncatalysed conditions are shown below.



What is the activation energy of the reverse reaction that is catalysed?

A -40kJ
B -10kJ
C +30kJ
D +40kJ

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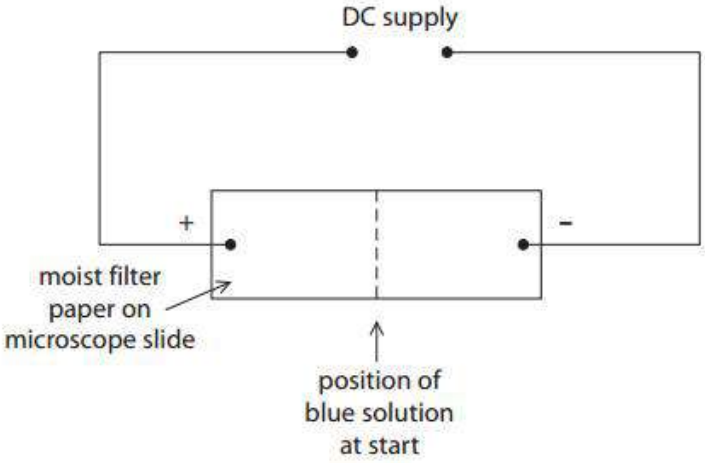
27 A spot of blue solution was placed in the centre of a piece of moist filter paper supported on a microscope slide and a DC voltage applied across the filter paper.



After some time, a blue colour moved towards the negative terminal and no change was visible in the region of the positive terminal. What statement best describes this observation?

A The negative ions in the solution were colourless and the positive ions were blue.
B The positive ions in the solution were colourless and the negative ions were blue.
C The negative ions in the solution had not moved but the positive ions had moved.
D The positive ions in the solution had not moved but the negative ions had moved.

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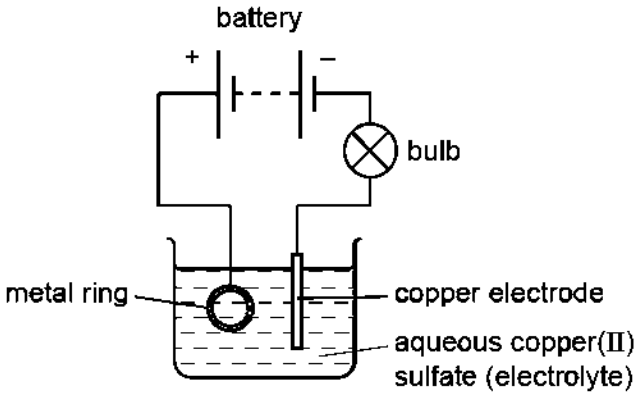
28 The diagram shows the apparatus used in an attempt to electroplate a metal ring with copper.



The experiment did not work.
Which change is needed in the experiment to make it work?

A Add solid copper(II) sulfate to the electrolyte.
B Increase the temperature of the electrolyte.
C Replace the copper electrode with a carbon electrode.
D Reverse the connection to the battery.

29 Metal **X** reacts with dilute hydrochloric acid. It is used in the building of bridges and beams in buildings.

Metal **Y** does not corrode easily. It can be used for jewellery.

Metal **Z** reacts rapidly with water to form hydrogen.

Which method of extraction of the metals from their ores is most likely to be used?

	Electrolysis of molten ore	**Heating with carbon**
A	X and Y	Z
B	X and Z	Y
C	Y	X and Z
D	Z	X and Y

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30 Three electrochemical cells are set up using copper metal as one electrode and one of three unknown metals, U, V and W as the second electrode, immersed in aqueous sodium nitrate of the same concentration.

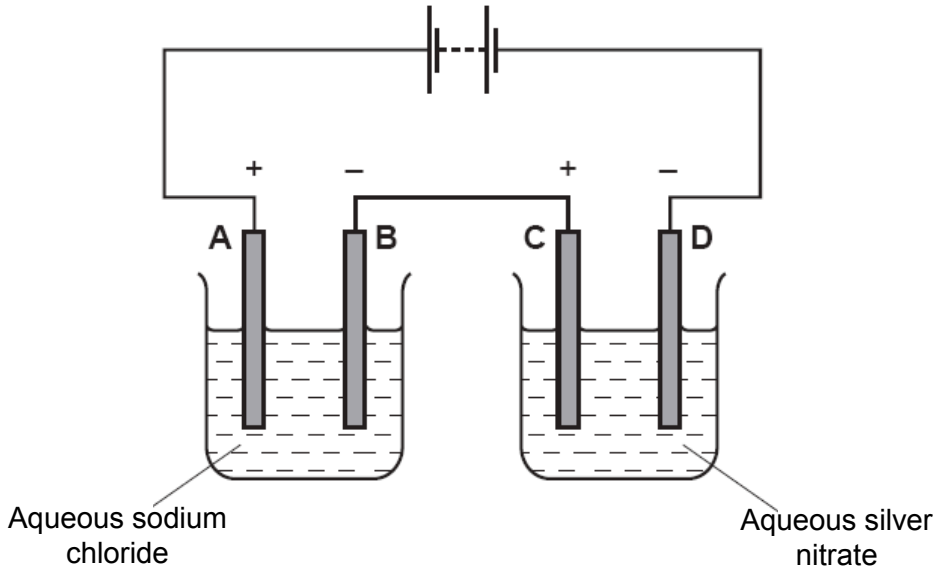
The potential differences between the metals are given in the table below.

Electrochemical cell	Metals used	Voltage/ V	Negative electrode
1	Cu, U	-0.45	Cu
2	Cu, V	+1.11	V
3	Cu, W	+2.71	W

Which of the following correctly lists the metals in order of **increasing** reactivity?

A U V Cu W
B U Cu V W
C W V Cu U
D W Cu V U

31 The diagram shows an electrolysis circuit. At which electrode is hydrogen formed?



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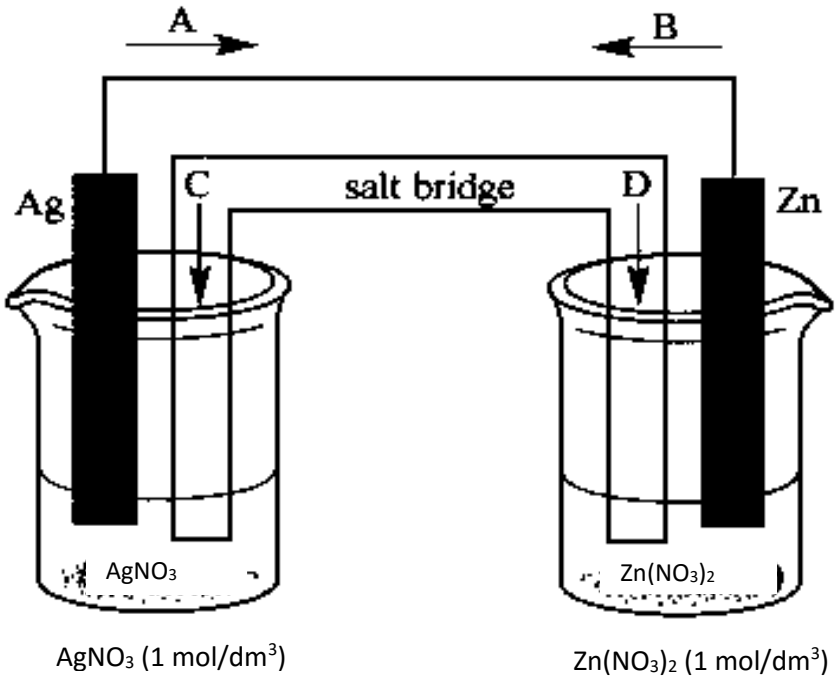
32 In an electrochemical cell shown below, which arrow indicates the spontaneous electron flow?



33 Hydrazine has the formula H_2NNH_2 and has similar properties to ammonia. Which statement correctly describes the property of hydrazine?

A It reacts with hydrogen chloride to form a compound with the chemical formula ClH_3NNH_3Cl.
B It reacts with sodium hydroxide to form a compound with the chemical formula NaHNNHNa.
C It is an ionic compound.
D It dissolves in water to form hydrogen ions.

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34 To reduce atmospheric pollution, the following waste gases are passed through powdered calcium carbonate.

Carbon monoxide	Carbon dioxide	Nitrogen monoxide
Nitrogen dioxide	Sulphur dioxide	Phosphorus (V) oxide

How many waste gases will **not** be removed by the powdered calcium carbonate?

A 1
B 2
C 3
D 4

35 What environmental effects do chlorofluorocarbons, methane and nitrogen dioxide result in?

	chlorofluorocarbons	**methane**	**nitrogen dioxide**
A	Acid rain	Depletion of the ozone layer	Global warming
B	Depletion of the ozone layer	Acid rain	Global warming
C	Depletion of the ozone layer	Global warming	Acid rain
D	Global warming	Depletion of the ozone layer	Acid rain

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36 The table below shows some data about the composition of the mixtures of exhaust gases from two cars, one fitted with a catalytic converter and one without.

	% by volume of nitrogen monoxide	% by volume of carbon dioxide	% by volume of water vapour
Car without catalytic converter	67.60	12.00	11.00
Car with catalytic converter	23.60	32.35	41.10

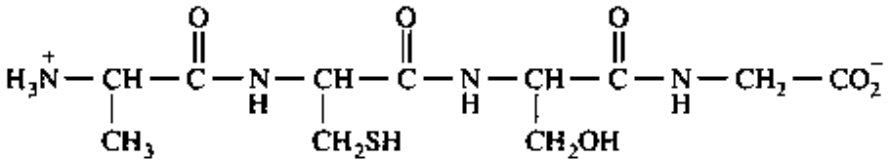
Which statement does **not** explain the above data?

A The percentage of nitrogen monoxide decreases as it is oxidised to form harmless nitrates, carbon dioxide and water in the catalytic converter.
B The percentage of nitrogen monoxide decreases as it is reduced to form nitrogen in the catalytic converter.
C The percentage of carbon dioxide increases as unburnt hydrocarbons undergo complete combustion in the catalytic converter.
D The percentage of water vapour increases as unburnt hydrocarbons undergo complete combustion in the catalytic converter.

37 Ammonia is produced by the Haber process. Which statement is **not** correct?

A A catalyst of iron(II) oxide is used.
B Each nitrogen molecule reacts with three hydrogen molecules to form two molecules of ammonia.
C Hydrogen for the process can be obtained by cracking of some fractions of crude oil.
D Two ammonia molecules decompose to form one nitrogen molecule and three hydrogen molecules.

38 What is the total number of amide linkages in the structure shown below?



A 1
B 2
C 3
D 4

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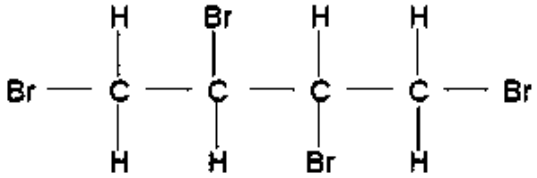
39 An ester is made by reacting alcohol **P** with a carboxylic acid **Q**. Alcohol **P** can be oxidised to form **Q** by warming with acidified potassium manganate(VII), under reflux.

What might be the structural formula for the ester made?

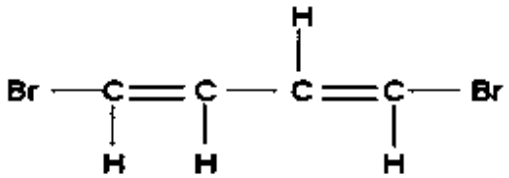
A CH_3OOCH_3
B $CH_3COOCH_2CH_3$
C $CH_3CH_2COOCH_2CH_3$
D $CH_3CH_2CH_2COOCH_2CH_3$

40 When an organic compound **R** reacts with aqueous bromine, the product formed is shown below.

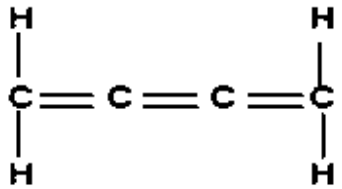


Which of the following structures is the organic compound **R** most likely to be?

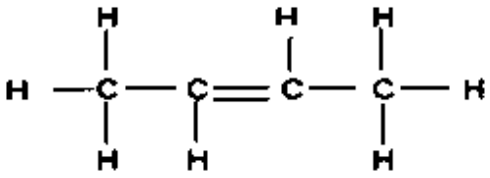
A



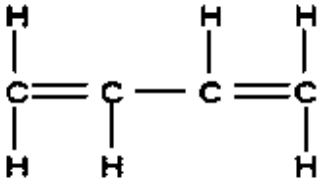
B



C



D



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SINGAPORE CHINESE GIRLS' SCHOOL
Preliminary Examination 2016

CHEMISTRY 5073/01

PAPER 1 Multiple Choice ANSWER

Friday **12 AUGUST 2016**

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

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SINGAPORE CHINESE GIRLS' SCHOOL
Preliminary Examination
Secondary Four

CANDIDATE NAME							
CLASS	4			REGISTER NUMBER			
CENTRE NUMBER					INDEX NUMBER			

Chemistry

5073/02

Paper 2 Theory

Thursday **4 August 2016** **1 hour 45 minutes**

Candidates answer on the Question Paper.
No Additional materials are required.
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, highlighters, glue or correction fluid/tape.

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

Section B
Answer **all** 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 printed on page 20.

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

For Examiner's Use	
Section A	/50
B8	/12
B9	/8
B10	/10
Total	/80

This question paper consists of **20** printed pages.

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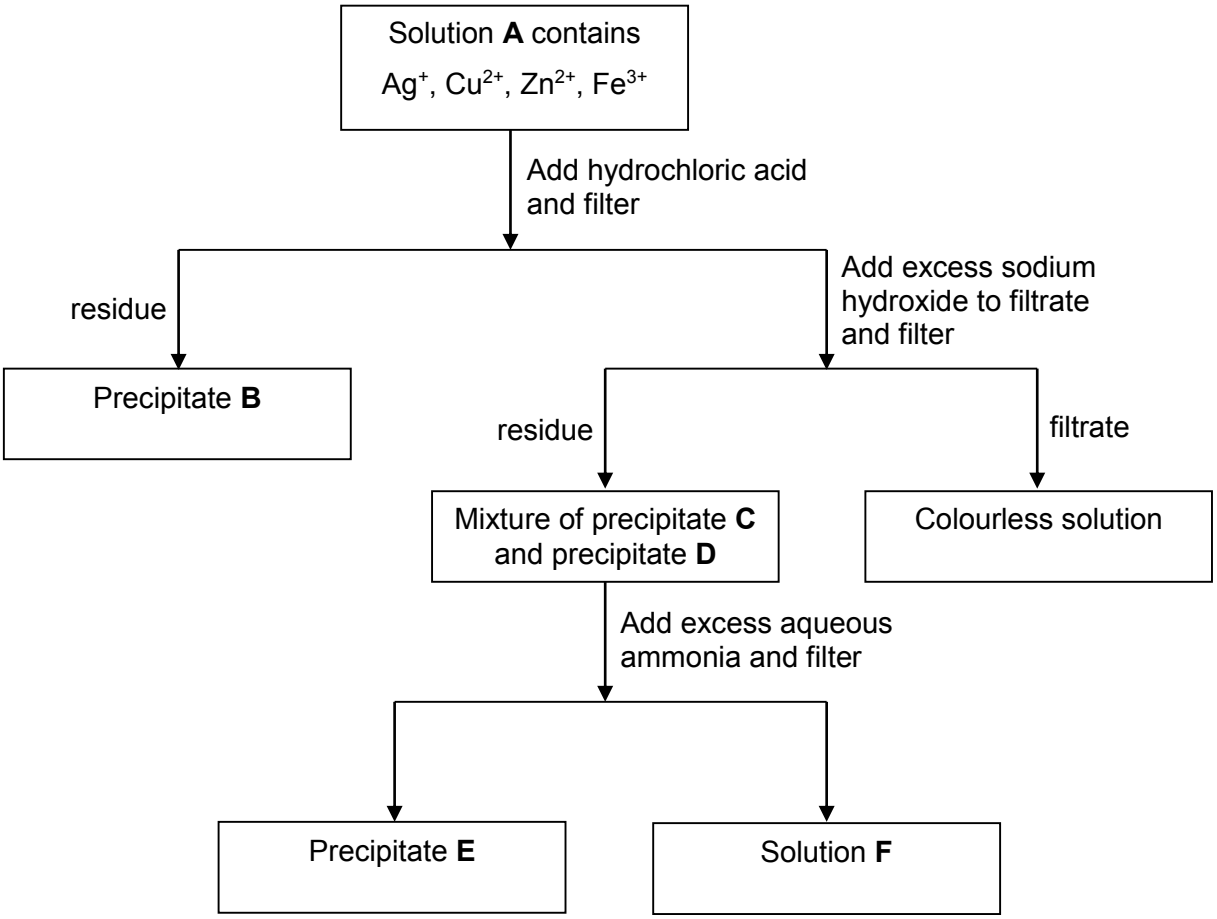
Section A

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

A1 The flowchart below shows how the ions present in solution **A** are separated.



(a) It is known that solution **A** contains 1 anion. Suggest the identity of this anion. Give a reason for your answer.

Identity of anion : ……

Reason : …….. [2]

(b) Describe a test to confirm the anion you named in part (a).

……

……

…… [2]

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(c) Name the precipitates **B**, **C** and **D**.

B : ……..

C : ……..

D : …….. [3]

(d) What are the colours of precipitate **E** and Solution **F**?

Precipitate **E** : ……

Solution **F** : …… [2]

[Total: 9]

A2 The level of dissolved oxygen is used as an indicator to gauge the health of a water body. Generally, the higher the concentration of dissolved oxygen, the less polluted the water and the more likely it is able to support living organisms. To measure the level of oxygen in a sample of water, the Winkler Method is used. This technique makes use of redox reactions and is carried out in the 3 steps shown below.

Reaction 1 : $2Mn^{2+}(aq) + O_2(g) + 4OH^-(aq) \rightarrow 2MnO_2(s) + 2H_2O(l)$

Reaction 2 : $MnO_2(s) + 2I^-(aq) + 4H^+(aq) \rightarrow Mn^{2+}(aq) + I_2(aq) + 2H_2O(l)$

Reaction 3 : $2S_2O_3^{2-}(aq) + I_2(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$

(a) Define a redox reaction.

……

……

…… [1]

(b) Choose any **one** of the above reactions and explain why it is a redox reaction, making reference to oxidation states.

Reaction ……

Explanation : ……

……

……

…… [2]

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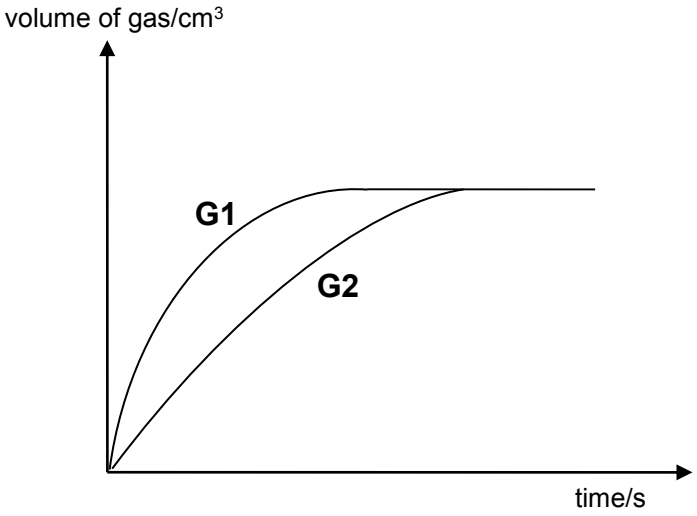
(c) 100 cm^3 of water was taken from the school's koi pond and analysed using this method. It was found that 0.0008 mole of iodide ions was formed in step 3. Calculate the mass of oxygen dissolved in this sample of pond water.

[2]

[Total: 5]

A3 A sample of 3.36 g of magnesium carbonate powder was divided equally into two portions. One portion was added into hydrochloric acid and the other portion was added into sulfuric acid. The volume and concentration of acids used were both 25.0 cm^3 and 5.00 mol/dm^3 respectively. The graphs below (**G1** and **G2**) show the volume of the gas collected over time.



(a) Which graph represents the results for hydrochloric acid? Explain your answer in terms of particle collision.

Graph ……

Explanation : ……

……

……

……

……

……

……

[4]

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(b) Another experiment was carried out by adding 2.00 g calcium carbonate powder into 25.0 cm^3 of sulfuric acid of concentration 5.00 mol/dm^3. On the same axes, sketch the graph you will expect to obtain and label it **C**. [1]

(c) Explain the shape of your graph.

……

……

……

……

…… [2]

[Total: 7]

A4 Astatine, At, is an element in Group VII of the Periodic Table. It exists as diatomic molecules similar to the other elements in the same Group. 2 isotopes of astatine are known to exist : astatine-210 and astatine-211. It reacts with strontium (Sr) to form the compound strontium astatide.

symbol	number of protons	number of electrons	number of neutrons
$^{210}_{85}At$	.....	.....	.....
$^{211}_{85}At$	.....	.....	.....

(a) Complete the table above. [1]

(b) What are isotopes?

……

……

…… [1]

(c) Draw the 'dot-and-cross' diagram for an astatine molecule, showing only the outer shell electrons.

[1]

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(d) Draw the "dot-and-cross" diagram of strontium astatide, showing only the outer shell electrons. Hence write the chemical formula of this compound.

Formula of strontium astatide : …….. [3]

(e) Predict 2 properties of strontium astatide. Give a reason for each of the properties which you state.

Property 1 : ……

Reason : ……

……. [2]

Property 2 : ……

Reason : ……

……. [2]

[Total: 10]

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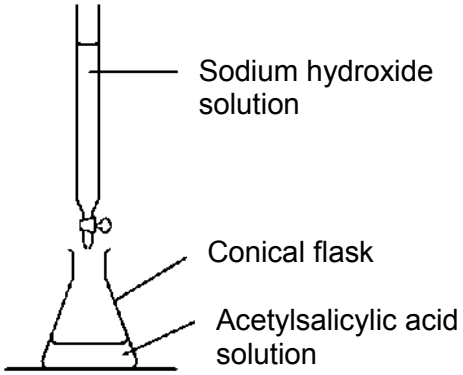
A5 The drug aspirin is used to relieve pain, fever and inflammation. However, if taken in high doses, it can cause gastric ulcers and bleeding in the stomach. The active ingredient is acetylsalicylic acid which a monobasic acid. The formula of the acid can be represented by HA and its relative molecular mass is 180.

A student was interested in determining the percentage of the acid in an aspirin tablet. An aspirin tablet was first weighed and then dissolved in water to make a solution in a conical flask. A few drops of indicator were then added and dilute sodium hydroxide solution was run in from a burette until the indicator changed colour.



The results were as follows :

Mass of aspirin tablet taken	0.50 g
Volume of dilute sodium hydroxide added	23.0 cm^3
Concentration of the dilute sodium hydroxide added	0.01 mol/dm^3

(a) Acetylsalicylic acid is a weak acid. Explain what is a *weak* acid.

……

…… [1]

(b) Explain why it is **not** important to know the volume of the aspirin solution originally taken.

……

…… [1]

(c) Calculate the number of moles of sodium hydroxide solution added. Hence, calculate the percentage of acetylsalicylic acid in the aspirin tablet.

[3]

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(d) The student wanted to make a crystalline sample of sodium acetylsalicylate, the salt formed in the reaction. This salt decomposes on strong heating. Describe briefly how this might be carried out using a solution of pure acetylsalicylic acid.

……

……

……

……

……

……

……

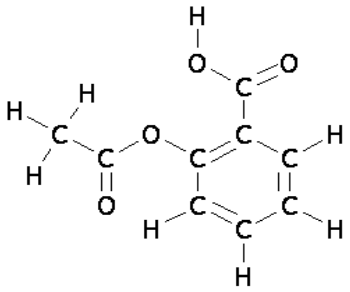
……

……

……

[3]

(e) The structure of acetylsalicylic acid is given below.



Draw the structure of sodium acetylsalicylate.

[1]

[Total: 9]

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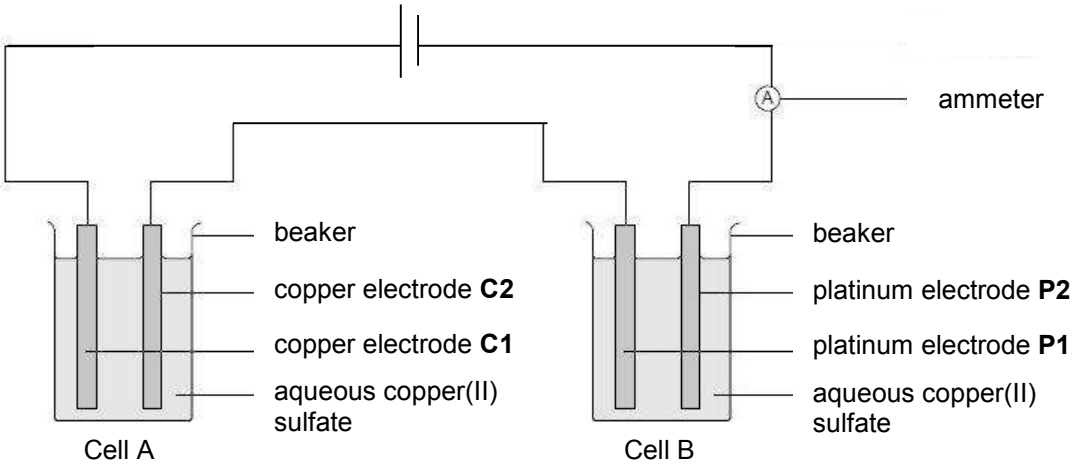
A6 A student carried out electrolysis of dilute potassium chloride and molten potassium chloride using platinum electrodes to determine what products are formed.

(a) Complete the table below.

Electrolyte	Ions in Electrolyte	Product at anode	Product at cathode
Dilute potassium chloride		oxygen	
Molten potassium chloride	K^+, Cl^-		

[2]

In another investigation, the electrolysis of aqueous copper(II) sulfate was carried out using the apparatus shown in the diagram below.



(b) **Briefly** describe the change(s), if any, which take place at the electrodes and electrolytes at the end of the experiment in the table below.

	Change(s), if any
Electrode **C1**	
Electrode **C2**	
Electrolyte (Cell A)	

	Change(s), if any
Electrode **P1**	
Electrode **P2**	
Electrolyte (Cell B)	

[3]

[Total: 5]

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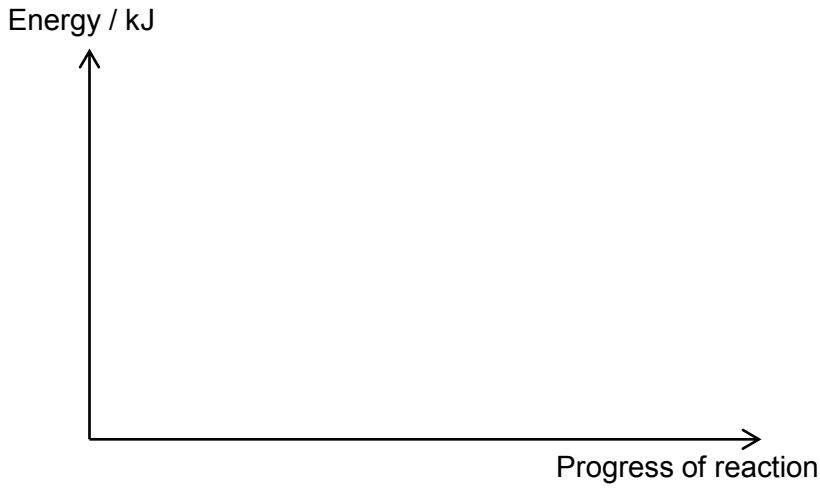
A7 Hydrazine (N_2H_4) is often used as a rocket fuel. It can react with oxygen or fluorine to release large amounts of heat. The equations for the 2 reactions are shown below.

$$N_2H_4\ (g) + O_2\ (g) \rightarrow N_2\ (g) + 2H_2O\ (g) \qquad \Delta H = -622kJ$$

$$N_2H_4\ (g) + 2F_2\ (g) \rightarrow N_2\ (g) + 4HF\ (g) \qquad \Delta H = -1166kJ$$

The ΔH values represent the energy change per mole of hydrazine reacted.

(a) Draw the energy profile diagram for the reaction between hydrazine and oxygen, showing the activation energy and the enthalpy change clearly.



[2]

(b) Based only on the information provided above, which other reactant (oxygen or fluorine) would have made a better choice for usage as a rocket fuel together with hydrazine? Briefly explain your answer.

……

……

……

……

……

…… [2]

(c) State 1 other factor that should be taken into consideration when deciding which fuel to use.

…… [1]

[Total: 5]

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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.

B8 The table below gives the current estimated percentage by mass of some of the elements found in the Earth's crust and the Earth's core.

Earth's Crust		**Earth's Core**	
Element	% by Mass	Element	% by Mass
Oxygen	40.6	Iron	31.0
Silicon	24.7	Oxygen	24.0
Nickel	8.1	Magnesium	16.0
Aluminium	8.1	Silicon	13.0
Iron	5.0	Nickel	11.7
Calcium	3.6	Aluminium	0.1
Sodium	2.8	Sodium	0.1
Potassium	2.6	Hydrogen	0.05
Magnesium	2.1	Potassium	0.04
Zinc	0.0078	Calcium	0.04
Copper	0.0068		
Tin	0.00022		

(a) Which metallic elements are more abundant in the Earth's crust compared to the Earth's core?

…… [1]

(b) Suggest a reason why oxygen is the most abundant element in the earth's crust.

……

……

…… [1]

(c) The estimated mass of the earth's crust is 2.125×10^{16} kg. The annual production of iron is 3.32×10^{9} tonnes. Assuming that the demand for this metal is the same each year, determine the number of years before the supply of iron from the Earth's crust runs out. (1 tonne = 1000 kg)

[2]

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(d) **Briefly** describe **one** advantage and **one** disadvantage of recycling metals.

Advantage : …….

……

Disadvantage : ……

…… [2]

(e) Globally, iron and aluminium are the most recycled metals because of the ease of recycling them. Suggest a property of each of these 2 metals that accounts for this.

Iron : …….

……

Aluminium : …….

…… [2]

A student studied the action of heat on 4 different substances (**A**, **B**, **C** and **D**). He knew that two of them were metals, and the other two were carbonates of the same two metals. He weighed out 5.00 g of each of the four solids and heated them in separate crucibles.

The table below shows the appearances and masses of the four solids before and after strong heating for some time.

Solid	Appearance		Mass/g	
	Before	**After**	**Before**	**After**
A	Brown	Black	5.00	6.25
B	Green	Black	5.00	3.22
C	White	White	5.00	5.00
D	Silvery	White	5.00	6.73

(f) Based on the data given above, suggest which 2 were the metals and which 2 were the metal carbonates. Explain your answers.

Metals : Solid …… and Solid ……

Metal carbonates : Solid …… and Solid …… [1]

Explanation : …….

……

……

……

…… [3]

[Total 12]

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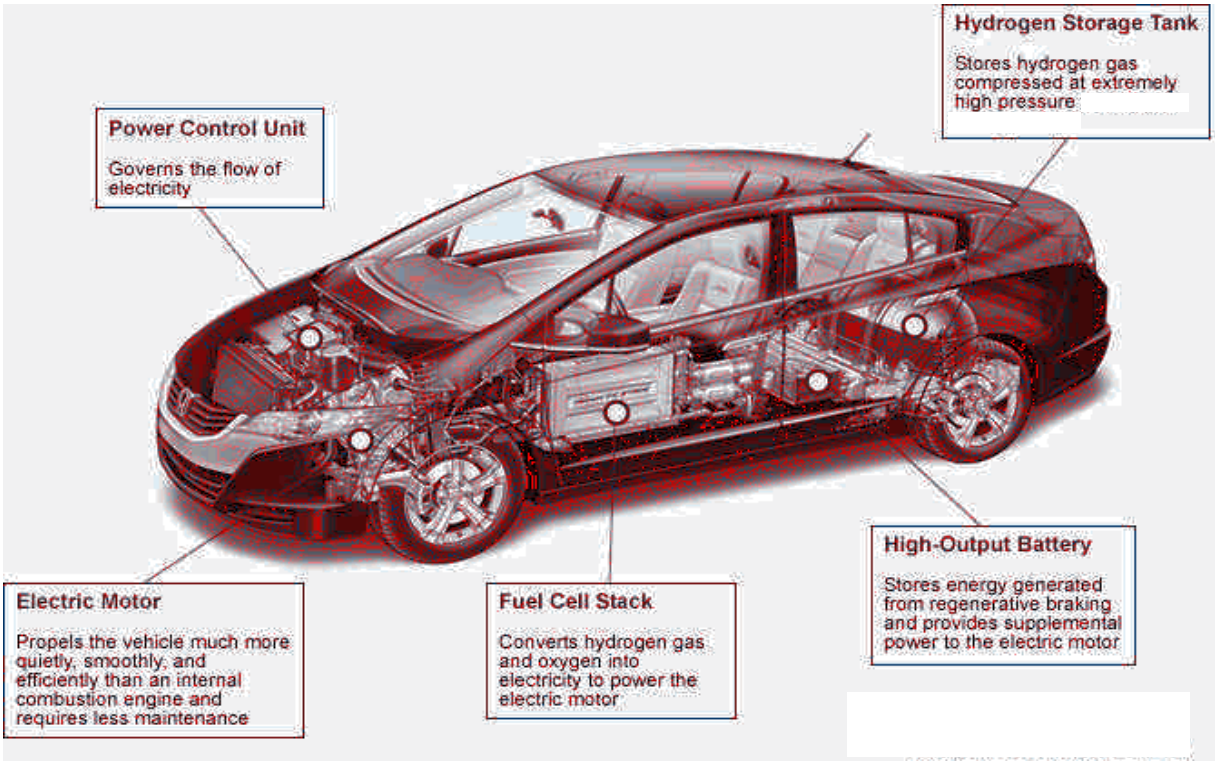
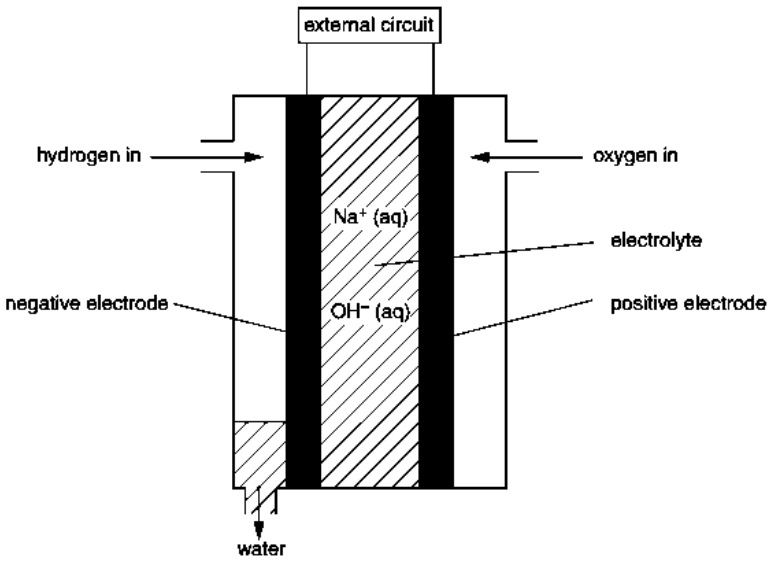
B9 The diagram below shows the internal setup of a modern eco-friendly car powered by hydrogen-oxygen fuel cells. The main advantages of the use of fuels cells is that hydrogen is an efficient source of energy and it does not cause pollution at the point of use.



The diagram below shows the hydrogen-oxygen fuel cell used in such a car.



At the positive electrode, the reaction which takes place is :

$$O_2\,(g) + 2H_2O\,(l) + 4\,e \rightarrow 4OH^-\,(aq)$$

At the negative electrode, the reaction which takes place is :

$$2H_2\,(g) + 4OH^-\,(aq) \rightarrow 4H_2O\,(l) + 4\,e$$

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(a) Write the overall equation for the reaction in the fuel cell.

…….. [1]

(b) Briefly explain why the use of fuel cells does not cause pollution at the point of use.

…….. [1]

(c) Suggest why the use of fuel cells may still generate pollution.

……..

…….. [1]

(d) Manufacturers claim that hydrogen is a renewable fuel. Do you agree? Explain your answer.

……..

…….. [1]

(e) Give a source of oxygen.

…….. [1]

(f) Suggest why the hydrogen and oxygen must be kept apart.

……

…… [1]

(g) Briefly describe one advantage and one disadvantage of compressing hydrogen fuel at high pressure.

Advantage : …….

……

Disadvantage : ……

…… [2]

[Total 8]

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EITHER

B10 One of the components in crude oil is undecane, $C_{11}H_{24}$. This molecule may be broken down into butene and one other product. The reaction is carried out in the oil refinery.

(a) What is the name of this type of reaction?

…… [1]

(b) Write the equation for this reaction.

…… [1]

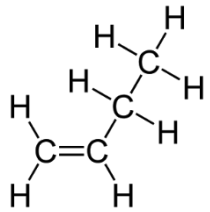
(c) Suggest **2** conditions required for this reaction to take place

…… [1]

(d) When the reaction is carried out, 1.00 mol of undecane gives 25.2 g of butene. Calculate the percentage yield of butene.

[2]

Butene can exist as 3 isomers. One of the isomers, but-1-ene, is shown in the diagram below.



(e) Draw the structures of the other 2 isomers of butene.

[2]

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(f) The isomers of butene can undergo addition polymerization. Draw the structure of the polymer formed by any **1** of the isomers in part (e), showing **3** repeating units.

[1]

Butan-2-ol is manufactured by the reaction between steam and butene. An isomer of butan-2-ol is also formed at the same time. The 2 isomers are miscible.

(g) Suggest, with reason, a method suitable for separating the components of the mixture of products.

Method : ……

Reason : …… [2]

[Total 10]

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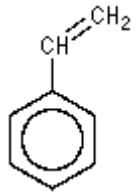
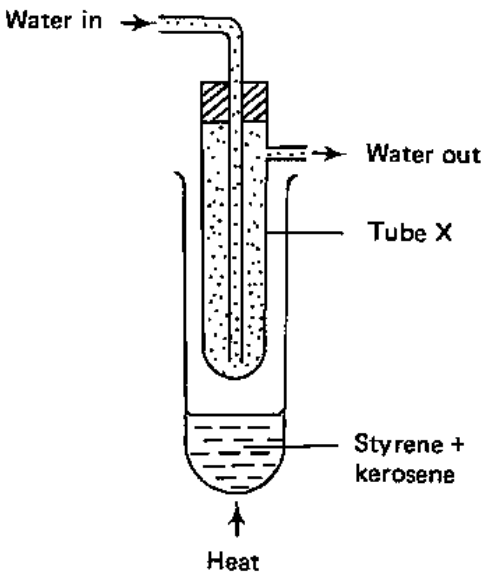
OR

B10 The compound styrene (chemical formula C_8H_8) has the following structure



It can undergo addition polymerisation to form polystyrene, a non-biodegradable thermoplastic polymer used for making disposable utensils such as styrofoam cups and plates. The polymerisation process is carried out by mixing styrene and kerosene and refluxing the mixture at about 150°C using the setup shown below.



After cooling, the reaction mixture is poured into methanol. Polystyrene, which appears as a waxy white solid will then form under the surface of the methanol.

(a) Suggest the function of

(i) tube **X** and

…… [1]

(ii) kerosene**.**

…… [1]

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(b) Draw the structural formula of polystyrene formed, showing 3 repeating units.

[1]

(c) What is meant by the term “non-biodegradable”?

……

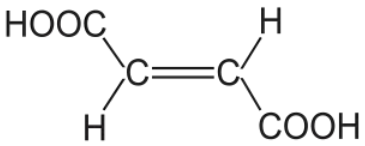
…… [1]

(d) Suggest a reason why polystyrene produces a lot of soot when burnt.

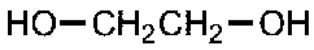
……

…… [1]

The structural formulae of two organic compounds, butenedioic acid and ethane- 1,2-diol are shown below.



butenedioic acid



ethane- 1,2- diol

(e) Butenedioic acid reacts with aqueous bromine and also with aqueous sodium carbonate. State an observation for each reaction and briefly explain why it is observed.

Reactant	Observation	Explanation
Aqueous bromine		
Aqueous sodium carbonate		

[4]

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(f) Butenedioic acid and ethane-1,2-diol can polymerize under the right conditions to form a polymer W. Draw the repeating unit of this polymer.

[1]

[Total 10]

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DATA SHEET
The Periodic Table of the Elements

Group																	
I	II										III	IV	V	VI	VII	0
							1 **H** Hydrogen 1									4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4										11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12										27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	64 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
86 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	[98] **Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57 *	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	[209] **Po** Polonium 84	[210] **At** Astatine 85	[222] **Rn** Radon 86
[223] **Fr** Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 †															

140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	[145] **Pm** Promethium 61	150 **Sm** Samarium 62	152 **Eu** Europium 63	157 **Gd** Gadolinium 64	159 **Tb** Terbium 65	162 **Dy** Dysprosium 66	165 **Ho** Holmium 67	167 **Er** Erbium 68	169 **Tm** Thulium 69	173 **Yb** Ytterbium 70	175 **Lu** Lutetium 71
232 **Th** Thorium 90	[231] **Pa** Protactinium 91	238 **U** Uranium 92	[237] **Np** Neptunium 93	[244] **Pu** Plutonium 94	[243] **Am** Americium 95	[247] **Cm** Curium 96	[247] **Bk** Berkelium 97	[251] **Cf** Californium 98	[254] **Es** Einsteinium 99	[253] **Fm** Fermium 100	[256] **Md** Mendelevium 101	[254] **No** Nobelium 102	[257] **Lr** Lawrencium 103

*58-71 Lanthanoid series
†90-103 Actinoid series

Key: a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

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

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SINGAPORE CHINESE GIRLS' SCHOOL
Preliminary Examination
Secondary Four

CANDIDATE NAME							
CLASS	4			REGISTER NUMBER			
CENTRE NUMBER					INDEX NUMBER			

Chemistry

5073/02

Paper 2 Theory

Thursday **4 August 2016** **1 hour 45 minutes**

Candidates answer on the Question Paper.
No Additional materials are required.
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, highlighters, glue or correction fluid/tape.

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

Section B
Answer **all** 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 printed on page 20.

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

Answers

For Examiner's Use	
Section A	/50
B8	/12
B9	/8
B10	/10
Total	/80

This question paper consists of **20** printed pages.

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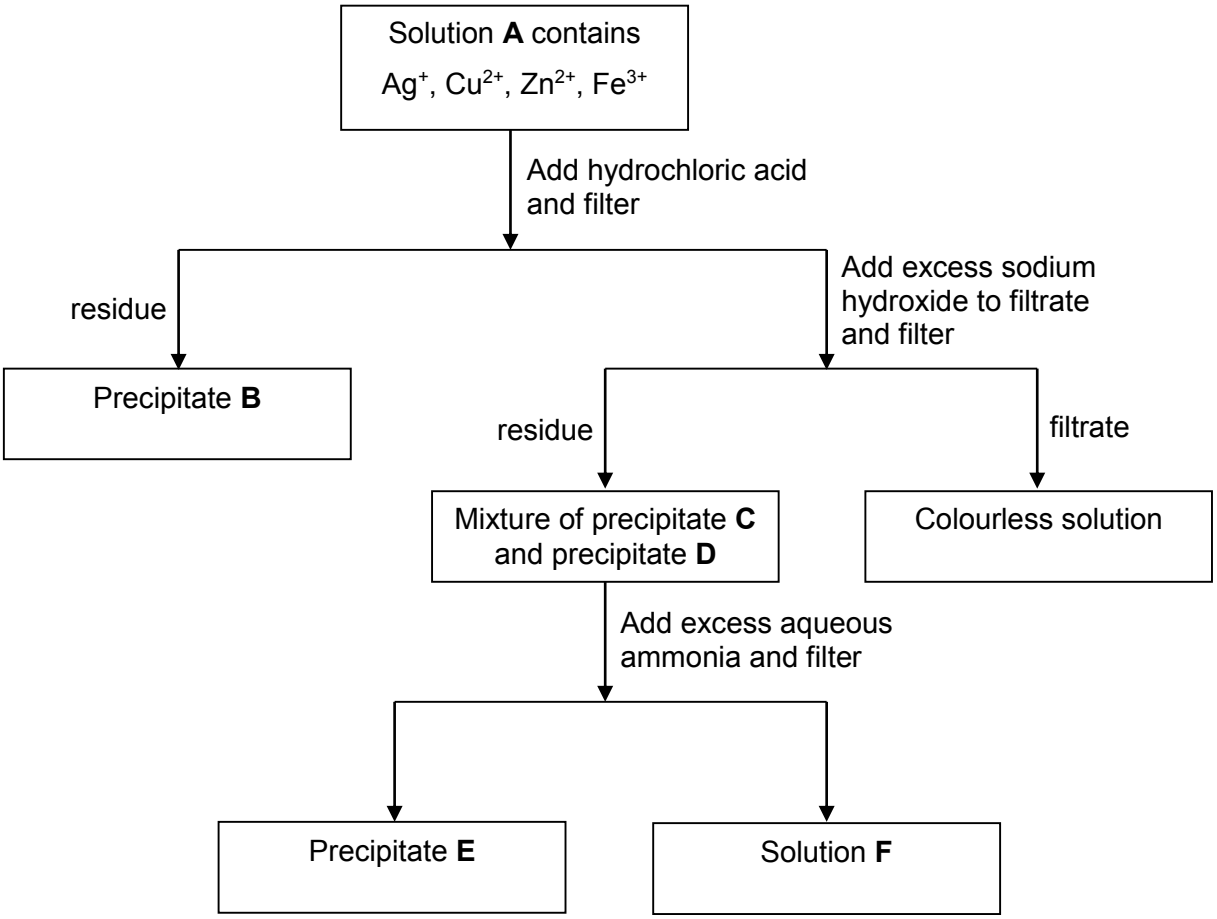
Section A

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

A1 The flowchart below shows how the ions present in solution **A** are separated.



(a) It is known that solution **A** contains 1 anion. Suggest the identity of this anion. Give a reason for your answer.

Identity of anion : Nitrate **1m**

Reason : All nitrates are soluble **1m** [2]

(b) Describe a test to confirm the anion you named in part (a).

Add aqueous sodium hydroxide, Devarda's alloy/aluminium and warm; **1m**

Gas given off turns moist red litmus paper blue **1m**

…… [2]

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(c) Name the precipitates **B**, **C** and **D**.

B : silver chloride **1m**

C : copper(II) hydroxide **1m**

D : iron(III) hydroxide **1m**

Answers to C and D interchangeable

[3]

(d) What are the colours of precipitate **E** and Solution **F**?

Precipitate **E** : reddish brown **1m**

Solution **F** : dark blue **1m** [2]

[Total: 9]

A2 The level of dissolved oxygen is used as an indicator to gauge the health of a water body. Generally, the higher the concentration of dissolved oxygen, the less polluted the water and the more likely it is able to support living organisms. To measure the level of oxygen in a sample of water, the Winkler Method is used. This technique makes use of redox reactions and is carried out in the 3 steps shown below.

Reaction 1 : $2Mn^{2+}(aq) + O_2(g) + 4OH^-(aq) \rightarrow 2MnO_2(s) + 2H_2O(l)$

Reaction 2 : $MnO_2(s) + 2I^-(aq) + 4H^+(aq) \rightarrow Mn^{2+}(aq) + I_2(aq) + 2H_2O(l)$

Reaction 3 : $2S_2O_3^{2-}(aq) + I_2(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$

(a) Define a redox reaction.

Reaction which involves oxidation and reduction simultaneously **1m**

……

…… [1]

(b) Choose any **one** of the above reactions and explain why it is a redox reaction, making reference to oxidation states.

Reaction 1 : Oxidation state of Mn increases from +2 in Mn^{2+} to +4 in MnO_2 **1m**
Oxidation state of O decreases from 0 in O_2 to -2 in MnO_2/H_2O **1m**

Reaction 2 : Oxidation state of Mn decreases from +4 in MnO_2 to +2 in Mn^{2+} **1m**
Oxidation state of I increases from -1 in I^- to 0 in I_2 1m

Reaction 3 : Oxidation state of S increases from +2 in $S_2O_3^{2-}$ to +2.5 in $S_4O_6^{2-}$ **1m**
Oxidation state of I decreases from 0 in I_2 to -1 in I^- **1m**

[2]

Any 1 of above

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(c) 100 cm^3 of water was taken from the school's koi pond and analysed using this method. It was found that 0.0008 mole of iodide ions was formed in step 3. Calculate the mass of oxygen dissolved in this sample of pond water.

0.0008 moles of I^- is produced by 0.0004 mole of I_2
0.0004 moles of I_2 is produced by 0.0004 mole of MnO_2
0.0004 moles of MnO_2 is produced by 0.0002 mole of O_2

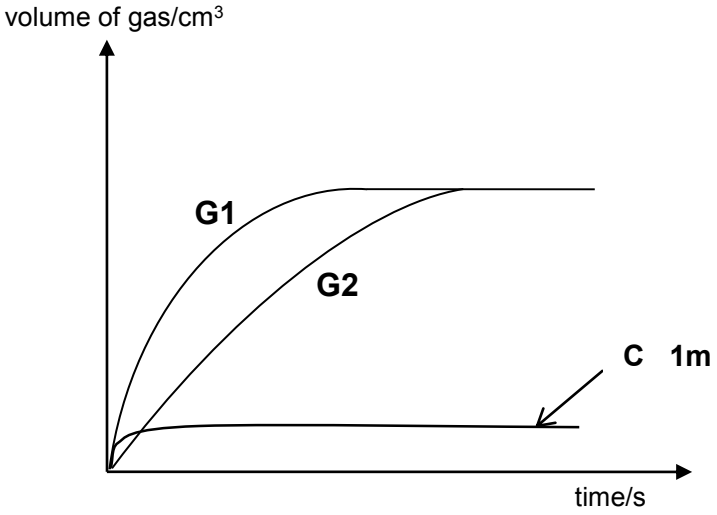
} Explanation **1m**

Mass of oxygen dissolved = 0.0002 x 32 = 0.0064 g **1m**

[2]

[Total: 5]

A3 A sample of 3.36 g of magnesium carbonate powder was divided equally into two portions. One portion was added into hydrochloric acid and the other portion was added into sulfuric acid. The volume and concentration of acids used were both 25.0 cm^3 and 5.00 mol/dm^3 respectively. The graphs below (**G1** and **G2**) show the volume of the gas collected over time.



(a) Which graph represents the results for hydrochloric acid? Explain your answer in terms of particle collision.

Graph G2 **1m**

Explanation : sulfuric acid is dibasic while hydrochloric acid is monobasic acid,

concentration of hydrogen ions in HCl is half that of H_2SO_4 ; **1m**

frequency of collisions is lower and hence number of effective collisions per

unit time is less in HCl compared to H_2SO_4; **1m**

rate of reaction is slower, graph is less steep; **1m**

MgCO3 is the same limiting reactant **1m**

Any 4 out of 5 points **4m**

…… [4]

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(b) Another experiment was carried out by adding 2.00 g calcium carbonate powder into 25.0 cm^3 of sulfuric acid of concentration 5.00 mol/dm^3. On the same axes, sketch the graph you will expect to obtain and label it **C**. [1]

(c) Explain the shape of your graph.

Calcium carbonate reacts with sulfuric acid to form calcium sulfate which is insoluble ; **1m**

layer of calcium sulfate around calcium carbonate prevents further reaction with the acid **1m**

…… [2]

[Total: 7]

A4 Astatine, At, is an element in Group VII of the Periodic Table. It exists as diatomic molecules similar to the other elements in the same Group. 2 isotopes of astatine are known to exist : astatine-210 and astatine-211. It reacts with strontium (Sr) to form the compound strontium astatide.

symbol	number of protons	number of electrons	number of neutrons
$^{210}_{85}At$	..... 85	..... 85	..... 125 .....
$^{211}_{85}At$	..... 85	..... 85	..... 126 .....

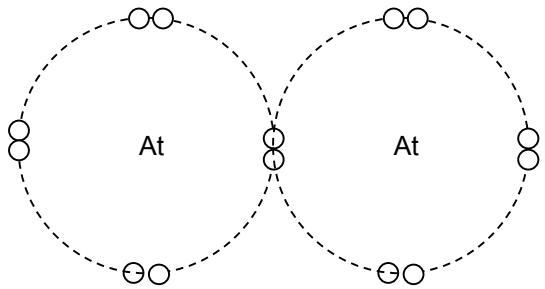
(a) Complete the table above. All correct **1m** [1]

(b) What are isotopes?

Atoms of same element with same number of protons but different number of neutrons **1m**

…… [1]

(c) Draw the 'dot-and-cross' diagram for an astatine molecule, showing only the outer shell electrons.



Correct number of electrons and 1 pair of shared electrons **1m**

[1]

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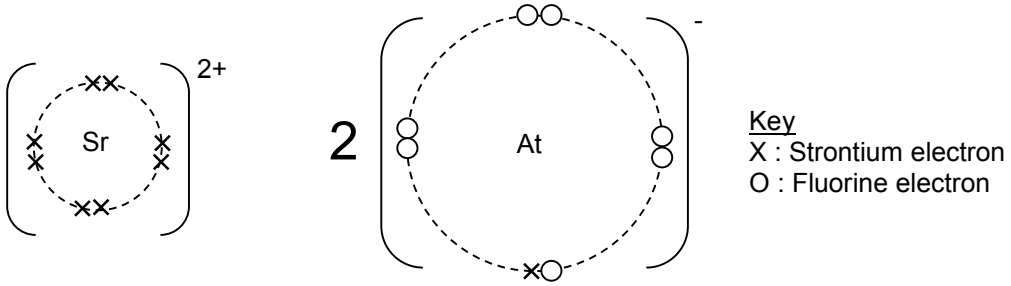
(d) Draw the "dot-and-cross" diagram of strontium astatide, showing only the outer shell electrons. Hence write the chemical formula of this compound.



1m **1m**

Formula of strontium astatide : $SrAt_2$ **1m** [3]

(e) Predict 2 properties of strontium astatide. Give a reason for each of the properties which you state.

Property 1 : high melting/boiling point **1m**

Reason : strong electrostatic forces of attraction between ions, a lot of energy required to overcome them **1m** [2]

Property 2 : can conduct electricity in the molten/aqueous state **1m**

Reason : mobile ions in the molten/aqueous state **1m**

[2]

[Total: 10]

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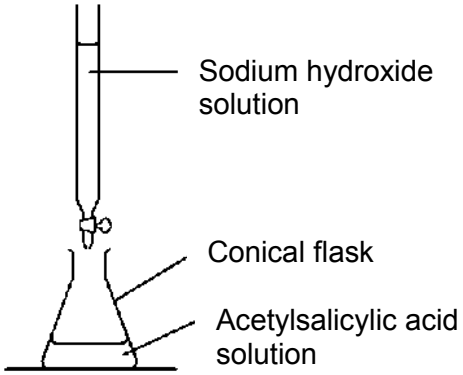
A5 The drug aspirin is used to relieve pain, fever and inflammation. However, if taken in high doses, it can cause gastric ulcers and bleeding in the stomach. The active ingredient is acetylsalicylic acid which a monobasic acid. The formula of the acid can be represented by HA and its relative molecular mass is 180.

A student was interested in determining the percentage of the acid in an aspirin tablet. An aspirin tablet was first weighed and then dissolved in water to make a solution in a conical flask. A few drops of indicator were then added and dilute sodium hydroxide solution was run in from a burette until the indicator changed colour.



The results were as follows :

Mass of aspirin tablet taken	0.50 g
Volume of dilute sodium hydroxide added	23.0 cm^3
Concentration of the dilute sodium hydroxide added	0.01 mol/dm^3

(a) Acetylsalicylic acid is a weak acid. Explain what is a *weak* acid.

Acid undergoes partial ionization in water **1m**

…… [1]

(b) Explain why it is **not** important to know the volume of the aspirin solution originally taken.

All the acetylsalicylic acid is dissolved in the water regardless of its volume **1m**

…… [1]

(c) Calculate the number of moles of sodium hydroxide solution added. Hence, calculate the percentage of acetylsalicylic acid in the aspirin tablet.

No of moles of NaOH = (23.0/1000) x 0.01 = 0.00023
Hence, no of moles of acid present = 0.00023 **1m**
Mass of acetylsalicylic acid present = 0.00023 x 180 = 0.0414 g **1m**

Hence, percentage of acetylsalicylic acid in tablet = (0.0414/0.50) x 100%
= 8.28% **1m**

[3]

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(d) The student wanted to make a crystalline sample of sodium acetylsalicylate, the salt formed in the reaction. This salt decomposes on strong heating. Describe briefly how this might be carried out using a solution of pure acetylsalicylic acid.

Determine the exact volume of sodium hydroxide required to neutralize a fixed volume of acetylsalicylic acid by titration using a suitable indicator. Repeat a few times to obtain accurate result ;

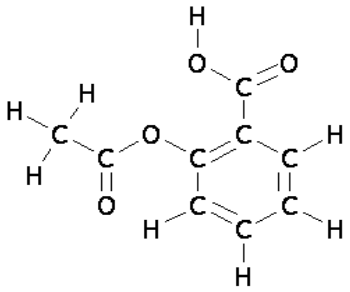
Add exact volume of sodium hydroxide into fixed volume of acetylsalicylic acid but do not add indicator, **1m** heat to obtain saturated solution and cool solution to allow crystallization to take place; **1m** filter to obtain crystals and dry between pieces of filter paper. **1m**

……

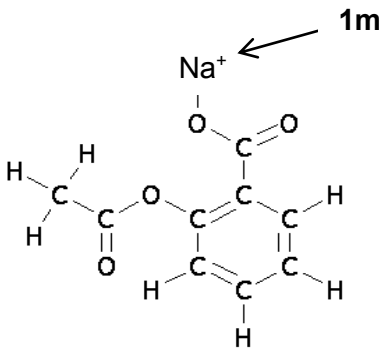
……

…… [3]

(e) The structure of acetylsalicylic acid is given below.



Draw the structure of sodium acetylsalicylate.



[1]

[Total: 9]

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A6 A student carried out electrolysis of dilute potassium chloride and molten potassium chloride using platinum electrodes to determine what products are formed.

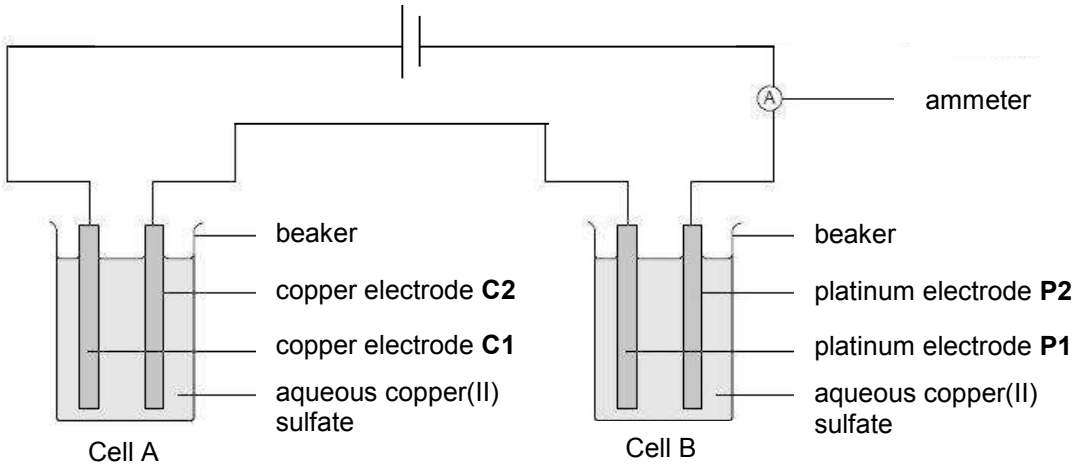
(a) Complete the table below.

Electrolyte	Ions in Electrolyte	Product at anode	Product at cathode
Dilute potassium chloride	$\underline{H^+}$, $\underline{OH^-}$, $\underline{K^+}$, $\underline{Cl^-}$	oxygen	<u>hydrogen</u>
Molten potassium chloride	K^+, Cl^-	<u>chlorine</u>	<u>potassium</u>

All correct **2m**, 2-3 correct **1m,** 0-1 correct **0m**

[2]

In another investigation, the electrolysis of aqueous copper(II) sulfate was carried out using the apparatus shown in the diagram below.



(b) **Briefly** describe the change(s), if any, which take place at the electrodes and electrolytes at the end of the experiment in the table below.

	Change(s), if any
Electrode **C1**	Copper electrode becomes <u>thinner/smaller</u>
Electrode **C2**	Copper electrode becomes <u>thicker/bigger</u>
Electrolyte (Cell A)	<u>No visible change</u>, solution remains blue

	Change(s), if any
Electrode **P1**	<u>Bubbles of gas observed</u>, colourless gas given off
Electrode **P2**	<u>Brown solid</u> appears on the electrode
Electrolyte (Cell B)	<u>Blue solution becomes pale blue/colourless</u>

All correct **3m**, 4-5 correct **2m,** 2-3 correct **1m,** 0-1 correct **0m**

[3]

[Total: 5]

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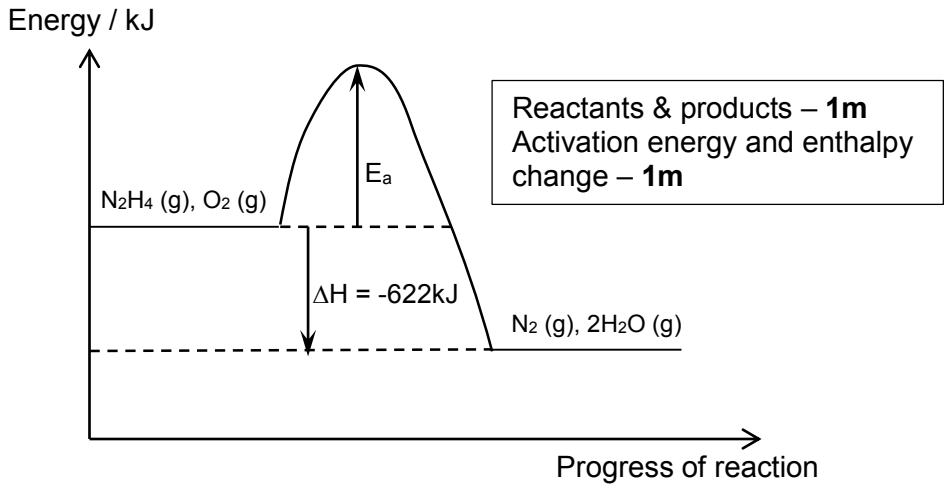
A7 Hydrazine (N_2H_4) is often used as a rocket fuel. It can react with oxygen or fluorine to release large amounts of heat. The equations for the 2 reactions are shown below.

$$N_2H_4\ (g) + O_2\ (g) \rightarrow N_2\ (g) + 2H_2O\ (g) \qquad \Delta H = -622kJ$$

$$N_2H_4\ (g) + 2F_2\ (g) \rightarrow N_2\ (g) + 4HF\ (g) \qquad \Delta H = -1166kJ$$

The ΔH values represent the energy change per mole of hydrazine reacted.

(a) Draw the energy profile diagram for the reaction between hydrazine and oxygen, showing the activation energy and the enthalpy change clearly.



Reactants & products – **1m**
Activation energy and enthalpy change – **1m**

[2]

(b) Based only on the information provided above, which other reactant (oxygen or fluorine) would have made a better choice for usage as a rocket fuel together with hydrazine? Briefly explain your answer.

Fluorine would be a better choice ;

Reaction with fluorine is more exothermic/releases more energy compared **1m**

to reaction with oxygen, enabling the rocket to travel further **1m**

……

……

…… [2]

(c) State 1 other factor that should be taken into consideration when deciding which fuel to use.

Cost/availability of gas/how "clean" reaction is/toxicity of gas/mass of gas [1]

Any 1 of above **1m**

[Total: 5]

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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.

B8 The table below gives the current estimated percentage by mass of some of the elements found in the Earth's crust and the Earth's core.

Earth's Crust		**Earth's Core**	
Element	% by Mass	Element	% by Mass
Oxygen	40.6	Iron	31.0
Silicon	24.7	Oxygen	24.0
Nickel	8.1	Magnesium	16.0
Aluminium	8.1	Silicon	13.0
Iron	5.0	Nickel	11.7
Calcium	3.6	Aluminium	0.1
Sodium	2.8	Sodium	0.1
Potassium	2.6	Hydrogen	0.05
Magnesium	2.1	Potassium	0.04
Zinc	0.0078	Calcium	0.04
Copper	0.0068		
Tin	0.00022		

(a) Which metallic elements are more abundant in the Earth's crust compared to the Earth's core?

Aluminium, calcium, sodium, potassium (can include zinc, copper, tin) **1m** [1]

(b) Suggest a reason why oxygen is the most abundant element in the earth's crust.

Oxygen, though a gas, is combined with other elements such as metals and

silicon in the form of oxides **1m**

…… [1]

(c) The estimated mass of the earth's crust is 2.125×10^{16} kg. The annual production of iron is 3.32×10^{9} tonnes. Assuming that the demand for this metal is the same each year, determine the number of years before the supply of iron from the Earth's crust runs out. (1 tonne = 1000 kg)

Mass of iron in Earth's crust = (5/100) x 2.125×10^{16} = 1.0625×10^{15}kg **1m**

3.32×10^{9} tonnes = 3.32×10^{12} kg

Hence no. of years Earth's crust can supply iron = 1.0625×10^{15}kg ÷ 3.32×10^{12}

= 320 years **1m**

[2]

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(d) **Briefly** describe **one** advantage and **one** disadvantage of recycling metals.

Advantage : conserve natural resources/reduce environmental problems

related to mining of land/ save cost of extracting metals from ores Any 1, **1m**

Disadvantage : High costs related to get people to do recycling/ environmental

issues related to release of harmful substances into environment Any 1, **1m** [2]

(e) Globally, iron and aluminium are the most recycled metals because of the ease of recycling them. Suggest a property of each of these 2 metals that accounts for the ease of recycling them.

Iron : magnetic property of iron enables it to be separated easily using

electromagnets **1m**

Aluminium : not easily corroded due to the layer of oxide **1m**

…… [2]

A student studied the action of heat on 4 different substances (**A**, **B**, **C** and **D**). He knew that two of them were metals, and the other two were carbonates of the same two metals. He weighed out 5.00 g of each of the four solids and heated them in separate crucibles.

The table below shows the appearances and masses of the four solids before and after strong heating for some time.

Solid	Appearance		Mass/g	
	Before	**After**	**Before**	**After**
A	Brown	Black	5.00	6.25
B	Green	Black	5.00	3.22
C	White	White	5.00	5.00
D	Silvery	White	5.00	6.73

(f) Based on the data given above, suggest which 2 were the metals and which 2 were the metal carbonates. Explain your answers.

Metals : Solid **A** and Solid **D**

Metal carbonates : Solid **B** and Solid **C** ALL 4 correct, **1m** [1]

Explanation : A and D has increased in mass due to reaction with oxygen in

the air to form metal oxide ; **1m** **B** has decreased in mass as carbonate

decompose on heating to form metal oxide and carbon dioxide; **1m**

C is carbonate of reactive metal as it is stable and does not decompose on

heating **1m** [3]

[Total 12]

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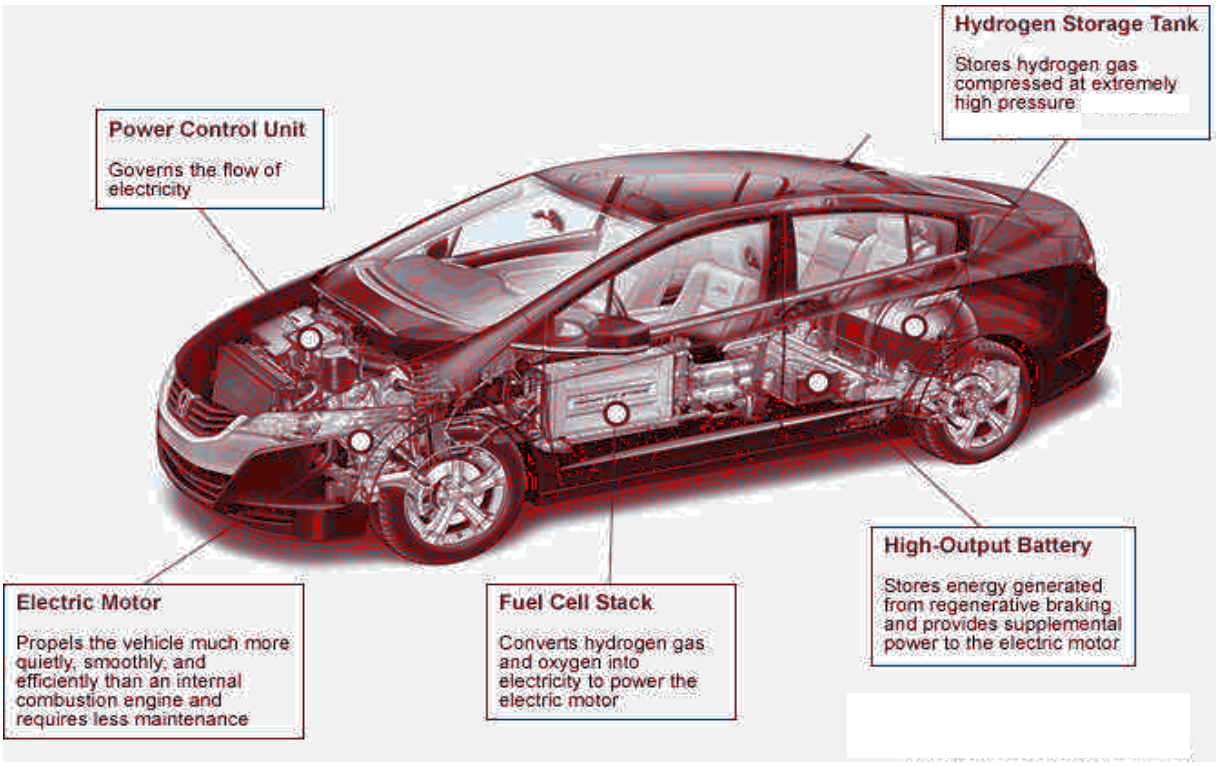
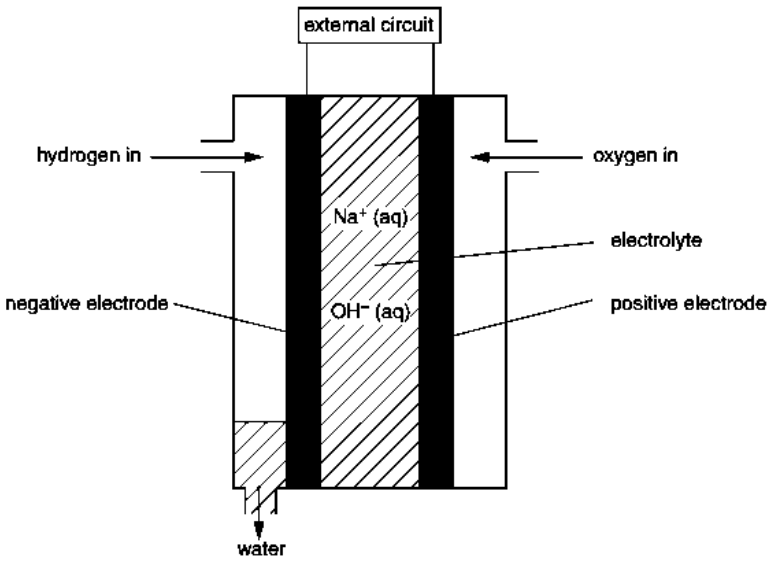
B9 The diagram below shows the internal setup of a modern eco-friendly car powered by hydrogen-oxygen fuel cells. The main advantages of the use of fuels cells is that hydrogen is an efficient source of energy and it does not cause pollution at the point of use.



The diagram below shows the hydrogen-oxygen fuel cell used in such a car.



At the positive electrode, the reaction which takes place is :

$$O_2\,(g) + 2H_2O\,(l) + 4\,e \rightarrow 4OH^-\,(aq)$$

At the negative electrode, the reaction which takes place is :

$$2H_2\,(g) + 4OH^-\,(aq) \rightarrow 4H_2O\,(l) + 4\,e$$

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(a) Write the overall equation for the reaction in the fuel cell.

$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$ **1m** [1]

(b) Briefly explain why the use of fuel cells does not cause pollution at the point of use.

Only product of reaction is water which is harmless **1m** [1]

(c) Suggest why the use of fuel cells may still generate pollution.

Hydrogen obtained from cracking/electrolysis still requires a lot of heat/electricity which comes from burning of fossil fuels **1m** [1]

(d) Manufacturers claim that hydrogen is a renewable fuel. Do you agree? Explain your answer.

No, hydrogen is not renewable. It is obtained from cracking of long-chained alkanes which is not renewable. **1m** [1]

(e) Give a source of oxygen.

oxygen from the air/fractional distillation of liquid air **1m** [1]

(f) Suggest why the hydrogen and oxygen must be kept apart.

Hydrogen and oxygen can react explosively if a spark is present **1m**

…… [1]

(g) Briefly describe one advantage and one disadvantage of compressing hydrogen fuel at high pressure.

Advantage : Hydrogen is a gas, compression will allow a greater mass to be carried in the tank so travel longer distances **1m**

Disadvantage : Hydrogen needs highly pressurized containers which are heavy hence difficult to transport **1m** [2]

[Total 8]

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EITHER

B10 One of the components in crude oil is undecane, $C_{11}H_{24}$. This molecule may be broken down into butene and one other product. The reaction is carried out in the oil refinery.

(a) What is the name of this type of reaction?

Cracking **1m** [1]

(b) Write the equation for this reaction.

$C_{11}H_{24} \rightarrow C_4H_8 + C_7H_{16}$ **1m** [1]

(c) Suggest **2** conditions required for this reaction to take place

Catalyst, high temperature Both points **1m** [1]

(d) When the reaction is carried out, 1.00 mol of undecane gives 25.2 g of butene. Calculate the percentage yield of butane.

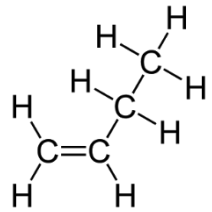
1 mole of undecane gives 1 mole of butene

Molar mass of butene is 56 g **1m**

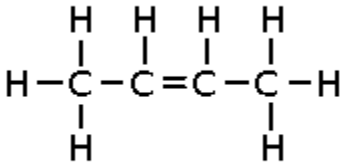
Hence percentage yield = (25.2/56) x 100% = 45.0% **1m**

[2]

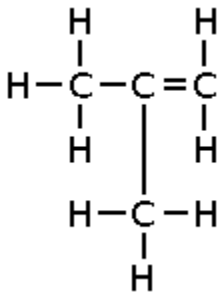
Butene can exist as 3 isomers. One of the isomers, but-1-ene, is shown in the diagram below.



(e) Draw the structures of the other 2 isomers of butene.



1m



1m

[2]

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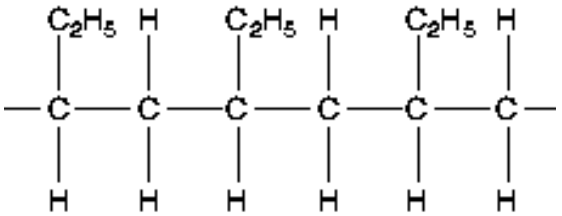
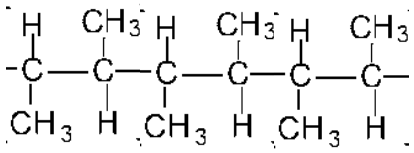
(f) The isomers of butene can undergo addition polymerization. Draw the structure of the polymers formed by any **1** of the isomers in part (e), showing **3** repeating units.



or



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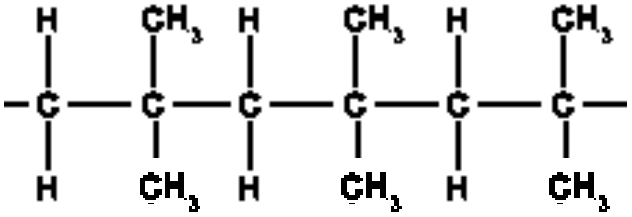

1m [1]

[1]

Butan-2-ol is manufactured by the reaction between steam and butene. An isomer of butan-2-ol is also formed at the same time. The 2 isomers are miscible.

(g) Suggest, with reason, a method suitable for separating the components of the mixture of products.

Method : <u>Fractional distillation</u> **1m**

Reason : They have <u>different boiling points</u> **1m** [2]

[Total 10]

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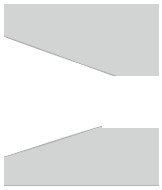
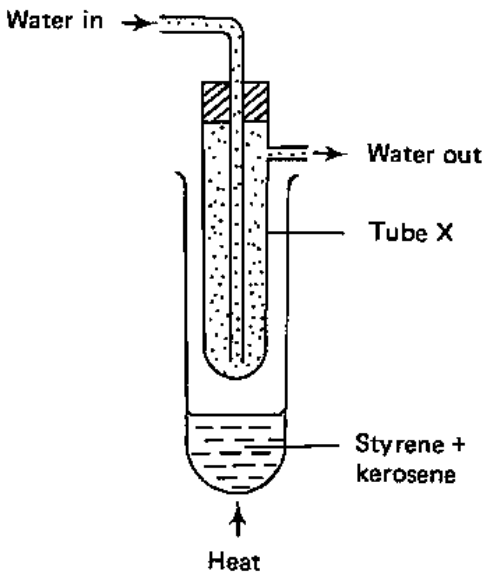
OR

B10 The compound styrene (chemical formula C_8H_8) has the following structure



It can undergo addition polymerisation to form polystyrene, a non-biodegradable thermoplastic polymer used for making disposable utensils such as styrofoam cups and plates. The polymerisation process is carried out by mixing styrene and kerosene and refluxing the mixture at about 150°C using the setup shown below.



After cooling, the reaction mixture is poured into methanol. Polystyrene, which appears as a waxy white solid will then form under the surface of the methanol.

(a) Suggest the function of

(i) tube **X** and

Provide cool surface to allow styrene/kerosene to condense **1m** [1]

(ii) kerosene**.**

Solvent. catalyst (Any 1, **1m)** [1]

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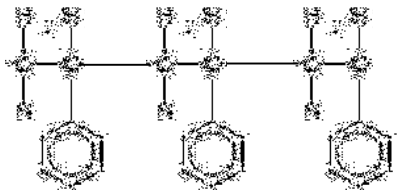
(b) Draw the structural formula of polystyrene formed, showing 3 repeating units.



1m

[1]

(c) What is meant by the term “non-biodegradable”?

Cannot be broken down by bacteria **1m**

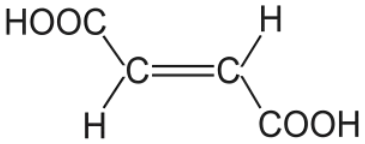
…… [1]

(d) Suggest a reason why polystyrene produces a lot of soot when burnt.

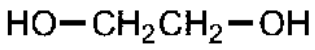
High percentage of carbon in the compound **1m**

…… [1]

The structural formulae of two organic compounds, butenedioic acid and ethane- 1,2-diol are shown below.



butenedioic acid



ethane- 1,2- diol

(e) Butenedioic acid reacts with aqueous bromine and also with aqueous sodium carbonate. State an observation for each reaction and briefly explain why it is observed.

Reactant	Observation	Explanation
Aqueous bromine	Reddish brown bromine decolourised **1m**	Addition reaction takes place to form colourless products **1m**
Aqueous sodium carbonate	Effervescence **1m**	Acid reacts with carbonates to form carbon dioxide gas which appear as bubbles **1m**

[4]

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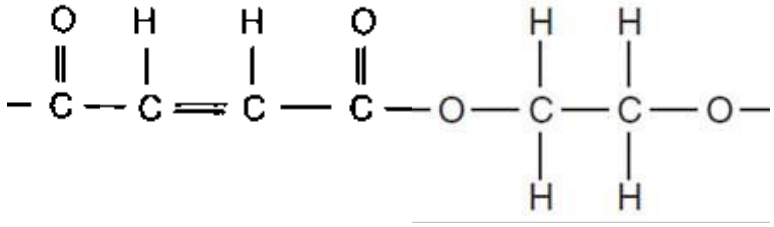
(f) Butenedioic acid and ethane-1,2-diol can polymerize under the right conditions to form a polymer W. Draw the repeating unit of this polymer.



1m

[1]

[Total 10]

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DATA SHEET
The Periodic Table of the Elements

Group																	
I	II										III	IV	V	VI	VII	0
							1 H Hydrogen 1									4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4										11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12										27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

*58-71 Lanthanoid series
†90-103 Actinoid series

Key: a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

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

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Candidate's Name : _____ Class Register No.

TANJONG KATONG GIRLS' SCHOOL
PRELIMINARY EXAMINATION 2016
SECONDARY FOUR

5073 **CHEMISTRY**

Friday 16 September 2016 1h

Additional Materials: Optical Answer Sheet (OAS)
Soft clean eraser
Soft pencil (type B or HB recommended)

INSTRUCTIONS TO CANDIDATES

DO not open this booklet 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 optical 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 optical 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 in this booklet.

A copy of the Periodic Table is printed on page 18.

Setter(s) : Mrs Lee-Ng Suan Ching

This Question Paper consists of 18 printed pages, including this page.

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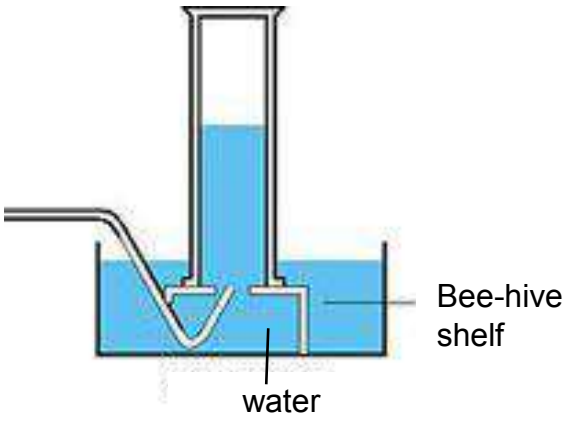
1 The diagram below shows the apparatus used for collecting a sample of gas in the laboratory.



Which set of gases can be collected using this method?

A ammonia and chlorine

B hydrogen chloride and hydrogen

C carbon monoxide and nitrogen

D sulfur dioxide and ammonia

2 Naturally occurring silver (proton number: 47; relative atomic mass: 108) consists of a mixture of two isotopes ^{107}Ag and ^{109}Ag.

Which of the following statements about silver atoms is likely to be correct?

A All silver atoms have a relative atomic mass of 108.

B Atoms of ^{107}Ag are more abundant than those of ^{109}Ag.

C Both ^{107}Ag and ^{109}Ag atoms form positive ion with the same charge.

D Both ^{107}Ag and ^{109}Ag atoms have the same number of neutrons.

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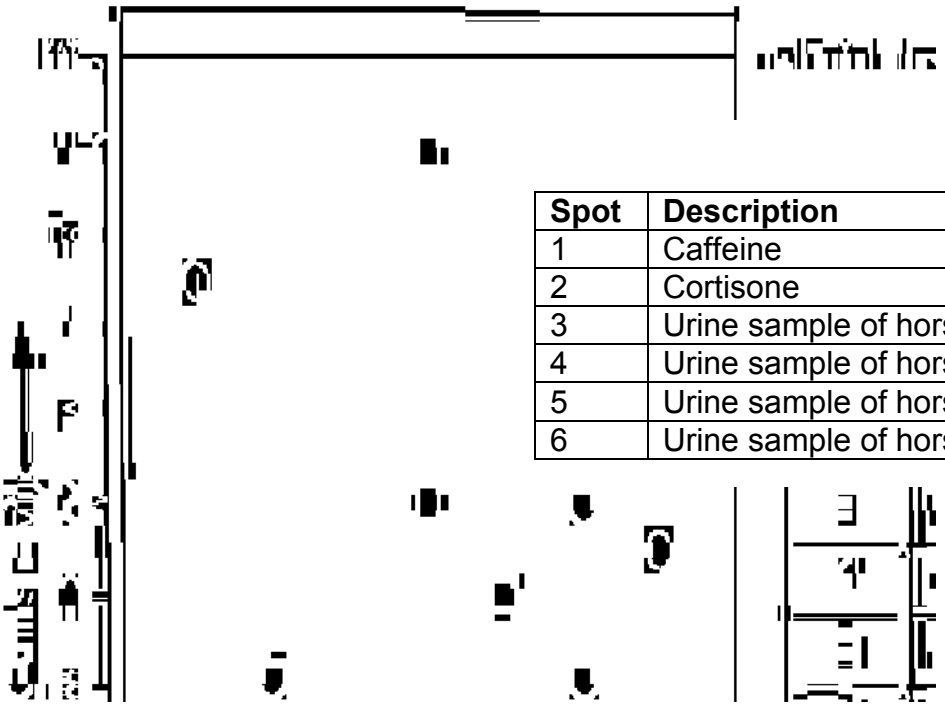
3 Substance **X** melts at 53°C and boils at 100°C. It dissolves in water but does not react with water.

Which of the following method is most suitable for separating **X** from a mixture of **X** and water?

A distillation **B** fractional distillation

C filtration **D** crystallisation

4 Prior to a race, urine samples from race horses are collected to test for the presence of caffeine and cortisone. If these banned drugs were found in the urine samples, the horses would be disqualified. The chromatogram below is obtained from the chromatography performed on caffeine, cortisone and urine samples from 4 different horses, **W**, **X**, **Y** and **Z** that are competing at a turf club.



Spot	Description
1	Caffeine
2	Cortisone
3	Urine sample of horse **W**
4	Urine sample of horse **X**
5	Urine sample of horse **Y**
6	Urine sample of horse **Z**

Which of the following analysis is correct?

A The R_f value of cortisone is 3.33.

B The R_f value of caffeine is 0.75.

C Horses **W** and **Y** should be disqualified from the competition.

D The caffeine spot in urine sample of horse **Z** could be invisible and requires a locating agent.

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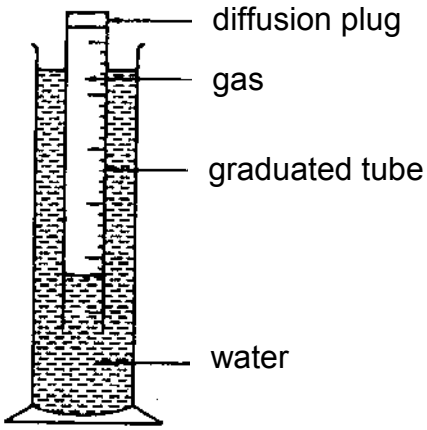
5 The diagram below shows an apparatus for measuring the rates of diffusion of gases. The time taken for 100 cm^3 of some gases at room temperature and pressure to diffuse from this apparatus is shown in the table.

Gas	Time/ s
CO	132
Cl_2	211
CH_4	100
O_2	141



What will be the time taken for nitrogen gas to diffuse from this apparatus?

A 66

B 72

C 100

D 132

6 Which statement explains why sodium chloride, NaCl has a lower melting point than magnesium oxide, MgO?

A Sodium chloride is covalent but magnesium oxide is ionic.

B Sodium is more reactive than magnesium.

C The melting point of sodium is lower than that of magnesium.

D The forces of attraction between Na^+ and Cl^- is weaker than that between Mg^{2+} and O^{2-}.

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7 Which one of the following represents the most likely structural formula for the covalent compound disulfur dichloride, S_2Cl_2?

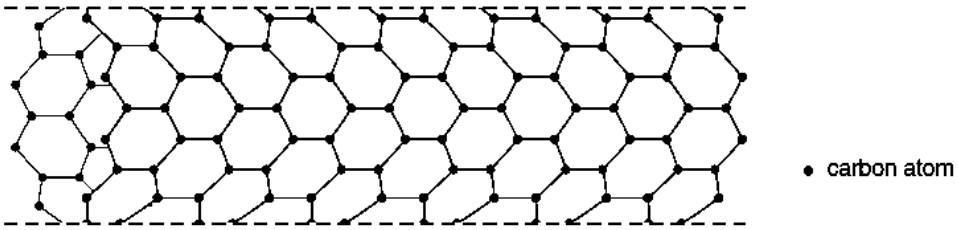
A S—Cl—Cl—S

B S—Cl—S—Cl

C Cl=S—S=Cl

D Cl—S—S—Cl

8 Carbon nanotubes have been made by scientists in recent years. The structure is shown below.



Which one of the following would most likely be the properties of nanotubes?

	melting point	**solubility in organic solvents**	**electrical conductivity as a solid**
A	high	insoluble	good
B	high	soluble	poor
C	low	insoluble	poor
D	low	soluble	good

9 In an experiment, 5 cm^3 of a gaseous hydrocarbon reacted with excess oxygen to form 30 cm^3 of carbon dioxide and 15 cm^3 of steam.

Assuming all volumes of gases were measured at the same temperature and pressure, what is the formula of the hydrocarbon?

A CH_4

B C_2H_4

C C_3H_6

D C_6H_6

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10 Zinc oxide is produced by heating zinc carbonate.

$$ZnCO_3 \rightarrow ZnO + CO_2.$$

What is the percentage yield of zinc oxide if 125 g of zinc carbonate on heating produces 75 g of zinc oxide? (*Mr* $ZnCO_3$ = 125, *Mr* ZnO = 81)

A $125 \times \frac{81}{75} \times 100$

B $125 \times \frac{75}{81} \times 100$

C $\frac{1}{125} \times \frac{75}{81} \times 100$

D $\frac{75}{81} \times 100$

11 **X**, **Y** and **Z** are in the same period of the Periodic Table. **Y** forms an oxide which reacts with aqueous sodium hydroxide. **Z** forms an oxide which reacts with dilute hydrochloric acid. **X** forms an oxide which is amphoteric. If **X**, **Y** and **Z** were placed in order of increasing atomic number, the order would be

A **X**, **Y**, **Z**.

B **Y**, **X**, **Z**.

C **Z**, **Y**, **X**.

D **Z**, **X**, **Y**.

12 Which one of the following statements about the elements lithium, sodium and potassium is correct?

A They are in the same period of the Periodic Table.

B Lithium has a higher melting point than potassium.

C They react with cold water to form oxides and hydrogen.

D Lithium reacts more rapidly with water than potassium does.

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13 9 g of magnesium metal is added to a beaker containing 250 cm^3 of 2 mol/dm^3 aqueous hydrochloric acid. The pH of the mixture in the beaker is measured as the reaction proceeds.

$$Mg\ (s) + 2HCl\ (aq) \rightarrow MgCl_2\ (aq) + H_2\ (g)$$

What is the final pH of the mixture and the volume of hydrogen gas produced at room temperature and pressure (r.t.p.)?

	Final pH of mixture	**Volume of hydrogen gas at r.t.p. (dm^3)**
A	1	9
B	3	9
C	7	6
D	9	6

14 When citric acid $C_6H_8O_7$ dissolves in an organic solvent, the solution formed ……

A contains both covalent molecules and ions.

B contains only covalent molecules.

C contains low concentration of hydrogen ions.

D produces carbon dioxide when reacted with carbonates.

15 The labels on two bottles fell off. One bottle was known to contain sodium chloride solution and the other sodium nitrate solution.

Which of the following test would most likely identify the solutions?

A Addition of blue litmus paper

B Addition of aqueous ammonia

C Addition of aqueous silver nitrate

D Addition of dilute sulfuric acid

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16 In each of three experiments, a halogen was added to separate solutions containing ions of one of the other two halogens. The table below shows the results.

Experiment	Halogen added	X^-	Y^-	Z^-
1	X_2	-	Black ppt	Reddish brown solution
2	Y_2	No reaction	-	No reaction
3	Z_2	No reaction	Black ppt	-

What were the halogens **X**, **Y** and **Z**?

	X	**Y**	**Z**
A	Br	Cl	I
B	Br	I	Cl
C	Cl	I	Br
D	Cl	Br	I

17 Which of the following should **not** be used with nitric acid to prepare silver nitrate?

A silver carbonate **B** silver hydroxide

C silver metal **D** silver oxide

18 Which of the following salts can be prepared by an acid-alkali titration method?

A Aluminium nitrate

B Ammonium chloride

C Iron(III) sulfate

D Calcium sulfate

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19 A solution containing Pb^{2+} ions can be distinguished from a solution containing Zn^{2+} by adding any of the following solutions except

A aqueous potassium chloride

B aqueous sodium sulfate

C dilute sulfuric acid

D aqueous sodium hydroxide

20 An excess of sodium hydroxide is added to an aqueous solution of salt **X** and boiled. No observable change seen. However, ammonia gas is only given off after aluminium foil is added to the hot solution.

What could **X** be?

A ammonium chloride **B** sodium chloride

C ammonium nitrate **D** sodium nitrate

21 In the Haber Process, the quantity of ammonia can be increased by

A using iron as a catalyst.

B increasing the pressure to 400 atmospheres.

C increasing the temperature of the reaction to 600^{o}C.

D using a mixture containing 3 parts nitrogen to 1 part hydrogen.

22 The equation below represents the reaction which takes place in a light sensitive photographic film. This photographic film was used before the invention of digital photography.

$$2AgBr \rightarrow 2Ag + Br_2$$

In this reaction,

A electrons are transferred from the bromide ions to the silver ions.

B silver ions are oxidised to silver atoms.

C bromide ions are reduced to bromine molecules.

D there is no electron transfer.

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23 Small portions of aqueous potassium iodide and of acidified aqueous potassium manganate(VII) were added to four solutions. The colour changes seen are shown in the table.

Solution number	Potassium iodide	Acidified potassium manganate(VII)
1	Colourless to brown	Purple to colourless
2	Colourless to brown	No change
3	No change	Purple to colourless
4	No change	No change

Which solutions contained an oxidising agent?

A 1 only **B** 1 and 2 only

C 1 and 3 only **D** 2 and 4 only

24 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	copper compound
B	gold	heat shield	gold compound
C	heat shield	carbon	copper compound
D	heat shield	gold	gold compound

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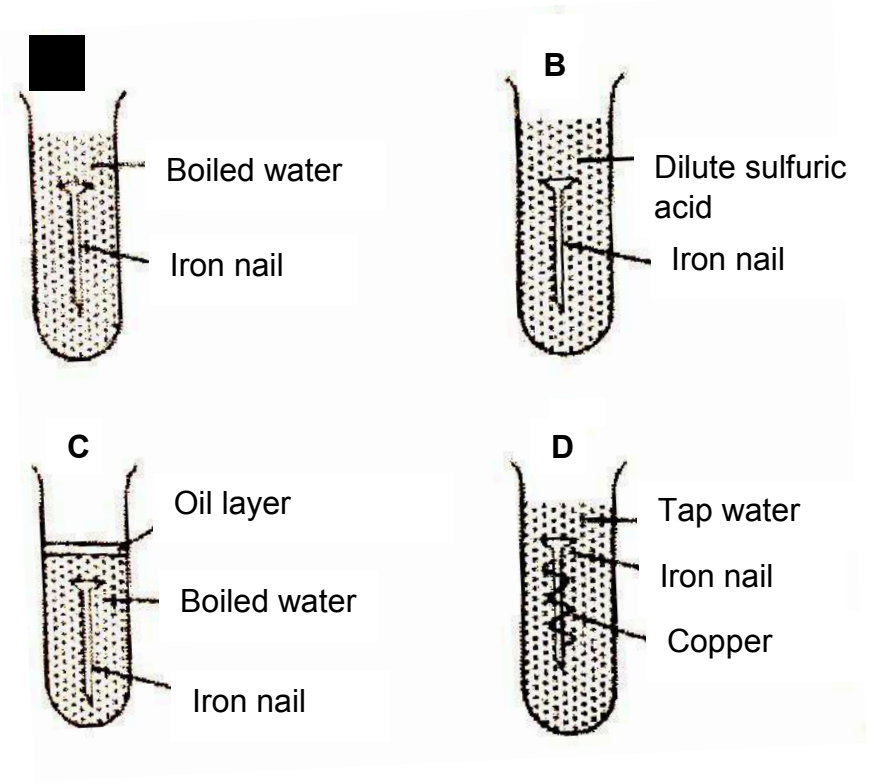
25 Which of the following conditions will the iron nail rust most slowly?



26 Manganese(IV) oxide (MnO_2) acts as a catalyst in the following reaction.

Hydrogen peroxide → water + oxygen

Several experiments were carried out using the same mass of manganese(IV) oxide and the same volume of hydrogen peroxide (H_2O_2) solution.

Experiment	Concentration of H_2O_2 (mol/dm^3)	Temperature (^oC)	Particle size of MnO_2
1	0.5	20	Powder
2	1.0	30	Lump
3	1.5	30	Lump
4	1.5	30	Powder
5	0.5	20	Lump
6	2.0	20	powder

Which two experiments should be used to study the effect of particle size on the speed of reaction?

A Experiments 1 and 5

B Experiments 1 and 3

C Experiments 2 and 4

D Experiments 3 and 6

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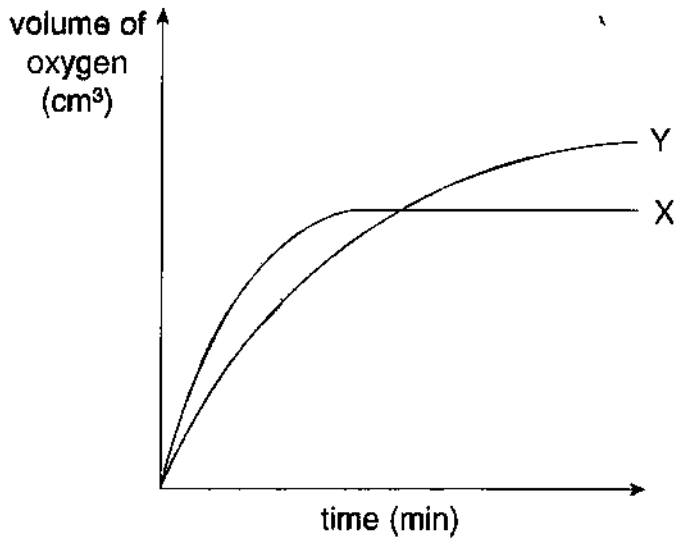
27 The results of an experiment involving the decomposition of 10 cm^3 of 0.40 mol/dm^3 hydrogen peroxide at 30°C is represented by graph **X** below.



Which of the following produced the graph **Y**?

	Volume of hydrogen peroxide (cm^3)	**Concentration of hydrogen peroxide (mol/dm^3)**	**Temperature (°C)**
A	10	0.25	30
B	12.5	0.40	30
C	20	0.25	30
D	20	0.40	40

28 Which of the following is the reason for recycling aluminium?

A Aluminium ore is expensive.

B Recycling metal helps to reduce wastage of limited raw materials.

C Recycling metals is generally not a costly operation.

D Low cost of transporting the scrap metal to the recycling plant.

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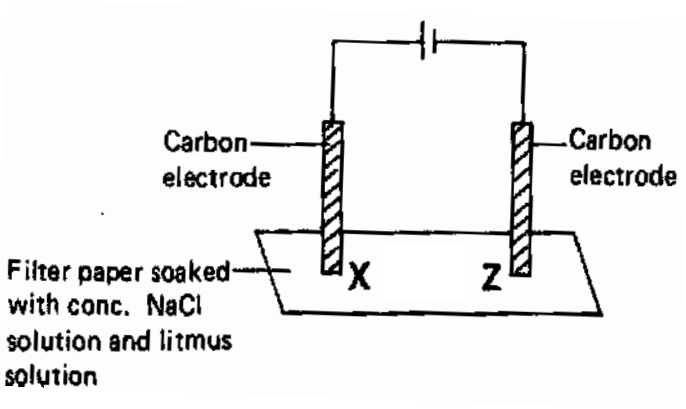
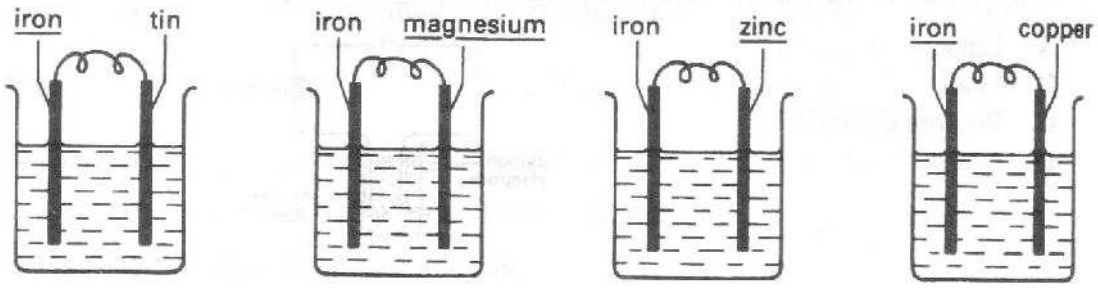
29 Referring to the diagram below, what colours would be observed on the filter paper at the two points, **X**, and **Z** after a current is passed through for about 10 minutes?



	X	Z
A	blue	white
B	white	red
C	white	blue
D	red	blue

30 Four electric cells were set up using aqueous sodium chloride as the electrolyte as shown in the diagrams.



In each cell, only the underlined electrode dissolved. To establish the order of reactivity of the metals, it is necessary to set up two or more cells. Which of the following pairs of cells are needed in addition to the four cells above?

	First cell electrodes	Second cell electrodes
A	iron/iron	iron/zinc
B	tin/copper	magnesium/zinc
C	tin/magnesium	zinc/copper
D	tin/zinc	magnesium/copper

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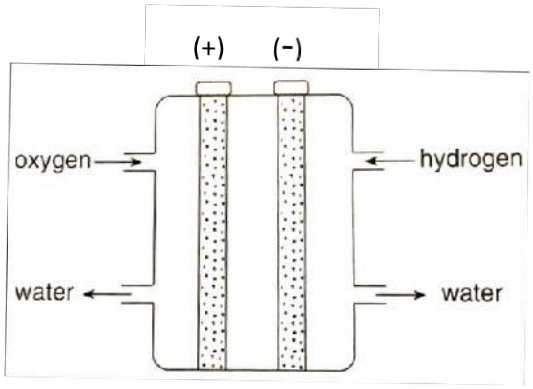
31 In the hydrogen fuel cell, hydrogen and oxygen gas flow into the anode and cathode respectively.



Which of the following shows the correct reaction at the cathode?

A $O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$

B $4OH^-(aq) \rightarrow O_2(g) + 2H_2O(l) + 4e^-$

C $2H_2(g) + 4OH^-(aq) \rightarrow 4H_2O(l) + 4e^-$

D $4H_2O(l) + 4e^- \rightarrow 2H_2(g) + 4OH^-(aq)$

32 Reactions of unknown metals, **P**, **Q**, **R** were studied. Zinc oxide was used in three of the experiments. It was found that

$\mathbf{Q} + HCl \rightarrow \mathbf{Q}Cl_2 + H_2$

$\mathbf{R} + ZnO \rightarrow \mathbf{R}O + Zn$

$\mathbf{Q} + ZnO \rightarrow \mathbf{Q}O + Zn$

$\mathbf{Q} + \mathbf{R}(NO_3)_2 \rightarrow$ no reaction

$\mathbf{P} + ZnO \rightarrow$ no reaction

$\mathbf{P}_2CO_3 \rightarrow \mathbf{P} + CO_2 + O_2$

Which of the following shows the most appropriate method of extraction for the metal?

A **Q** is extracted by electrolysis of aqueous solution of its compound.

B **R** is extracted by electrolysis of molten compound.

C **P** is extracted by reduction with hydrogen.

D **P** is extracted by reduction with carbon.

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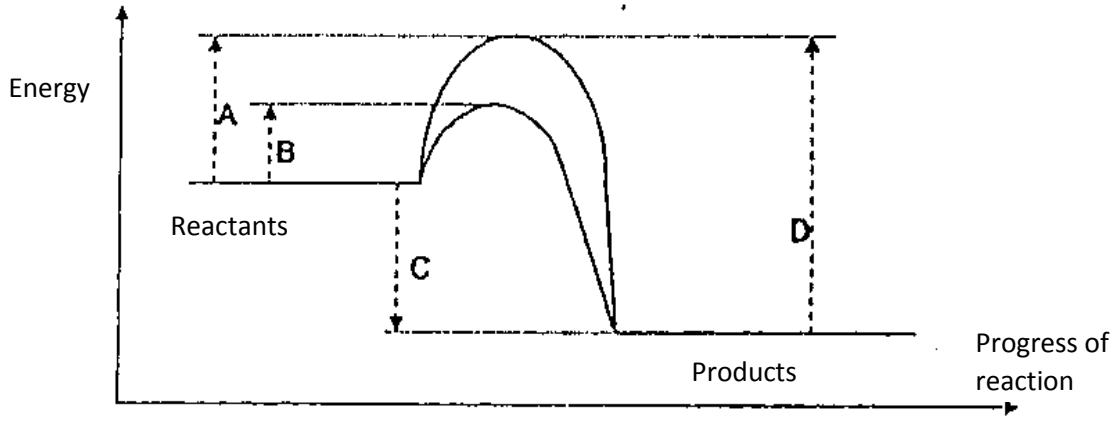
33 The diagram shows an energy profile diagram for a chemical reaction.

Which energy change (**A**, **B**, **C** or **D**) represents the activation energy for the non-catalysed reaction?



34 The table compares the strengths of the bonds for reactions of the type below.

$$R_2 + Q_2 \rightarrow 2RQ$$

Which reaction is the most exothermic?

	Bonds in R_2	**Bonds in Q_2**	**Bonds in RQ**
A	Strong	Strong	Strong
B	Strong	Strong	Weak
C	Weak	Weak	Strong
D	Weak	Weak	Weak

35 Identify the type of reaction below and where the reaction takes place.

$$2CO + 2NO \rightarrow 2CO_2 + N_2$$

	Type of reaction	**Location of reaction**
A	Neutralisation	Blast furnace
B	Redox	Blast furnace
C	Neutralisation	Catalytic converter
D	Redox	Catalytic converter

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36 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

37 Amines are organic compounds with the functional group $–NH_2$.

The first four members of the amine homologous series is shown below.

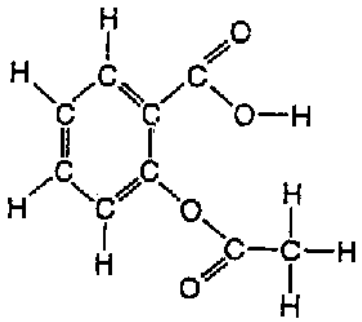
Name	**Chemical formula**
methylamine	CH_3NH_2
ethylamine	$CH_3CH_2NH_2$
propylamine	$CH_3CH_2CH_2NH_2$
butylamine	$CH_3CH_2CH_2CH_2NH_2$

What is the general formula for amines?

A $C_nH_{2n+3}N$ **B** $C_nH_{2n+1}NH_2$

C $C_nH_{2n-1}NH_2$ **D** $C_nH_{2n+1}CHNH_2$

38 Aspirin is a drug which is used as a general painkiller. The structural formula of aspirin is shown below.



Which statement about aspirin is **incorrect**?

A One mole of aspirin in aqueous solution reacts with one mole of sodium hydroxide.

B One mole of aspirin in aqueous solution reacts with 106 g of sodium carbonate, Na_2CO_3.

C It will turn green universal indicator yellow.

D It can be formed from a reaction between ethanoic acid and an alcohol.

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39 Water can be formed from a number of reactions involving organic substances.

Which reaction does **not** produce water?

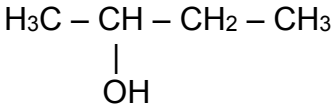
A Incomplete combustion of methane

B Reaction of ethanoic acid with ethanol

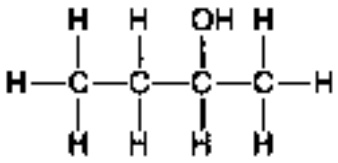
C Oxidation of ethanol to ethanoic acid

D Fermentation of sugar solution

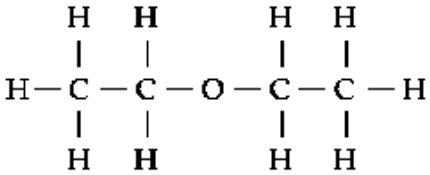
40 A chemical **X** with the formula, $C_4H_{10}O$, has the following structure.



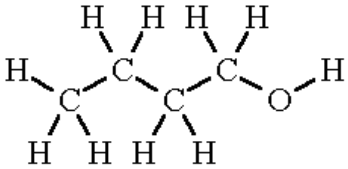
Which one of the following structure is **not** an isomer of **X**?



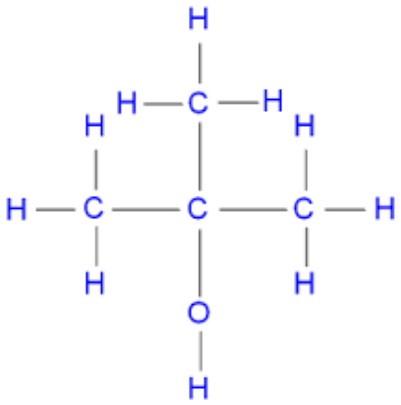
A



B



C



D

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DATA SHEET
The Periodic Table of Elements

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							H Hydrogen 1									4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4										11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12										27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	209 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	147 Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	231 Pa Protactinium 91	238 U Uranium 92	237 Np Neptunium 93	244 Pu Plutonium 94	243 Am Americium 95	247 Cm Curium 96	247 Bk Berkelium 97	251 Cf Californium 98	252 Es Einsteinium 99	257 Fm Fermium 100	258 Md Mendelevium 101	259 No Nobelium 102	260 Lr Lawrencium 103

* 58–71 Lanthanoid series
† 90–103 Actinoid series

Key: a X b — a = relative atomic mass; X = atomic symbol; b = atomic (proton) number

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

TKGS/Chemistry P1/Prelim Exam 2016

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Answer to 2016 TKGS Chemistry Prelim Paper 1

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

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Marking Scheme

Name of Setter/s: Siti Munira Bte Haidad Ali

Name of Assessment: Chemistry 5073 Prelim 2016 Duration: 1 h 45 min

No. of Papers: P2 Date of Sep: 14 Sep 2016

Legend:

CAO	**Correct answer only**
OWTTE	**Other words to that effect**
ECF	**Error carried forward**

Section A [50 marks]

Q/No.	Answer	Comments/Instructions/ Suggestions	Marks
A1(a)	Chlorine/ Any Group I elements/calcium or alkaline acidic	CAO	1
A1(b)	compound alloy/mixture	CAO	1
A1(c)	amphoteric acidic or silicon Lead/aluminium/zinc	CAO	1
A1(d)	nine ten or electrons protons	CAO	1

Q/No.	Answer	Comments/Instructions/ Suggestions	Marks
A2(a)	A: Fe^{3+} B: I^- C: Fe^{2+}	CAO CAO CAO	1 1 1
A2(b)(i)	NH_4NO_3	CAO	1

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A2(b)(ii)	No of moles of HNO_3 = 10 x1000/ [1+ 14 + (16x3)] =158.7 mol No of moles of NH_4NO_3 = 158.7 mol Mass of NH_4NO_3 = 158.7 x [(2x 14) + 4 + (3x16)] = 12 696 g =<u>12.7kg</u>	CAO	1 1
A2(c)(i)	The residue was not washed with distilled water. The residue of lead (II) chloride and crystals of sodium nitrate should not be dried in the oven. Lead (II) nitrate and sodium chloride may be in excess and present in the filtrate. Therefore, crystals of sodium nitrate may not be formed when the solution was cooled down.	CAO OWTTE	1 1
A2(c)(ii)	The residue should have been washed to remove any soluble impurities. Lead (II) chloride and sodium nitrate may decompose in the oven due to the high temperature.	CAO OWTTE	1 1

Q/No.	Answer	Comments/Instructions/ Suggestions	Marks
A3(a)	$BaCO_3$ is less soluble than $CaCO_3$, and can act as a protective layer.	CAO OWTTE	1 1
A3(b)(i)	$2BaCO_3 + 2SO_2 + O_2 \rightarrow 2BaSO_4 + 2CO_2$	CAO	1
A3(b)(ii)	Slow down as reaction consumes SO_2. Less H_2SO_3 formed reduces the reaction with $CaCO_3$. or $BaSO_4$ is even less soluble than $BaCO_3$ and forms a better protective layer.	CAO OWTTE	1 1

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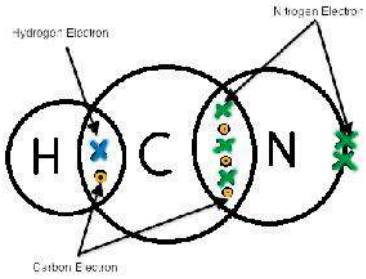
Q/No.	Answer	Comments/Instructions/ Suggestions	Marks
A4(a)	Mr=1.125 x 24 = 27	CAO	1
A4(b)(i) (ii) (iii)	No. of moles of nitrogen atoms in one mole of **X**= $\frac{12}{24}$ **x** 2=1 No. of moles of hydrogen atoms in one mole of **X** = $\frac{9}{18}$ **x** 2 = 1 Mass of carbon in one mole of **X** = 27-1-14 =12 No. of moles of carbon atoms in one mole of Q = 12/12=1 Molecular formula of **X** is <u>HCN</u> (shown).	CAO OWTTE [Allow ECF]	1 1 1 1
A4(c)	Draw covalent bond of HCN.  	CAO Legend: x- electron from H atom • - electron from C atom ×- electron from N atom	2

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Q/No.	Answer	Comments/Instructions/ Suggestions	Marks
A5(a)	Aluminium	CAO	1
A5(b)	Aluminium reacts with oxygen to form oxide and this protective layer of oxide prevents Al from reacting with steam.	CAO	1
A5(c)	change to any acid (e.g H_2SO_4, HCl, HNO_3) or change metal to Mg	CAO	1

Q/No.	Answer	Comments/Instructions/ Suggestions	Marks
A6(a)	Argon: Electronic structure is 2.8.8 or Full octet structure or noble gas configuration Argon is unreactive. Potassium: Electronic structure is 2.8.8.1 Can lose the valence electron easily. Potassium is very reactive.	OWTTE	1 1
A6(b)	Tellurium and Iodine	CAO	1
A6(c)	Any one of the following: Elements with similar chemical properties / same number of valence electrons would not be in the same Group No two elements share the same proton number, but some elements may share the same mass number (e.g. Co and Ni) The Ar of some elements could not be accurately determined (e.g. Fr, At)	OWTTE	1

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Q/No.	Answer	Comments/Instructions/ Suggestions	Marks
A7(a)(i)	$CaO + H_2O \rightarrow Ca(OH)_2$	CAO	1
A7(a)(ii)	Powdered CaO has larger surface area. More effective collisions, rate is faster.	OWTTE	1 1
A7(a)(iii)	Acidic> basic condition. The amount of heat given out is the greatest when acid is added as <u>heat is given out due to neutralisation of $Ca(OH)_2$</u> in addition to heat given out when CaO reacts with water.	CAO OWTTE	1 1
A7(b)(i)	measuring the time taken for a fixed volume of gas produced/ time taken for maximum volume of gas produced/ time taken for mass of content to stop dropping/reach constant	CAO OWTTE	1
A7(b)(ii)	1, 2, 3	CAO	1
A7(b)(iii)	Hot	CAO	1
A7(b)(iv)	240 cm^3 ; 8 °C ; between 6-12 sec	CAO 2 out of 3 correct	2 1

Q/No.	Answer	Comments/Instructions/ Suggestions	Marks
A8(a)(i)	Between 5 th and 6 th day.	CAO	1
A8(a)(ii)	It decreases the production of ethene by the fruits.	CAO	1

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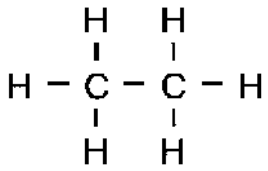
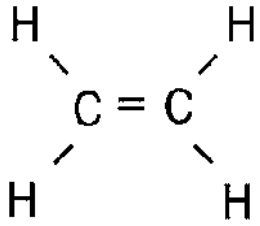
A8(b)(i)	Correct structures of ethane  <u>and</u> ethene 	CAO	1
A8(b)(ii)	Bromine solution is added to both ethane and ethene separately, the reddish brown colour remains for ethane but turns colourless for ethene.	OWTTE	1 1
A8(b)(iii)	C – H: 413 x 4 = 1 652 kJ C=C H-H 610 kJ 432 kJ Total energy absorbed = 2 694 kJ C – C 346 x 1 = 346 kJ C – H 413 x 6 = 2 478 kJ Total energy released = 2 824 kJ ΔH = 2694-2824 = <u>- 130</u> kJ (shown) (negative value = exothermic) <u>Or</u> $\Delta H = E_{BB}-E_{BF}$ = (610+432)-(346+2(413)) = <u>-130</u> kJ	OWTTE [Allow ECF]	 1 1 1 1

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Section B [30 marks]

Q/No.	Answer	Comments/Instructions/ Suggestions	Marks
B9(a)(i)	Octane has the lowest boiling point among the fraction hence it is collected from the top of the column while hexadecane has the highest boiling point among the fractions hence it is collected from the bottom of the column.	OWTTE	1 1
B9(a)(ii)	There is an increase in viscosity from octane to dodecane to hexadecane. As the relative molecular mass of the compounds increases, the intermolecular forces of attraction also increases. Thus, lots of energy needed to weaken/overcome strong forces. Hence, there is greater resistance for liquid to flow. Or Longer molecule will get tangled up.	OWTTE	1 1
B9(a)(iii)	Both ethanol and hydrogen are renewable sources of energy (ie. ethanol can be obtained from fermentation of glucose and hydrogen from cracking of alkane.	OWTTE	1
B9(b)(i)	electron	CAO	1
B9(b)(ii)	highest m/z v alue is 60. Total Mr of (CH_3COOH) =12 x 3(1) + 12 + (16 x 2) + 1 = 60 Ethanoic acid	CAO	1 1

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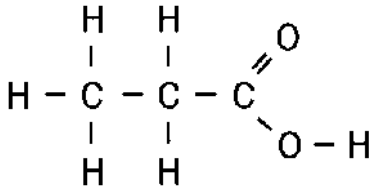
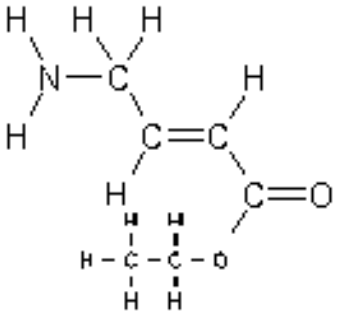
B9(b)(iii)	Draw 2-carbon with COOH group propanoic acid 	CAO	1
B9(c)(i)	The water should flow in from the bottom of the condenser and out from the top.	OWTTE	1
B9(c)(ii)	conditions: concentrated sulfuric acid, warm. structure: 	OWTTE	1 1

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Q/No.	Answer	Comments/Instructions/ Suggestions	Marks
B10(a)(i)	At the cathode, Cu^{2+} ions gains electrons/reduces to form Cu which is deposited at the cathode. So the mass of cathode increase.	OWTTE	1
B10(a)(ii)	When all the Cu^{2+} ions in the solution are discharged at the cathode, no additional deposit of copper.	OWTTE	1
B10(a)(iii)	In Cell **X**, the anode does not change in mass because the platinum anode is an inert/unreactive electrode. It does not dissolve in the electrolyte. In Cell **Y**, the copper anode slowly dissolves in the electrolyte forming Cu^{2+} by losing electrons. Hence it decrease in mass.	OWTTE	1 1
B10(b)(i)	Carbon is a conductor of electricity. When coated, the flower can act as an electrode.	OWTTE	1
B10(b)(ii)	Cathode : flower electrolyte : aqueous silver nitrate Equations: Anode: $Ag \rightarrow Ag^{+} + e^{-}$ Cathode: $Ag^{+} + e^{-} \rightarrow Ag$	CAO CAO	1 1 1

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Either

Q/No.	Answer	Comments/Instructions/ Suggestions	Marks
B11(a)(i)	$TiO_2 + 2Cl_2 + 2C \rightarrow TiCl_4 + 2CO$	CAO	1
B11(a)(ii)	Below potassium but above zinc. Potassium is able to displace titanium from titanium chloride but not zinc.	OWTTE	1
B11(a)(iii)	Titanium become stronger/harder. Pure titanium is made up atoms that are orderly arranged. The layer of atoms slides past each other easily when force is applied. Molybdenum disrupts the orderly arrangement of titanium and hence preventing the layers of atoms from sliding past when a force is applied. Or The melting point of the mixture will be lower. The melting point of pure titanium is higher as there is strong metallic bond between the positive ions and sea of delocalized electrons. Adding impurities like Molybdenum will lower the melting point of the mixture.	OWTTE	1 1 1
B11(b)(i)	Raw material A is limestone, which is added to remove the acidic impurities. The calcium oxide then reacts with the acidic oxide in the impurities/acidic impurities to form calcium silicate which is removed as slag.	OWTTE	1 1
B11(b)(ii)	$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$	CAO	1
B11(b)(iii)	No. The compound with sodium as the metal is more stable and cannot be extraction by reduction.	OWTTE	1 1

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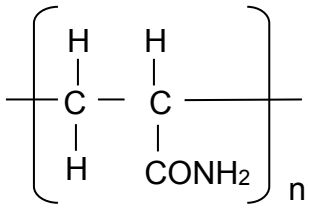
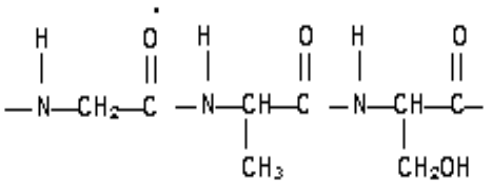
Q/No.	Answer	Comments/Instructions/ Suggestions	Marks
B11(a)		CAO	1
B11(b)(i)	Condensation polymerisation	CAO	1
B11(b)(ii)	Structure of repeating unit 		1
B11(c)	In the addition polymerisation of acrylamide, it involves the breaking up of the double bond in the monomers to form a single product that is the polymer. In the condensation polymerisation reaction to form silk protein, water is also formed besides the silk protein.	OWTTE	1 1
B11(d)(i)	Add aqueous sodium hydroxide to the solution containing ammonium ions. Warm mixture gently. If a gas produced turns damp red litmus paper blue, then ammonium ions are present.	OWTTE	1 1
B11(d)(ii)	Add magnesium/metal carbonate Rate of bubbling is slower. Or Add universal indicator and observe the colour change from green to orange/yellow.	OWTTE	1

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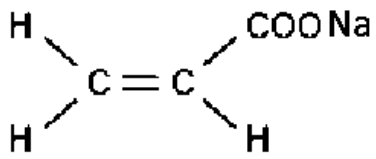
B11(e)	Structural formula of sodium acrylate  C_2H_3COOH (aq) + NaOH (aq) → C_2H_3COONa (aq) + H_2O (l)	CAO	1 1

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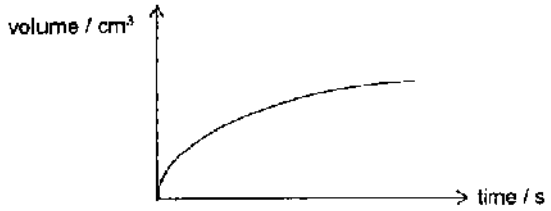
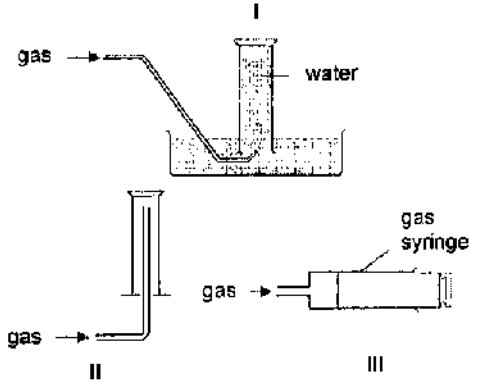
1 A student measured the rate of reaction between calcium carbonate and dilute hydrochloric acid. A graph showing the volume of gas produced against time is shown.



Which apparatus was used to measure the variables shown on the graph?

A burette and pipette
B electronic balance and gas syringe
C gas syringe and stop watch
D pipette and stop watch

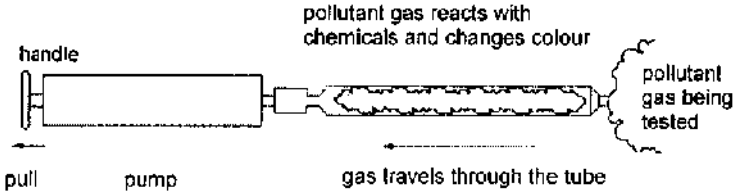
2 Ethene can be prepared by heating ethanol with excess concentrated sulfuric acid. Ethene is an insoluble gas that has a lower density than air.



Which set-ups can be used to collect the ethene produced?

A I and II only
B II and III only
C I and III only
D All of the above

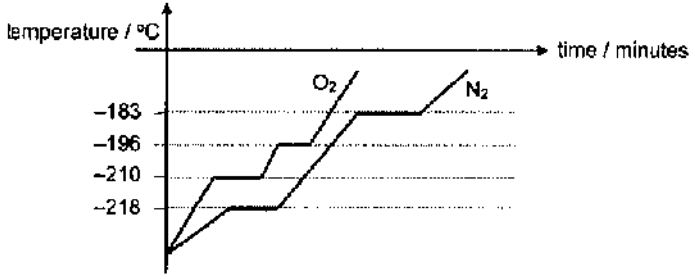
3 A special syringe is used to determine how long a gaseous pollutant takes to diffuse out of car exhausts.



Which pollutant gas would cause a colour change most rapidly?

A CO
B SO_2
C NO_2
D CH_4

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 °C
B – 210 °C
C – 200 °C
D – 220 °C

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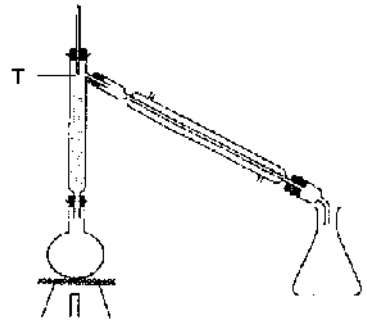
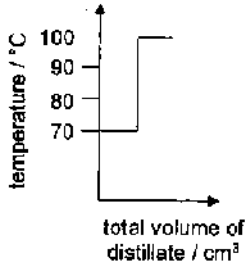
5 The diagram shows the apparatus used to separate hexane, boiling point of 70°C, and heptane, boiling point of 98°C.

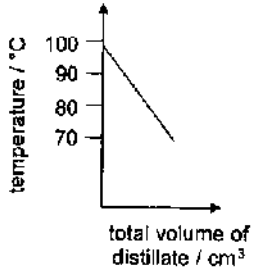


Which graph would be obtained if the temperature at point T was plotted against the total volume of distillate collected?

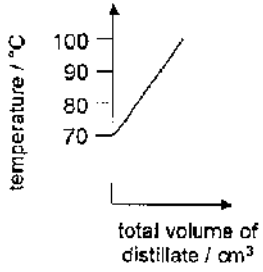
A



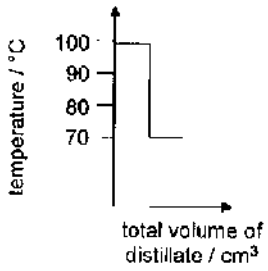
B



C



D

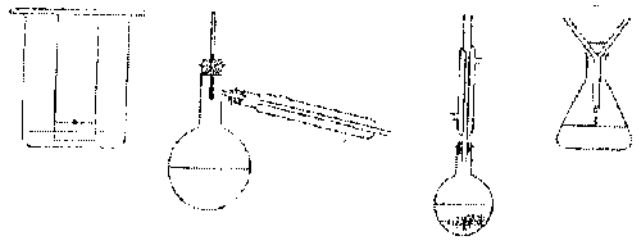


6 Compound P has the following properties:

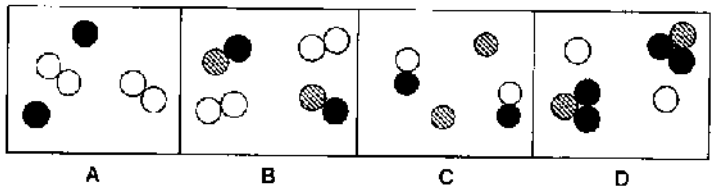
melting point	:	85 °C
boiling point	:	130 °C
solubility in water	:	high

Which apparatus can be used to separate pure P from a mixture of P and water at room temperature?

A B C D



7 Which diagram best represents a mixture of neon and hydrogen bromide?



8 Fullerene was discovered in 1985. It is a perfect sphere with the chemical formula C_{60}. From this information, what can be deduced about the structure of fullerene?

A It contains only one element.

B It is a compound of 60 elements.

C It is a mixture of 60 atoms.

D It is a mixture of 60 elements.

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9 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 60 %
C 40 %
D 80 %

10 An isotope of element Y has 19 protons and 20 neutrons in its nucleus. Which is the symbol for the ion of Y?

A $^{20}_{19}Y^{+}$
B $^{39}_{19}Y^{+}$
C $^{20}_{19}Y^{-}$
D $^{39}_{19}Y^{-}$

11 The table below gives some information about particles S and T.

particle	number of protons	number of neutrons	electronic configuration
S	9	10	2,8
T	16	18	2,8,8

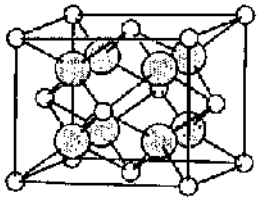
What are particles S and T?

A atoms of metals
B ions of metals
C atoms of noble gases
D ions of non-metals

12 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^{3+}
C Z^{2+}
D Z^{2-}

13 The diagram shows the structure of an ionic compound.



What is a possible formula for this compound?

A CaF_2
B SO_2
C KF
D MgO

14 The table below shows some of the physical properties of some unknown substances V, W, X and Y.

substance	melting point/°C	boiling point/°C	electrical conductivity		solubility in water
			solid state	liquid state	
V	122	150	poor	poor	insoluble
W	680	1790	poor	good	soluble
X	1510	2489	poor	poor	insoluble
Y	1453	2730	good	good	insoluble

Which statement about the four substances is correct?

A Substance V has a simple molecular structure and it has weak intermolecular forces of attraction between its molecules.
B Substance W can conduct electricity because it has free mobile electrons.
C Substances X and Y are macromolecules.
D Substance Y has a giant molecular structure and it has strong covalent bonds between its atoms.

16 Which fertilizer has the highest percentage composition of nitrogen in a formula unit?

A NH_4NO_3
B $NaNO_3$
C $(NH_4)_3PO_4$
D $(NH_4)_2SO_4$

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16 Potassium permanganate(VII) decomposes when gently heated according to the equation:

$$2KMnO_4 \rightarrow K_2MnO_4 + MnO_2 + O_2$$

When 1.65 g of a sample of impure potassium permanganate(VII) crystals is heated until no more gas evolves, the volume of oxygen gas collected under room temperature and pressure is 120 cm^3. What is the percentage purity of the crystals of potassium permanganate(VII)?

A 20 % B 24 % C 48 % D 96 %

17 Chlorine gas is a severe irritant to the eyes and respiratory system. The maximum safe toleration level of chlorine gas is 0.005 mg/dm^3. How many molecules of chlorine gas are present in 1 dm^3 of air at this toleration level?

A $\frac{0.005}{6\times10^{23}}\times71$ B $\frac{0.005}{1000}\times\frac{1}{71}\times6\times10^{23}$

C $\frac{0.005}{71}\times6\times10^{23}$ D $\frac{0.005}{1000}\times71\times6\times10^{23}$

18 When 0.002 mol of a metal V was reacted with an excess dilute acid, 48 cm^3 of hydrogen gas given off was measured at room temperature and pressure. Which is a correct equation for the reaction?

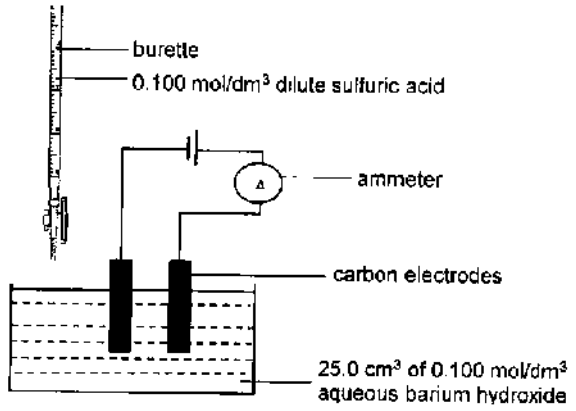
A $2V(s) + 6H^+(aq) \rightarrow 2V^{3+}(aq) + 3H_2(g)$

B $2V(s) + 2H^+(aq) \rightarrow 2V^{3+}(aq) + H_2(g)$

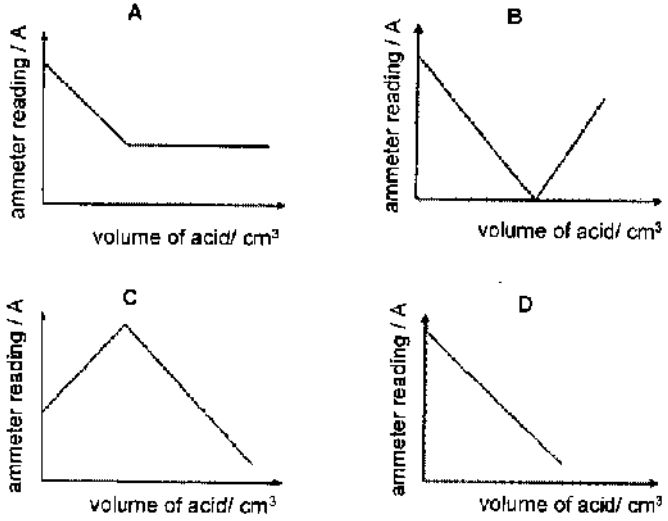
C $V(s) + 2H^+(aq) \rightarrow 2V^{2+}(aq) + 2H(g)$

D $V(s) + 2H^+(aq) \rightarrow V^{2+}(aq) + H_2(g)$

19 In an experiment, an excess of 0.100 mol/dm^3 dilute sulfuric acid was added to 25.0 cm^3 of 0.100 mol/dm^3 aqueous barium hydroxide.



The acid was added from the burette in portions of 5.0 cm^3 until 40.0 cm^3 of the acid was added. After each addition, the solution was stirred and the ammeter reading was noted. Which graph correctly represents the relationship between the ammeter reading and the volume of acid added?



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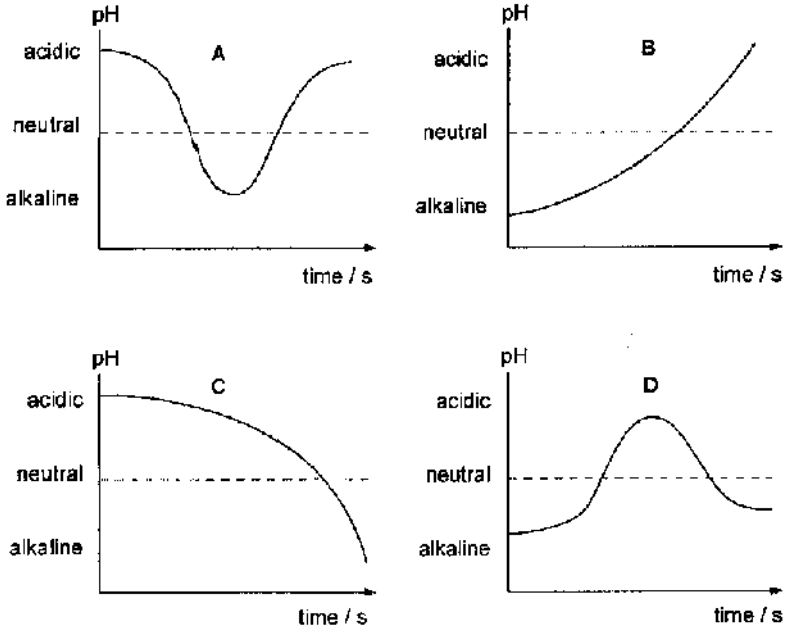
20 Element R reacts with oxygen to form a gas, T. T changes the colour of damp litmus paper from blue to red. T is used to kill bacteria in the preservation of dried fruit. Identify R.

A carbon
B nitrogen
C chlorine
D sulfur

21 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?



22 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 sulfate
D zinc sulfate

23 Disproportionation is a reaction in which the same element is both oxidised and reduced. Which reaction is an example of disproportionation?

A $3\,Cu + 8\,HNO_3 \rightarrow 3\,Cu(NO_3)_2 + 2NO + 4\,H_2O$
B $Cl_2 + 2\,NaOH \rightarrow NaCl + NaOCl + H_2O$
C $Fe_2(SO_4)_3 + 2\,KI \rightarrow 2\,FeSO_4 + K_2SO_4 + I_2$
D $2\,Pb(NO_3)_2 \rightarrow 2\,PbO + 4\,NO_2 + O_2$

24 A solid deposit of element X is formed at the cathode when an aqueous solution containing ions of X is electrolyzed. Which statement about element X is true?

A Ions of X gain electrons at the cathode.
B Ions of X lose electrons at the cathode.
C X is above hydrogen in the reactivity series.
D X forms negative ions.

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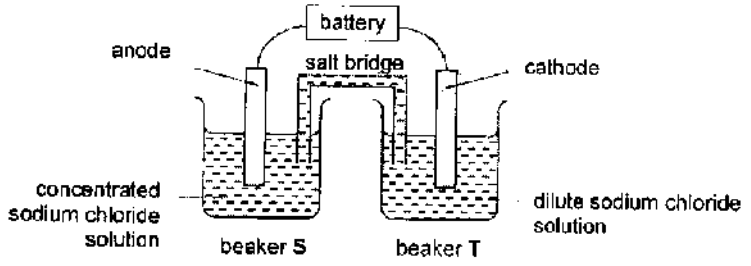
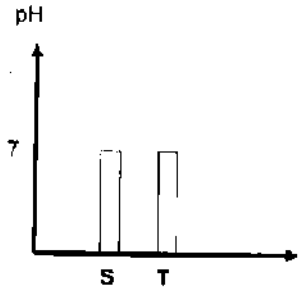
25 The following apparatus was set up as shown.

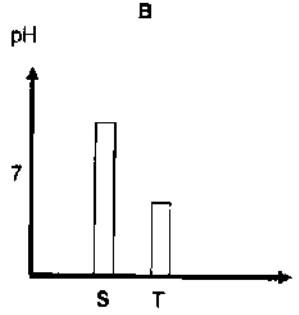


If platinum electrodes were used, which diagram shows the pH of the solution in each beaker at the end of the experiment?

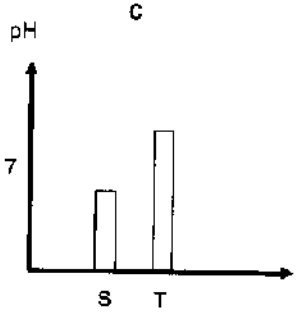
A



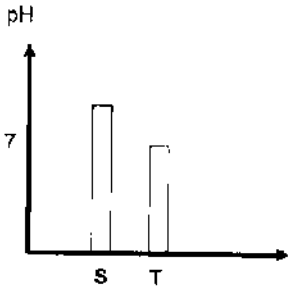
B



C



D

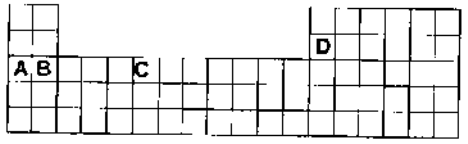


26 Elements X and Y are in Group VII of the Periodic Table. X is a liquid at room temperature. Y is a solid at room temperature. Which statement(s) is / are correct?

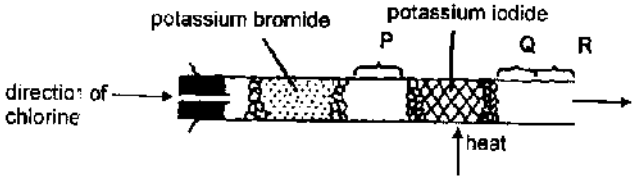
I Atoms of Y have more protons than atoms of X.
II Molecules of Y have more atoms than molecules of X.
III Y displaces X from aqueous solution of X^- ions.

A I only
B III only
C II only
D All of the above

27 The positions of four elements are shown on the outline of part of the Periodic Table. Element T has a high melting point and is a good electrical conductor. It forms chlorides TCl_2 and TCl_3. Which element is T?



28 Using the apparatus shown, chlorine gas was passed through the tube containing solid potassium bromide and potassium iodide. After a short time, coloured substances were seen at P, Q and R.



	at P	at Q	at R
A	green gas	violet vapour	black solid
B	green gas	red-brown vapour	violet vapour
C	red-brown vapour	violet vapour	black solid
D	violet vapour	red-brown vapour	red-brown vapour

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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:

$$4Fe\,(s) + 3O_2\,(g) \rightarrow 2Fe_2O_3\,(s) \qquad \Delta H = -823\ kJ/mol$$

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 If a strip of magnesium is dropped into excess hydrochloric acid, an exothermic reaction occurs. Why does the rate of this reaction increase during the first few seconds?

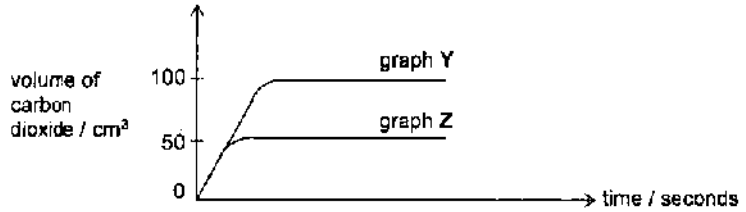
A The mass of magnesium is decreasing.

B The magnesium is acting as a catalyst.

C The solution is becoming hotter.

D The surface area of the magnesium is increasing.

31 Some crystals of sodium carbonate were added to excess sulfuric acid at room temperature. The volume of carbon dioxide produced was measured over a period of time. The results are shown in graph Y. The experiment was repeated and graph Z was obtained.



Which one change was used to obtain the results shown in graph Z?

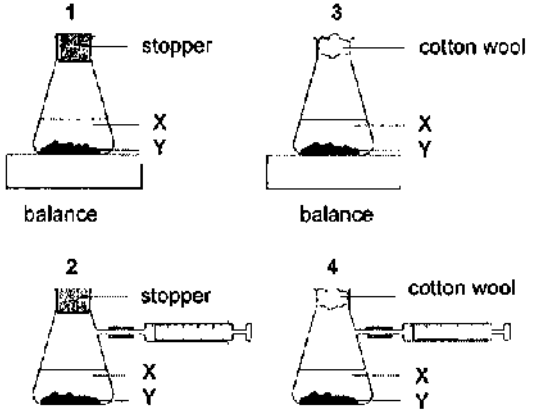
A A lower temperature was used.

B Acid of half the original concentration was used.

C Half the mass of sodium carbonate was used.

D Larger crystals of sodium carbonate were used.

32 A liquid X reacts with solid Y to form a gas. Which two diagrams show suitable methods for investigating the speed of the reaction?



A 1 and 3

B 2 and 3

C 1 and 4

D 2 and 4

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33 Ammonia is produced by Haber process. Which statement is **not** correct?

A A catalyst of iron is used.

B Each hydrogen molecule reacts with three nitrogen molecules to form two molecules of ammonia.

C Hydrogen for the process can be obtained by cracking of oil.

D The reaction is reversible.

34 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.

35 A steel works and a chemical works are built near to a city. The limestone buildings in the city begin to crumble. Which gas is most likely to cause this damage?

A carbon monoxide

B nitrogen

C oxygen

D sulfur dioxide

36 For which property of the alkanes does the numerical value decrease as the number of carbon atoms in the homologous series of alkane molecules increases?

A density

B flammability

C number of isomers

D viscosity

37 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 fraction S?

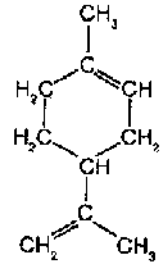
A Fraction P is more viscous than fraction S.

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.

38 Liquid limonene can be extracted from oranges. Its structure is shown below.



Which statement about limonene is **not** correct?

A It can be oxidised into a carboxylic acid directly in the presence of bacteria in the air.

B It is an unsaturated hydrocarbon with alkene functional group.

C It undergoes hydrogenation in the presence of nickel catalyst to form limonane.

D When it undergoes cracking, the following reaction is possible:
limonene → $C_6H_8 + C_3H_8 + CH_4$

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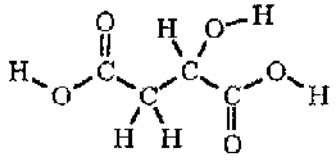
39 Malic acid is found in unripe fruit. It was first isolated from an apple in 1785. The structural formula of malic acid is shown below.



How many moles of sodium hydroxide are needed to react completely with 1 mol of malic acid?

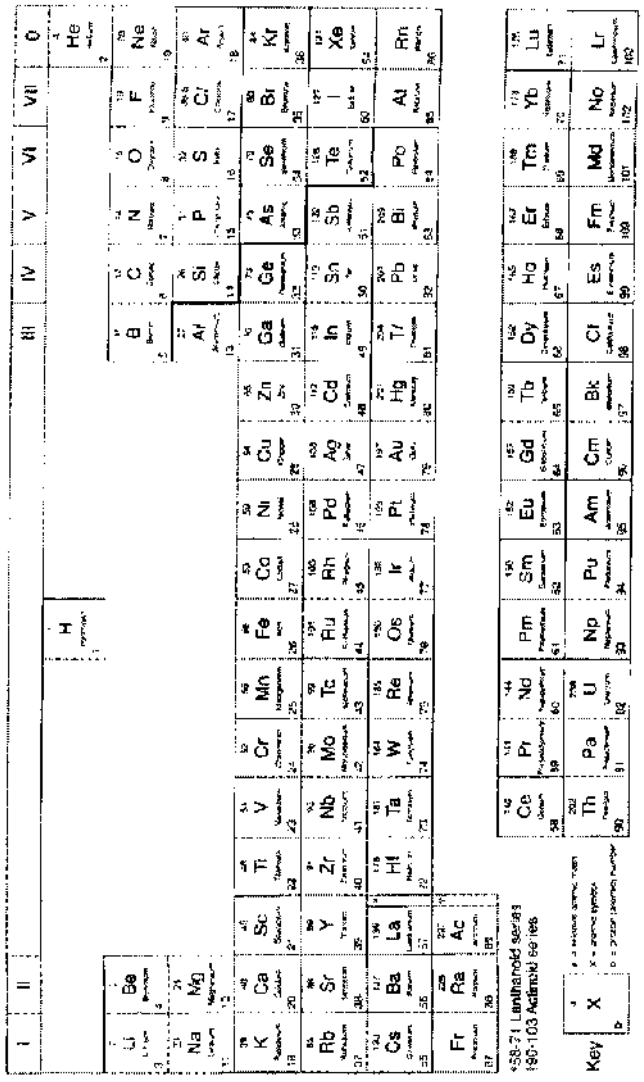
A 1
B 3
C 2
D 4

40 Alcohol **G** and acid **H** can react to form an ester, $C_6H_{12}O_2$. Alcohol **G** can be oxidized to acid **H** by acidified potassium dichromate(VI). What is the formula of the ester formed?

A $HCOOC_5H_{11}$
B $CH_3COOC_4H_9$
C $C_2H_5COOC_3H_7$
D $C_3H_7COOC_2H_5$

- END OF PAPER -

The Periodic Table of Elements



The volume of one mole of any gas is 24 dm^3 at room temperature and pressure.

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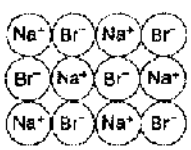
Section A

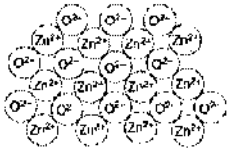
Answer **all** the questions in this section in the spaces provided.

The total marks for this section is 50.

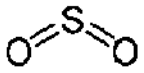
1 The diagram shows the structures of various compounds.



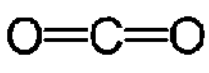
A



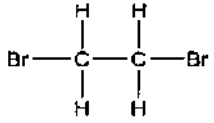
B



C



D



E

Using the letters **A** to **E**, choose the compound that is best described in the statements below. Each compound may be used once, more than once or not at all.

(a) A compound that is most likely to contribute to acid rain.

..... [1]

(b) A compound that is an amphoteric oxide.

..... [1]

(c) A compound that is a product of a substitution reaction of an alkane.

..... [1]

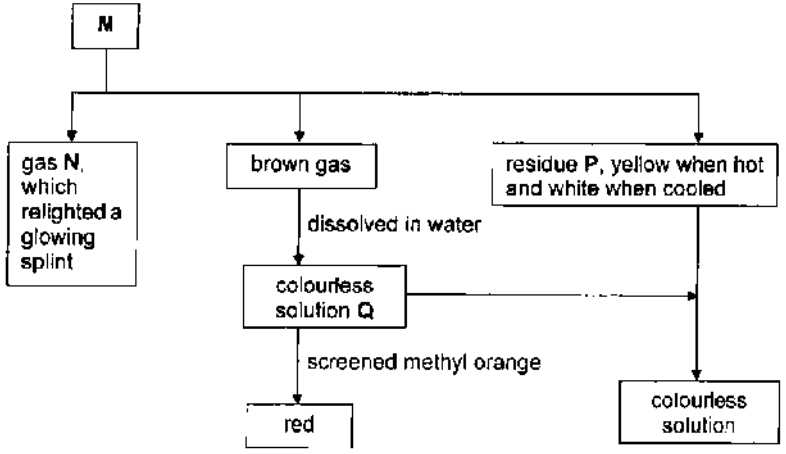
(d) A compound, in molten state, that releases a reddish-brown gas at the anode when electrolysed.

..... [1]

(e) A compound that is produced in catalytic converters of cars.

..... [1]

2 The flow diagram below shows the decomposition of compound **M**.



Identify and name the following unknown substances.

(a) (i) compound **M** : ..... [1]

(ii) gas **N** : ..... [1]

(iii) residue **P** : ..... [1]

(iv) solution **Q** : ..... [1]

(b) State the type of reaction that occurs between residue **P** and colourless solution **Q**.

..... [1]

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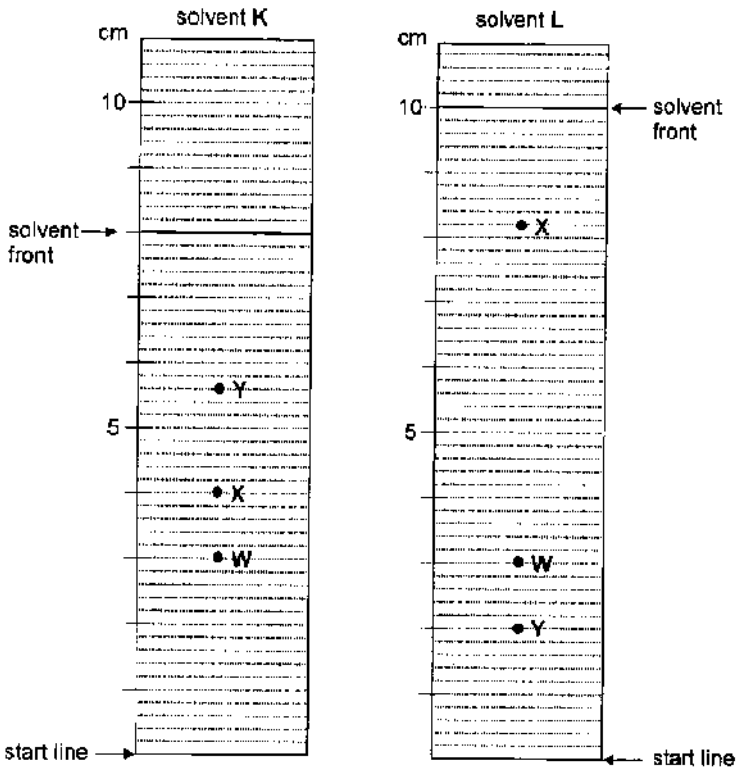
3 Chromatography is an important tool for chemical investigation. A mixture of amino acids was separated by paper chromatography using two different solvents; K and L. After treating with a locating agent, the results are shown below. The positions of the amino acids on the two chromatograms are labelled W, X and Y.



(a) Suggest a reason why a locating agent was used.

.....

..... [1]

(b) Calculate the R_f value of each amino acid in each solvent and write them in the table. Your answers must be given to **2 significant figures**.

amino acid 'spot' on chromatogram	R_f value in solvent K	R_f value in solvent L
W		
X		
Y		

[2]

(c) The R_f values of a number of amino acids in the two solvents are listed below.

amino acid	R_f value in solvent K	R_f value in solvent L
glutamic acid	0.38	0.30
glysine	0.50	0.26
tyrosine	0.66	0.45
arginine	0.70	0.20
alanine	0.72	0.38

For each of the amino acids in the mixture, use the table above and the chromatography results to either name the amino acid or state that it is not in the list given.

W : .....

X : .....

Y : .....

[2]

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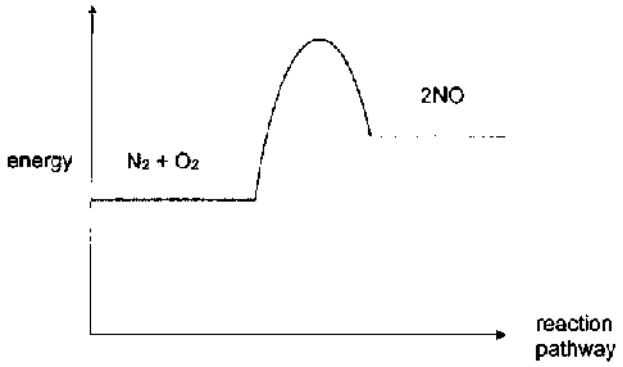
4 During a thunderstorm, lightning strikes the Eiffel Tower. In lightning, the temperature can reach 30 000 °C. This causes nitrogen and oxygen in the air to react, producing nitrogen monoxide. This reaction has high activation energy and is endothermic.

A chemical equation that represents this endothermic reaction is:

$$N_2 + O_2 \rightarrow 2NO$$

The energy level diagram for this reaction is given below.



(a) Explain how the energy level diagram shows that this reaction is endothermic.

.....

..... [1]

(b) Label activation energy (E_a) and enthalpy change (ΔH) in the diagram above. [2]

(c) The table below shows the bond energies.

bond	bond energy (kJ/mol)
N≡N	945
N–N	146
N=O	630
O=O	498

(i) Use the bond energies in the table to calculate the enthalpy change, ΔH for this reaction.

ΔH = ... kJ/mol [3]

(ii) In terms of bond forming and bond breaking, explain why this reaction is endothermic.

.....

.....

..... [1]

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5 Both ethanoic acid and butanoic acid are weak acids that are found in some plants and bacteria.

(a) (i) Explain what is meant by *weak acid*.

.....

..... [1]

(ii) Describe a simple chemical test to show that butanoic acid is a weak acid.

.....

.....

..... [2]

(b) Butanoic acid can be converted into an ester by heating it with an alcohol and a few drops of concentrated sulfuric acid. A sample of the ester contains 0.18 g of carbon, 0.03 g of hydrogen and 0.08 g of oxygen. The relative molecular mass of the ester is 116.

(i) Find the empirical formula of this ester.

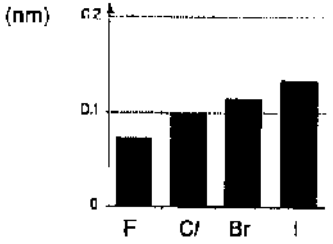
[2]

(ii) Hence, deduce the full structural formula of the ester.

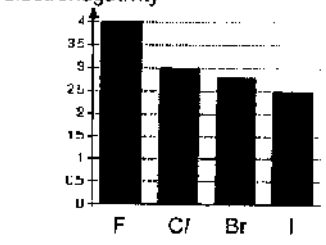
[2]

6 The graphs below show some properties of Group VII elements, the halogens. **Graph 1** shows the atomic radii and **Graph 2** shows the electronegativity of the Group VII elements. Electronegativity is a measure of the tendency of an atom to attract a bonding pair of electrons. It is usually measured on the Pauling scale, on which the most electronegative element is given an electronegativity of 4.0.

Graph 1



Graph 2



(a) Using your knowledge on atomic structure, state and explain the trend seen in **Graph 1**.

.....

.....

..... [2]

(b) Use the information from **Graph 2** to explain the reactivity of the halogens on going down the group.

.....

.....

..... [2]

(c) Write a balanced chemical equation for the reaction when chlorine gas is passed through colourless potassium bromide solution.

..... [1]

(d) Draw a dot and cross diagram to show the bonding in potassium bromide, showing only the valence electrons.

[2]

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7 Poly(butene) is a polymer made from crude oil in two stages.

(a) The first stage in making poly(butene) is to break down large hydrocarbon molecules from crude oil into smaller hydrocarbon molecules, as shown below.

$$C_{16}H_{34} \longrightarrow C_8H_{18} + C_4H_8 + 2C_2H_4$$

(i) Name the process where poly(butene) is broken down into smaller hydrocarbon molecules.

..... [1]

(ii) The products contain two types of hydrocarbon with different general formulae. Name one type of hydrocarbon.

..... [1]

(iii) Suggest a reason why air cannot be introduced in this reaction.

..... [1]

(iv) The labels on the bottles of C_4H_8 and C_4H_{10} are missing. Describe, how to distinguish, the two substances.

.....

..... [2]

(b) The second stage is to use butene to produce poly(butene).

(i) Draw the structural formula of a butene molecule.

[1]

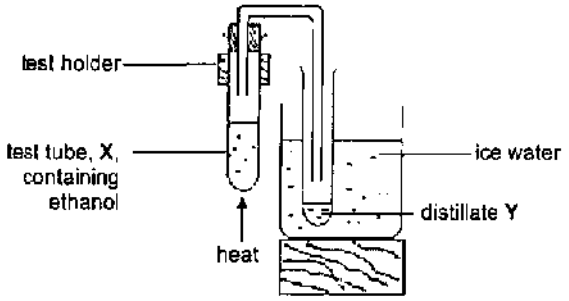
(ii) Describe how molecules of butene form poly(butene).

.....

.....

..... [2]

8 The set up below shows a test tube containing ethanol being heated.



(a) 5 cm^3 of acidified potassium manganate is added to test-tube X.

(i) State the colour change observed in test tube X when acidified potassium manganate is added.

..... [1]

(ii) Name the type of reaction taking place in test-tube X when acidified potassium manganate is added.

..... [1]

(b) Name distillate Y and draw its full structural formula.

Name: ..... [1]

Full structural formula:

[1]

(c) State two chemical properties of distillate Y.

.....

..... [2]

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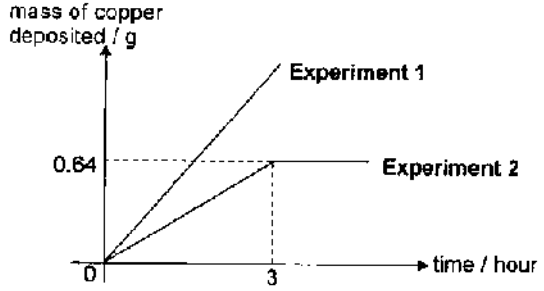
Section B

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

The total marks for this section is 30.

1 Harry carried out two separate experiments in the laboratory for 3 hours. In each experiment, he electrolysed 2 dm^3 of aqueous copper(II) sulfate containing 0.64 g of copper(II) ions. The two solid electrodes were placed the same distance apart in each experiment. The diagram below shows the results of the two experiments. After 3 hours, there was no more solid deposited in **Experiment 2**.



(a) (i) Two different electrodes, carbon electrode and copper electrode were used in these two experiments. State the electrode used in each experiment.

Experiment 1: .....

Experiment 2: ..... [1]

(ii) Using your answer to **(i)**, explain the shape of the 2 graphs.

.....

.....

..... [3]

(b) Write a balanced chemical equation, with state symbols, for the reaction happening at the anode and cathode for **Experiment 1**. [2]

Anode: .....

Cathode: .....

(c) Describe what would be observed when Universal Indicator was added to electrolytic cell of **Experiment 2** after three hours. Explain your answer.

.....

.....

..... [2]

(d) The overall equation for **Experiment 2** is as follows:

$$2Cu^{2+}(aq) + 4OH^-(aq) \rightarrow 2Cu(s) + 2H_2O(l) + O_2(g)$$

Calculate the volume of oxygen gas produced at the end of three hours.

volume of oxygen gas = ... dm^3 [2]

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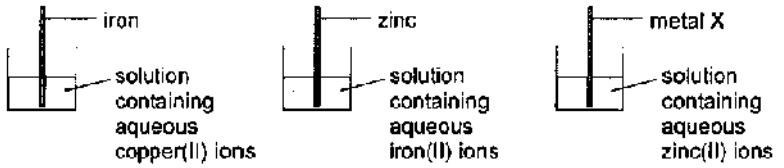
2 A student investigated the reactivity of four metals; iron, copper, zinc and metal X. He set up three experiments as shown below.



Experiment 1 **Experiment 2** **Experiment 3**

(a) In **Experiment 1**, the student sees changes happen to both the iron rod and the solution.

(i) Describe the changes that the student sees.

.....

..... [1]

(ii) Explain why these changes occur.

.....

.....

..... [2]

(b) The student observes that a reaction happens in all the three experiments.

(i) Arrange the four metals in **increasing** order of reactivity.

..... [1]

(ii) Explain your reasoning for such an arrangement in **(b)(i)**.

.....

..... [2]

(iii) Suggest an identity for metal X.

..... [1]

(c) The student decides to investigate the thermal stability of the carbonates of the four metals. He heats each metal carbonate in a test tube and bubbles the gas produced into limewater.

(i) Describe what he would observe in limewater.

..... [1]

(ii) Describe how he could use the results obtained to place the metal carbonates in order of thermal stability.

.....

.....

.....

..... [2]

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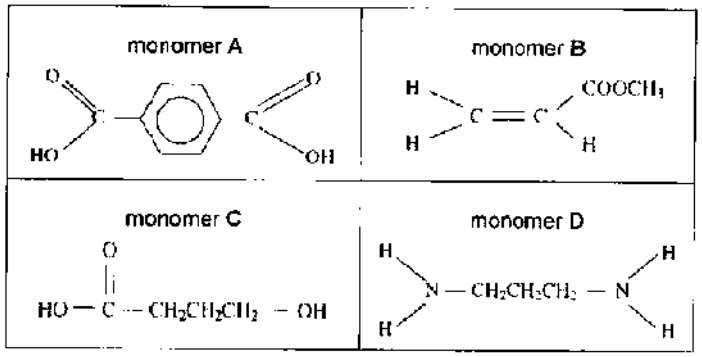
3 Either

The diagrams below show four monomers, A to D.



(a) Monomer B was formed by reacting $CH_2CHCOOH$ with another compound, X. State the conditions of the reaction and the name of compound X.

Conditions: ..... [1]

Compound X: ..... [1]

(b) (i) State the monomer that can be used to produce a polymer by itself via condensation polymerisation.

..... [1]

(ii) State the monomer that will undergo polymerisation without a change in percentage composition. Explain your answer.

.....

.....

.....

..... [2]

(c) (i) Using two monomers from above, draw a repeat unit of the polymer formed, which has the same linkages as those found in nylon.

[1]

(ii) Give a reason why the polymer formed in (c)(i) should not be disposed by burning.

.....

..... [1]

(d) A student has three solutions containing monomers A to C each. Describe chemical tests the student could do to identify the three solutions.

.....

.....

.....

.....

.....

..... [3]

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3 Or

In the recent years, the build-up of greenhouse gases has been one of the greatest environmental concerns. The table below compares the effects of some of these greenhouse gases.

gas	heat trapping effectiveness compared to CO_2	overall contribution to increased global warming (%)	percentage abundance of gas / dm^3
carbon dioxide	1	50	0.03
methane	30	18	0.00017
ozone (at ground level)	2000	14	0.000004
CFCs	10000 - 25000	12	0.000004

(a) (i) Draw a dot and cross diagram to show the bonding in $CFCl_3$, showing only the valence electrons.

[2]

(ii) State whether $CFCl_3$ has a high or low boiling point. Explain your answer, referring to the bonding in $CFCl_3$.

.....

.....

..... [2]

(b) Describe the trend between the gases' heat trapping effectiveness and its contribution to global warming.

.....

..... [1]

(c) Though CFCs are thousands of times better at absorbing heat than carbon dioxide, their effect on global warming is low compared to carbon dioxide. Suggest why.

.....

..... [1]

(d) Flue gases containing acidic gases are produced in power stations as oil and coal are burnt to produce electricity. Sulfur dioxide is one such pollutant.

(i) A certain chemical can be lined on the chimneys of power stations to reduce the amount of sulfur dioxide released. Suggest the name of the chemical.

..... [1]

(ii) Write a balanced chemical equation to represent the reaction that takes place in (d)(i).

..... [1]

(iii) 50 dm^3 of sulfur dioxide was released from the chimney. Calculate the mass of the chemical suggested in (d)(i) needed to react.

mass of substance = ... g [2]

- END OF PAPER -

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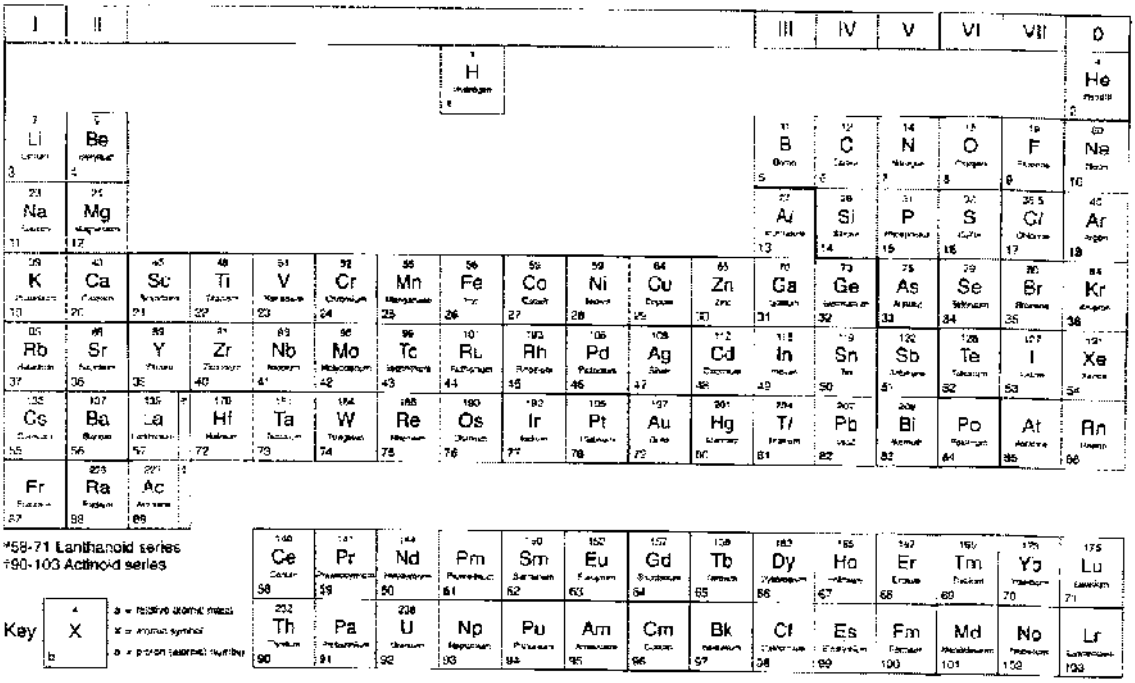
The Periodic Table of Elements



The volume of one mole of any gas is 24 dm³ at room temperature and pressure.

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ASSUMPTION ENGLISH SCHOOL
Preliminary Examination 2015
Pure Chemistry 5073 – Marking Scheme

PAPER 1: (40 marks)

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

PAPER 2
SECTION A: (50 marks)

1	(a)	C		[1]
	(b)	B		[1]
	(c)	E		[1]
	(d)	A		[1]
	(e)	D		[1]
2	(a)	(i)	Zinc nitrate	[1]
		(ii)	Oxygen	[1]
		(iii)	Zinc oxide	[1]
		(iv)	Nitric acid	[1]
	(b)	Neutralization		[1]

3 (a) Amino acids are colourless, thus a locating agent is required to react with the amino acids and make it visible/identify it. **[1]**

Stating colourless is not sufficient!

(b)

amino acid 'spot' on chromatogram	R_f value in solvent K	R_f value in solvent L
W	0.38	0.30
X	0.50	0.82
Y	0.70	0.20

[2]

All 6 correct – award 2 marks
3/4/5 correct – award 1 mark

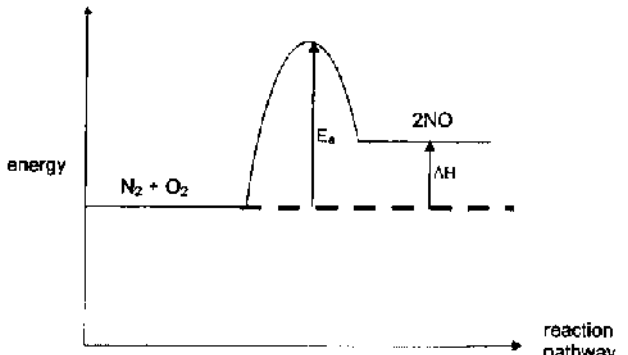
(c) W: Glutamic acid
X: Not in the list
Y: Arginine **[2]**

All 3 correct – award 2 marks
2 correct – award 1 mark

4 (a) The energy level of the products is higher than that of the reactants, showing that energy is taken in. **[1]**

[Reject if answer is in terms of bond breaking of reactants and bond forming of products]

(b)



Each correct labelling – 1 mark **[2]**

(c) (i) Energy taken in for bond breaking
= 945 + 498
= +1443 kJ **[1]**

Energy given out for bond forming
= 2(-630)
= -1260 kJ **[1]**

ΔH reaction = ΔH bond breaking + ΔH bond forming
= 1443 – 1260
= +183 kJ **[1]**

Deduct 1 mark overall for following:
- $\Delta H_{\text{bond forming}}$ or $\Delta H_{\text{bond breaking}}$ without signs
- No units

(ii) The energy absorbed in bond breaking of N≡N and O=O bonds is greater than the energy released in bond making of N=O bonds. **[1]**

cannot write: needed, used, required (too general)

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6 (a) (i) A weak acid is a substance that dissociates/ionises partially in water to release hydrogen ions. **[1]**

Do not award mark if hydrogen ions are not in answer.

No such thing as dissociate incompletely!!

(ii) Compare rate of effervescence for metal dissolving in butanoic acid and any named strong acid and indicating observation for butanoic acid.

When a strip of zinc metal (can be any reactive metal) is dissolved in butanoic acid, the rate of effervescence / volume of effervescence produced would be less than that of a strip of zinc metal in hydrochloric acid. **[1] [1]**

Deduct 1 mark if bubbles are used. **Strict use of effervescence only.**

Simple chemical test!!!
Universal indicator is not chemical test!

(b) (i)

	C	H	O
mass /g	0.18	0.03	0.08
mr	12	1	16
no. of moles	$\frac{0.18}{12} = 0.015$	$\frac{0.03}{1} = 0.03$	$\frac{0.08}{16} = 0.005$
simplest ratio	$\frac{0.015}{0.005} = 3$	$\frac{0.03}{0.005} = 6$	$\frac{0.005}{0.005} = 1$

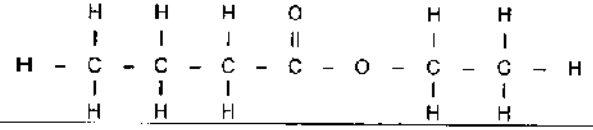
[1]

empiricial formula: C_3H_6O **[1]**

(ii) Let the molecular formula of the ester be $(C_3H_6O)_n$

Mr = 3n(12) + 6n(1) + 16n
116 = 36n + 6n + 16n = 58n
n = 2

Molecular formula = $C_6H_{12}O_2$ **[1]**



[1]

6 (a) The atomic radii increase down the group. **[1]**
As the number of electrons increases, more electron shells are required to 'house' the electrons, thus creating a bigger atom. **[1]**

(b) As seen in Graph 2, the electronegativity decreases on going down the group.
The ability of attraction of another electron from other atom decreases on going down the group. **[1]**
Hence, the decrease in electronegativity leads to the decrease in reactivity down the group. **[1]**

Trend and reason must tally!

No mark for just stating electronegativity decreases. READ question. It is about reactivity!!

(c) $Cl_2 + 2\ KBr \rightarrow 2\ KCl + Br_2$ (state symbols not required) **[1]**

(d) correct number of electrons in cation K^+ **[1]**
correct number of electrons in bromide Br^- **[1]**

7 (a) (i) Cracking **[1]**

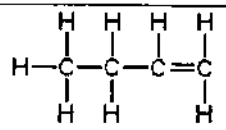
(ii) Alkanes **OR** Alkenes **[1]**

(iii) The hydrocarbons would undergo combustion with oxygen. **[1]**

(iv) Add aqueous bromine/bromine solution/bromine water to separate test tubes containing butane and butene. **[1]**

The test tube with butene will decolourise aqueous reddish brown bromine. **[1]**

(b) (i)



Accept alternate structures (2nd C = 3rd C) **[1]**

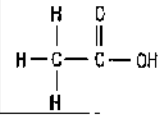
(ii) Under a high pressure and high temperature in the presence of a catalyst, the carbon carbon double bond in butane is broken to form poly(butene). **[1] [1]**

8 (a) (i) Purple to colourless **[1]**

(ii) Oxidation **[1]**

(b) Name: Ethanoic acid **[1]**

Structural formula: **[1]**



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	(c)	It can react with metal to form salt and hydrogen gas. It can react with metal carbonates to form salt, carbon dioxide gas and water. It can react with base to form salt and water. It can react with alcohol to produce sweet smelling liquid (ester). Any two answers	[2]

SECTION B: [30 marks]

1.	(a)	(i)	Experiment 1: copper Experiment 2: carbon Both must be correct to be awarded 1 mark.	[1]
		(ii)	Experiment 1 uses copper anode, reaction continues and copper(II) ions are reduced at the cathode as long as the anode is not used up. Experiment 2 uses an inert electrode, the copper(II) ions from the electrolyte is oxdised to form copper at the cathode. When all the copper ions in the electrolyte are discharged, the reaction stops. This explains why reaction stops when about 0.6g of copper is deposited.	[1] [1] [1]
	(b)		Anode: $Cu\ (s) \rightarrow Cu^{2+}\ (aq) + 2e$ Cathode: $Cu^{2+}\ (aq) + 2e \rightarrow Cu\ (s)$ State symbols must be given.	[1] [1]
	(c)		The resulting solution would turn the indicator red. The resulting solution contains H^+ (hydrogen ions) that causes it to be acidic and turn U.I. red.	[1] [1]
	(d)		No. of moles of oxygen = (0.64 ÷ 64) ÷ 2 = 0.005 Volume of oxygen = 0.005 × 24 =0.12 dm^3	[1] [1]

2.	(a)	(i)	Blue solution turns green. A pink solid is deposited on the rod.	[1]
		(ii)	The more reactive iron metal displaces the less reactive copper ions from the solution. The solution turns green due to iron(II) ions. A pink solid is formed due to copper metal.	[1] [1]
	(b)	(i)	Copper , Iron, Zinc, X	[1]
		(ii)	Experiment 2 shows that zinc is more reactive than iron. Experiment 3 shows that X is more reactive than zinc. Thus the reactivity is such: Copper, Iron, Zinc, X.	[1] [1]
		(iii)	K/Na/Ca/Mg/Al Name or formula can be accepted.	[1]
	(c)	(i)	A white precipitate will be formed.	[1]
		(ii)	The more reactive a metal, the more difficult it is to decompose its carbonate by heat. Hence the test tube that forms the least volume of gas in a given time contains the metal carbonate of the most reactive metal. OR Hence the test tube that takes the longest time for bubbles to stop forming contains the metal carbonate of the most reactive metal.	[1] [1]

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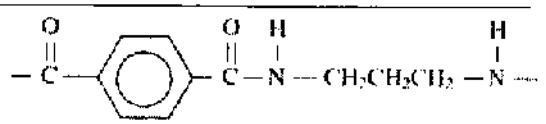
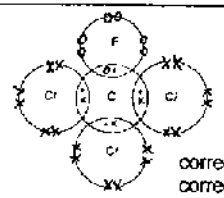
3E	(a)		Conditions: Warm / Heat with <u>concentrated sulfuric acid</u> Compound **X**: methanol (no formula to be accepted)	[1] [1]
	(b)	(i)	Monomer **C**.	[1]
		(ii)	Monomer **B** contains <u>carbon-carbon double bonds (C = C) bonds</u> **needed** to undergo <u>addition reaction</u> to form polymers <u>without losing small molecules</u> in the polymerisation process.	[1] [1]
	(c)	(i)		[1]
		(ii)	Burning of the polymer results in nitrogen dioxide that causes acid rain Production harmful air pollutants to the environment. Any logical reason related to environmental issues. **Don't write harmful. Give identity of gas and its effect.**	[1]
	(d)		Heat the three solutions with acidified potassium dichromate(VI). If orange potassium dichromate(VI) <u>turns green</u>, the solution contains monomer **C**. Add aqueous bromine to the remaining two solutions. If reddish brown aqueous bromine <u>decolourises</u> rapidly, the solution contains monomer **B**. Add magnesium / sodium carbonate to the remaining solution. If effervescence is observed, the solution contains monomers **A**.	[1] [1] [1]

3 Or	(a)	(i)	 correct number of bonding electrons – 1mark correct number of non-bonding electrons – 1 mark	[2]
		(ii)	It will have a low boiling point. Little amount of energy is required to overcome the weak intermolecular forces of attraction/van der waals' forces between the molecules	[1] [1]
	(b)		The gas with the smallest heat trapping effectiveness has the greatest contribution towards global warming.	[1]
	(c)		CFCs are present in the atmosphere at low percentages.	[1]
	(d)	(i)	calcium carbonate /limestone **<u>OR</u>** calcium oxide/lime	[1]
		(ii)	$SO_2 + CaCO_3 \rightarrow CaSO_3 + CO_2$ **<u>OR</u>** $SO_2 + CaO \rightarrow CaSO_3$	[1]
		(iii)	No. of moles of $SO_2 = 60 \div 24$ $= 2.5$ No. of moles of $CaCO_3 = 2.5$ Mass of $CaCO_3$ needed $= 2.5 \times (40 + 12 + 3 \times 16)$ $= 250g$ **<u>OR</u>** No. of moles of $CaO = 2.5$ Mass of CaO needed $= 2.5 \times (40 + 16)$ $= 140g$	[1] [1] **<u>OR</u>** [1]

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Anglo-Chinese School (Barker Road)

PRELIMINARY EXAMINATION 2016

SECONDARY FOUR (EXPRESS)

CHEMISTRY PAPER 1
5073/1

1 HOUR

INSTRUCTIONS TO CANDIDATES

Do not open this booklet until you are told to do so.

Read the instructions on the OTAS answer sheet carefully.

Write your index number, subject code and paper number clearly on the OTAS answer sheet provided for you.

There are forty multiple choice 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 you choice in **soft pencil** on the separate OTAS 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 in this booklet.

INFORMATION FOR CANDIDATES

A copy of the Periodic Table is printed on page 18.

This question paper consists of 18 printed pages.

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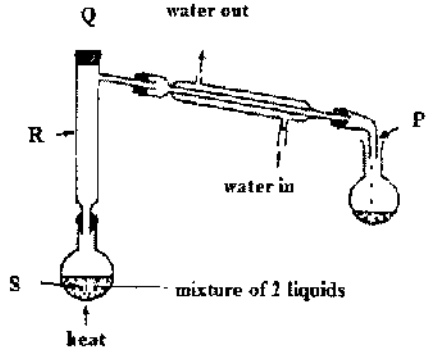
The use of an approved scientific calculator is expected, where appropriate.

Paper 1 (40 Marks)

1 A mixture of two liquids is fractionally distilled in the apparatus shown below.



Which of the following modifications would improve the separation of the two liquids efficiently?

A filling tube R with glass beads
B fitting a rubber stopper at P
C inserting a thermometer at Q
D putting boiling chips in flask

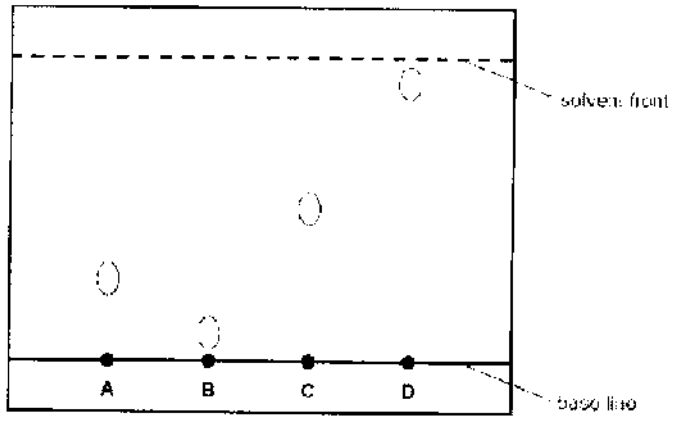
2 When x cm^3 of water and x cm^3 of ethanol are mixed, the total volume is less than $2x$ cm^3.

Which of the following best explains this?

A The water molecules and the ethanol molecules mix together by diffusion.
B The water molecules react with the ethanol molecules.
C The smaller water molecules fit into the spaces between the ethanol molecules
D The total mass, being greater, pushes the molecules closer together.

3 The diagram shows the chromatogram of four different sugars using the same solvent

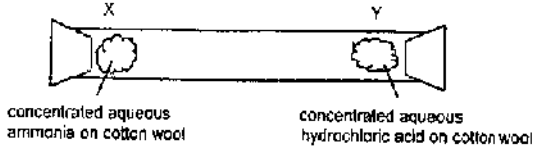
Given that glucose has an R_f value of 0.5 which of the following is glucose?



4 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 formed within the tube. The experiment was then repeated at a higher temperature.

Which of the following is true of the repeated experiment?



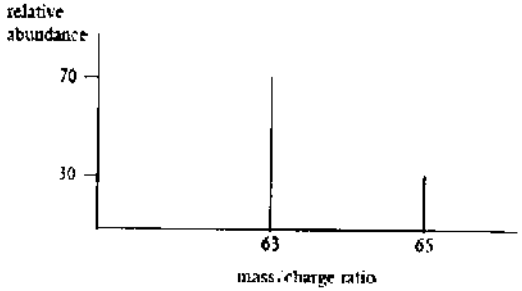
A The white solid now forms even closer to X compared to the first experiment
B The white solid now forms even closer to Y compared to the first experiment.
C The white solid now forms at a much faster rate compared to the first experiment.
D Yellow solid is now being formed instead.

5 What is the structure of the ion $^{90}_{38}Sr^{2+}$?

	protons	neutrons	electrons
A	38	90	52
B	38	52	41
C	38	52	36
D	52	38	38

6 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.

The relative atomic mass of Y is



A 63.2
B 63.4
C 63.6
D 64.0

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7 Element Q has an electronic structure 2, 4

Element R has an electronic structure 2, 8, 6

Element Q reacts with element R to form a new compound.

Which of the following correctly shows how element Q reacts with element R?

A two electrons are shared between an atom of Q and an atom of R
B four electrons are shared between an atom of Q and an atom of R
C four electrons are transferred from an atom of Q to an atom of R
D two electrons are transferred from an atom of Q to an atom of R

8 Ethene is a colourless gas at room temperature while polyethene is a solid at room temperature.

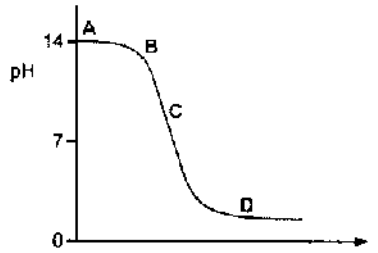
Which statement best explains this observation?

A The covalent bond in ethene is stronger than the intermolecular forces of attraction in polyethene.
B The covalent bonds in polyethene is stronger than the intermolecular forces in ethene.
C The intermolecular forces of attraction in polyethene is weaker than the intermolecular forces of attraction in ethene.
D The intermolecular forces of attraction in polyethene is stronger than the intermolecular forces of attraction in ethene.

9 The graph shows how the pH changes as an acid is added to an alkali, according to the following reaction:

acid + alkali → salt + water

Which letter represents the portion of the graph where both acid and salt are present?



10 Which statement does not describe a property of a weak acid in solution?

A It forms a salt with sodium hydroxide.
B It has a pH of between 8 and 9.
C It is only partially dissociated into ions.
D It reacts violently with sodium metal.

11 Coloured glass, as used in church windows, requires three oxides – a macromolecular, an amphoteric and one of a transition metal.

Which combination is likely to produce a coloured glass?

A	Al_2O_3	MgO	Ag_2O
B	P_4O_{10}	CaO	MnO_2
C	SiO_2	MgO	Fe_2O_3
D	SiO_2	PbO	CuO

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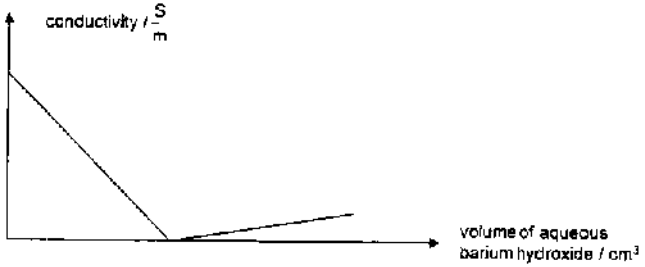
12 The diagram below shows the change in electrical conductivity when aqueous barium hydroxide is added to a fixed volume of substance X.



Which of the following is a possible identity for substance X?

A aqueous copper(II) chloride
B aqueous iron(II) iodide
C aqueous magnesium nitrate
D aqueous zinc sulfate

13 Which of the following are uses of sulfuric acid?

I: making of 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

14 Nitrogenous fertilizer such as ammonium nitrate is used to increase crop yield.

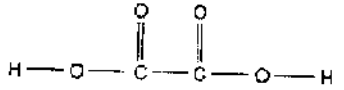
Which of the following substances can be added to increase pH of the acidic soil without causing a loss of nitrogen?

A calcium carbonate
B calcium hydroxide
C magnesium hydroxide
D magnesium sulfate

15 In the Haber Process, a high yield of ammonia is favoured by conditions of high pressure and low temperature. However in practice, a high temperature is employed because

A at low temperature, ammonia decomposes back to its original reactant.
B at low temperature, the activation energy is too low.
C at low temperature, the catalyst is inactive.
D at low temperature, the reaction is too slow.

16 The structure of oxalic acid is shown below



A 25.0 cm^3 solution of oxalic acid reacts completely with 15.0 cm^3 of 2.5 mol/dm^3 NaOH. The concentration of the oxalic acid solution is _____

A 0.667 mol/dm^3
B 0.750 mol/dm^3
C 1.33 mol/dm^3
D 1.50 mol/dm^3

17 60 cm^3 of the gaseous oxide of element W requires 30 cm^3 of oxygen for complete combustion to produce 120 cm^3 of the gaseous oxide WO_2.

What is the molecular formula of the original oxide?
(All volumes are measured at room temperature and pressure.)

A WO
B W_2O
C W_2O_3
D W_3O

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18 The active component of tobacco, nicotine, found in cigarette smoking is thought to increase the chances of a person developing lung cancer. The relative molecular mass of nicotine is 162 and quantitative elemental analysis gave the following percentages by mass:

carbon: 74.0%
hydrogen: 8.7%
nitrogen: 17.3%

Which of the following is the correct molecular formula for nicotine?

A C_5H_7N
B $C_9H_{10}N_2$
C $C_{10}H_{14}N_2$
D $C_{10}H_{15}N_2$

19 Sulfur and selenium, Se, are in the same group of the Periodic Table.

From this, we would expect selenium to form compounds having the formulae

A Se_2O, Na_2Se and $NaSeO_4$.
B SeO_2, Na_2Se and $NaSeO_4$
C SeO_2, Na_2Se and Na_2SeO_4.
D SeO_3, NaSe and $NaSeO_4$.

20 A commercial production of iodine involves the reduction of a solution of iodate(V) ions, IO_3^-, with hydrogen sulfite ions, HSO_3^-.

The equation for the reaction may be written as

$xIO_3^- + yHSO_3^- \rightarrow zSO_4^{2-} + I_2 + 3H^+ + H_2O$

	x	y	z
A	2	5	5
B	2	5	2
C	5	2	2
D	5	5	2

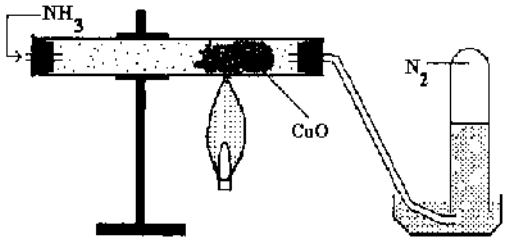
21 Which statement about group(s) in the Periodic Table is correct?

A All groups contain both metals and non-metals.
B Atoms of elements in the same group have the same number of electrons in total.
C In group I, the reactivity of the elements decreases with increasing proton number.
D In group VII, the melting point of the elements increases with increasing proton number.

22 Which of the following reactions is an example of a redox reaction?

A $2SO_2 + O_2 \rightarrow 2SO_3$
B $Ag^+ + Cl^- \rightarrow AgCl$
C $CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$
D $H^+ + OH^- \rightarrow H_2O$

23 The diagram below shows an experiment on ammonia on copper(II) oxide



In this experiment, copper(II) oxide functions as

A a base.
B a dehydrating agent.
C a reducing agent.
D an oxidising agent.

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24 Metal U displaces metal V from an aqueous solution of the nitrate of V.

Metal W reacts with cold water to give hydrogen, but metal U gives hydrogen only when reacted with steam.

Metal U can be extracted from its oxide by reaction with carbon but not with hydrogen.

What could elements U, V and W be?

	U	V	W
A	copper	iron	magnesium
B	magnesium	lead	sodium
C	iron	silver	calcium
D	zinc	copper	calcium

25 Iron pipes corrode rapidly when exposed to sea water.

Which metal, when attached to the iron, would not offer protection against corrosion?

A aluminium
B copper
C magnesium
D zinc

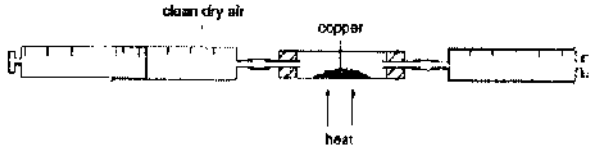
26 Three types of steel have different properties:

steel 1: easily shaped
steel 2: brittle
steel 3: resistant to corrosion

What of the following best describes these three types of steel?

	steel 1	steel 2	steel 3
A	high carbon	mild	stainless
B	high carbon	stainless	mild
C	high carbon	stainless	high carbon
D	mild	high carbon	stainless

27 A 240 cm^3 sample of clean, dry air is passed over hot excess copper at room temperature and pressure until there is no further change in volume with the pink copper metal turns black.



What is the mass of the black solid formed when the reaction is complete?

A 0.17 g
B 0.34 g
C 0.80 g
D 1.60 g

28 Which reaction occurring in the blast furnace is an acid-base reaction?

A $C + CO_2 \rightarrow 2CO$
B $C + O_2 \rightarrow CO_2$
C $CaO + SiO_2 \rightarrow CaSiO_3$
D $Fe_2O_3 + 3CO \rightarrow 3Fe + 3CO_2$

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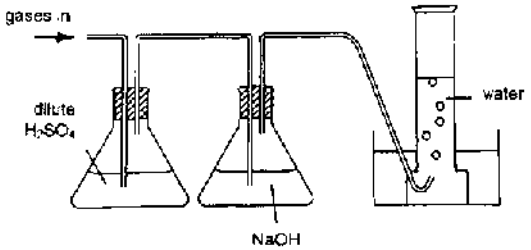
29 A sample of three gases was passed through the apparatus shown below.

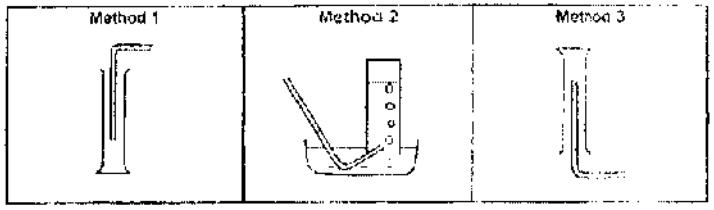


It was found that only one gas was collected in the gas jar at the end.

Which of the following could be the mixture of gases in the sample?

A ammonia, hydrogen, carbon monoxide
B hydrogen chloride, sulfur dioxide, carbon monoxide
C nitrogen, helium, carbon dioxide
D oxygen, nitrogen, hydrogen chloride

30 The diagrams show three methods commonly used to collect gases.



Which of the above are the best methods for collecting the following gases?

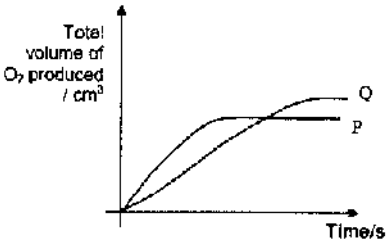
	CO_2	H_2	O_2	NH_3
A	2	3	1	2
B	3	2	2	1
C	1	2	2	3
D	1	2	1	2

31 Biodiesel, made by vegetable oil can be used as a fuel for cars. Even though carbon dioxide is released when biodiesel is combusted, some scientists still claimed that biodiesel is a carbon neutral fuel.

What is the basis for this argument?

A Biodiesel is not a carbon compound.
B Biodiesel produces less carbon dioxide when it burns.
C Plants release carbon dioxide in respiration.
D Plants take up carbon dioxide as they grow.

32 Graph P was produced from the results obtained from the decomposition of 100 cm^3 of 2 mol/dm^3 of aqueous hydrogen peroxide, using a metal oxide catalyst.



Which change to the conditions would produce graph Q?

A adding some 0.1 mol/dm^3 of aqueous hydrogen peroxide
B using a different and more effective catalyst
C using a lower temperature
D using a smaller mass of metal oxide catalyst

33 In an electrolysis experiment, the same amount of charge deposited 32 g of copper and 13 g of chromium.

What is the charge of chromium ion?

A 1+
B 2+
C 3+
D 4+

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34 Which of the following correctly describes what takes place in a hydrogen-oxygen fuel cell?

A Hydrogen gas is oxidized at the negative electrode to form water
B Hydrogen gas is reduced at the negative electrode to form water.
C Hydrogen ions are oxidized at the positive electrode to form hydrogen.
D Hydrogen ions are reduced at the positive electrode to form hydrogen

35 The scheme shows four stages I to IV in the conversion of solid candlewax, $C_{30}H_{62}$, into carbon dioxide and water.

$$C_{30}H_{62}(s) \xrightarrow{I} C_{30}H_{62}(l) \xrightarrow{II} C_{30}H_{62}(g) \xrightarrow{III} \begin{matrix}30CO_2(g)\\+\\31H_2O(l)\end{matrix} \xrightarrow{IV} \begin{matrix}30CO_2(g)\\+\\31H_2O(g)\end{matrix}$$

Which stages are endothermic?

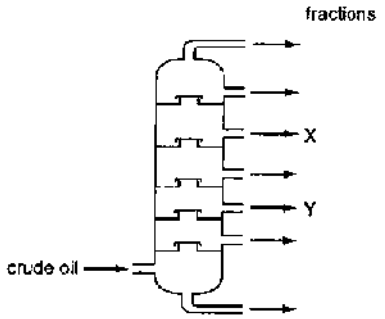
A I and II
B II and III
C I, II and IV
D II, III and IV

36 Useful fractions are obtained by the fractional distillation of petroleum.

Which fraction is correctly matched to its use?

	fraction	use
A	bitumen	for making roads
B	lubricating oils	aircraft fuel
C	paraffin	fuel in cars
D	petrol	for making waxes and polishes

37 Crude oil is fractionally distilled in a fractionating column. The positions at which fractions X and Y are collected are shown.



Which statement is correct?

A The temperature increases up the column.
B X condenses at a lower temperature than Y.
C X has a higher boiling point than Y.
D X has longer chain molecules than Y.

38 A molecule of $C_{17}H_{36}$ undergoes catalytic cracking. The products of the reaction are one butane molecule, one propene molecule and some ethene molecules.

How many ethene molecules are produced during the reaction?

A 3
B 5
C 6
D 8

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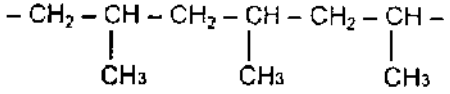
39 A compound X has all of the following properties:

- It is a liquid at room temperature and atmospheric pressure.
- It dissolves in water.
- It decolourises acidified potassium manganate(VII)

Which of the following could be X?

A ethane
B ethanoic acid
C ethanol
D ethene

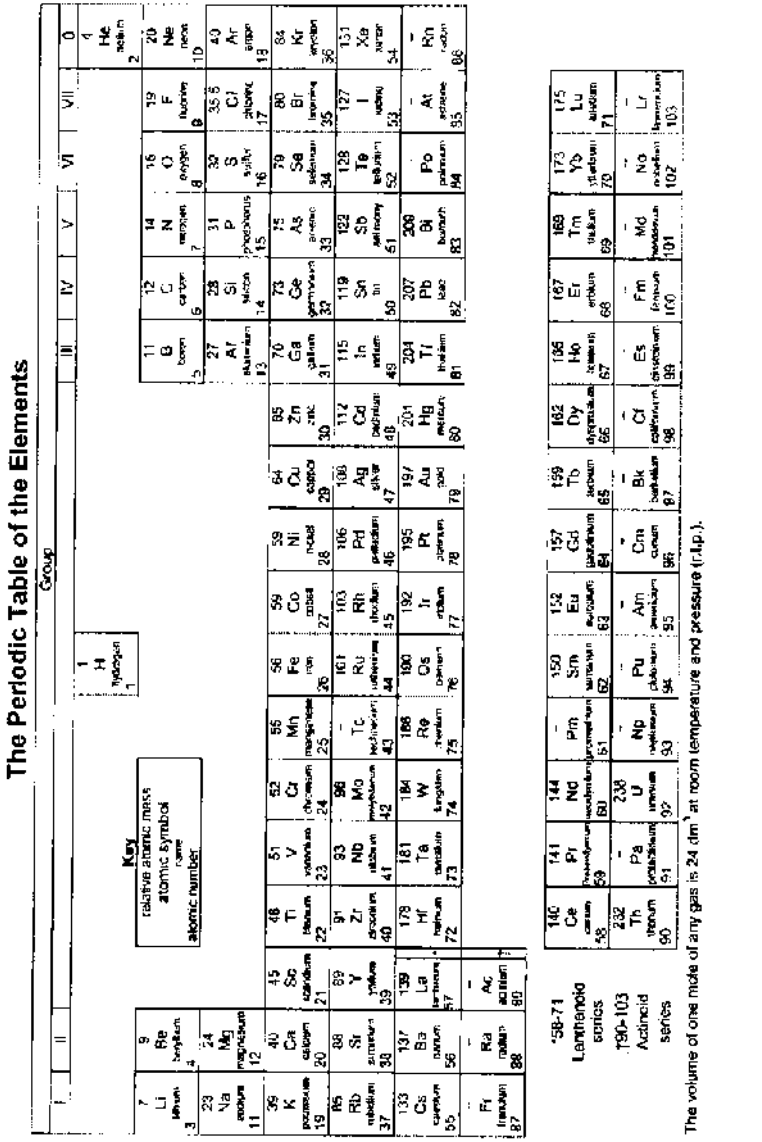
40 The structure of the polymer is shown below.



Which is the molecular formula of the monomer?

A C_2H_6
B C_3H_6
C C_3H_8
D C_4H_8

END OF PAPER



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BENDEMEER SECONDARY SCHOOL
2016 PRELIMINARY EXAMINATION 2
SECONDARY 4 EXPRESS
CHEMISTRY PAPER 1
5073/01

DATE : 25 Aug 2016
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 is provided on page **15**.

40

This document consists of **15** printed pages.

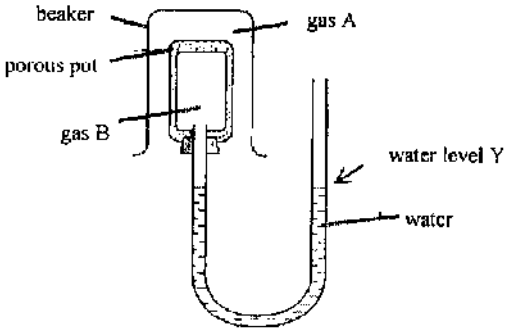
1 Study the following statements in a student's notebook.

I In a solid, the particles are stationary and held in fixed positions due to strong forces of attraction.
II When a solid is heated, the particles expand and become larger.
III At the melting point, the particles are able to slide and roll over one another.
IV When the boiling point is reached, evaporation and boiling start to take place and the gas is formed.

Which statement(s) is/are true?

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

2 A student uses the following apparatus to carry out a series of experiments to compare the rate of diffusion between different gases K, L, M and N.



The table below summarises the observations made.

experiment	gas A	gas B	observation after 5 mins
1	K	L	water level Y rises
2	M	N	water level Y falls
3	L	N	water level Y rises

What is the correct order of gas in increasing relative molecular mass?

A K, L, M, N
B K, L, N, M
C M, L, N, K
D M, N, L, K

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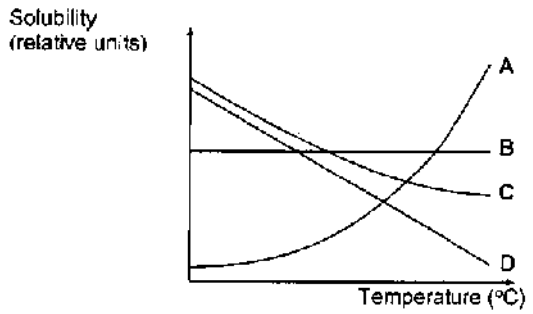
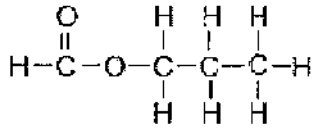
3 The solubility curves for four solids, **A**, **B**, **C** and **D**, in water are shown below.
Which solid is most suitable to be collected by crystallisation from its aqueous salt?



4 An ion X^{2-} has **p** nucleons and **q** electrons.
What does the nucleus of an atom X contain?

	number of protons	number of neutrons
A	q – 2	p – q
B	q – 2	p – (q – 2)
C	q + 2	p – (q – 2)
D	q + 2	q – (p + 2)

5 The diagram shows the molecule propyl methanoate.



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

A 8 B 12 C 20 D 28

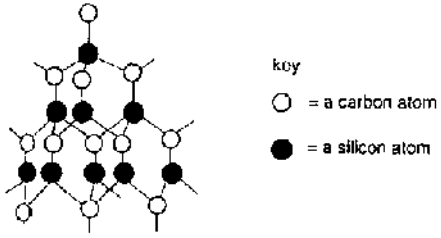
6 Two statements about chlorine are made below.

Statement 1: Chlorine has weak covalent bonds in its simple molecular structure.
Statement 2: Chlorine is soluble in water.

What statement(s) is/are correct?

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

7 The diagram shows part of the structure of the compound silicon carbide.



Which set of information about silicon carbide is correct?

	empirical formula	when strongly heated in oxygen
A	SiC	burns, giving a solid residue only
B	SiC	burns, giving a solid residue and a colourless gas
C	Si_2C	burns, giving a solid residue only
D	SiC_2	burns, giving a solid residue and a colourless gas

8 All of the following substances can conduct electricity in the solid state except

A aluminium.
B graphite.
C mercury.
D sodium chloride.

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9 4 g of hydrogen is mixed with 16 g of oxygen and the mixture is ignited. What is the mass of reactants left and product formed at the end of the reaction?

	mass of hydrogen / g	mass of oxygen / g	mass of water / g
A	0	0	20
B	0	8	12
C	2	0	18
D	2	8	20

10 Which of the following has the same number of atoms as 6 dm^3 of fluorine gas at r.t.p?

A 0.5 g of hydrogen gas
B 8.5 g of ammonia
C 10 g of argon
D 23 g of sodium

11 When 200 g of compound X containing carbon, hydrogen, aluminium and oxygen is heated in excess oxygen, 42.2 g of aluminium oxide is obtained as residue.
What is the percentage by mass of aluminium in the sample?

A 11.2% B 13.5% C 21.1% D 27.0%

12 The percentage composition by mass of a compound containing carbon, fluorine and chlorine is as follows:

Carbon : 18.05% Fluorine : 28.50% Chlorine : 53.45%

Which of the following could be the molecular formula of this compound?

A CF_3Cl B CF_2Cl_2 C $C_2F_2Cl_2$ D C_2F_2Cl

13 Both hydrochloric acid and ethanoic acid have the same concentration of 1.00 mol/dm^3.
Which method(s) is/are suitable to test for their strengths?

I using a pH meter
II measuring their electrical conductivity
III titration using sodium hydroxide solution

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

14 In a titration experiment, five students each added hydrochloric acid from a burette to 25.0 cm^3 of aqueous sodium hydroxide in a conical flask.

The volume of hydrochloric acid used by each student is shown in the table below.

student	1	2	3	4	5
volume / cm^3	25.2	25.3	25.3	26.1	25.2

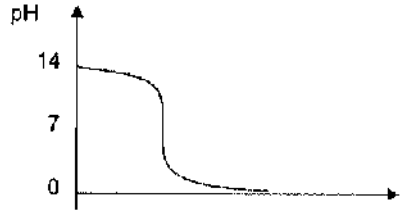
What could be a reason for the result obtained by student 4?

A The burette had been washed with hydrochloric acid.
B The flask had been washed with aqueous sodium hydroxide.
C The student had used too much indicator.
D The pipette had been washed with aqueous sodium hydroxide.

15 Which two processes are involved in the preparation of zinc sulfate crystals from dilute sulfuric acid and zinc oxide?

A neutralisation and filtration
B neutralisation and oxidation
C precipitation and filtration
D precipitation and oxidation

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



What are W and X?

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

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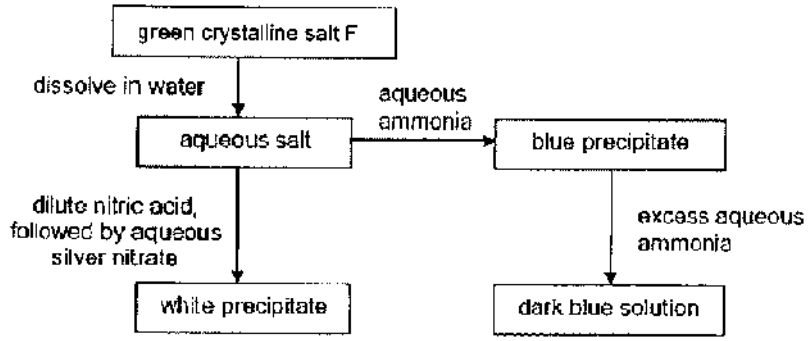
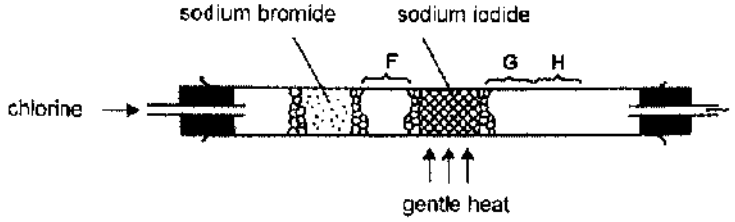
17 The scheme shows some reactions of salt F.



What is the identity of F?

A copper(II) chloride
B copper(II) iodide
C iron(II) chloride
D iron(II) iodide

18 Using the apparatus shown, chlorine is passed through the tube. After some time, coloured substances are seen at F, G and H.



What are these coloured substances?

	F	G	H
A	green gas	violet vapour	black solid
B	green gas	red brown vapour	violet vapour
C	red brown vapour	violet vapour	black solid
D	violet vapour	red brown vapour	red brown vapour

19 The element, selenium (Se), is found in the same group of the Periodic Table as sulfur. What is the chemical formula of lithium selenide?

A LiSe B Li_2Se C $LiSeO_4$ D $Li(SeO_4)_2$

20 The table below shows four metals and some of their reactions.

metal	action of heat on carbonate	effect of hydrogen on heated oxide	action of dilute sulfuric acid on metal
G	decompose	reduced	no reaction
H	no reaction	no reaction	hydrogen evolved
I	decompose	no reaction	hydrogen evolved
J	decompose	reduced	hydrogen evolved

What is the correct order of reactivity for these four metals?

	most reactive → least reactive			
A	H	J	I	G
B	H	I	J	G
C	I	J	G	H
D	I	H	G	J

21 Different types of steel differ in how much carbon they contain. Which are the properties of a high carbon steel?

A soft and brittle
B soft and easily shaped
C strong and brittle
D strong and easily shaped

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22 Ethanol reacts with acidified potassium manganate(VII) to form ethanoic acid.
The half-equation for manganate can be written as:

$$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$$

Which line of information can be deduced?

	reducing agent	change in oxidation state of Mn	colour change
A	ethanol	+7 to +2	purple to colourless
B	ethanol	+8 to +2	no change
C	hydrogen ions	+7 to +2	purple to colourless
D	hydrogen ions	-1 to +2	no change

23 When a mineral is heated strongly to constant mass, a colourless gas is evolved and forms a white precipitate with limewater. The remaining solid is cooled and added to hydrochloric acid. Vigorous effervescence is observed.

What is the mineral?

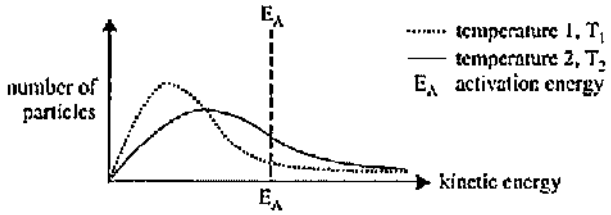
A $CaCO_3$
B $MgCO_3.CaCO_3$
C $Mg(OH)_2.3H_2O$
D $Na_2CO_3.CaCO_3.5H_2O$

24 Which processes are endothermic?

1 $Br_2 \rightarrow 2Br$
2 burning fossil fuel
3 obtaining lime from limestone
4 reacting hydrogen with oxygen

A 1 and 2
B 1 and 3
C 2 and 4
D 3 and 4

25 The diagram represents the distribution of kinetic energy of reactant particles at two different temperatures. Assuming that the areas under the two curves are equal, which statement is correct?

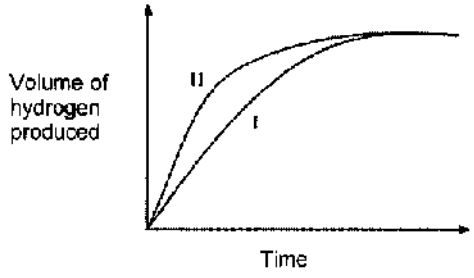


A At T_1, the activation energy is lower than at T_2.
B At T_1, the enthalpy change of the reaction is higher than at T_2.
C At T_2, a greater number of particles have sufficient energy to react.
D At T_2, the reaction takes a longer time to complete.

26 Which quantities of the acid will produce the fastest initial rate of reaction when 4.00 g of magnesium ribbon is added to it at r.t.p.?

A 15.0 cm^3 of 2.00 mol/dm^3 nitric acid
B 20.0 cm^3 of 1.00 mol/dm^3 hydrochloric acid
C 20.0 cm^3 of 1.00 mol/dm^3 sulfuric acid
D 30.0 cm^3 of 2.00 mol/dm^3 ethanoic acid

27 Excess zinc was added to 100 cm^3 of hydrochloric acid, concentration 1 mol/dm^3. Graph I shows the results obtained from this reaction.



Graph II could be obtained by adding excess

A magnesium reacting with 100 cm^3 of 1 mol/dm^3 hydrochloric acid.
B zinc reacting with 100 cm^3 of 1 mol/dm^3 sulfuric acid.
C zinc reacting with 100 cm^3 of 2 mol/dm^3 ethanoic acid.
D zinc reacting with 100 cm^3 of 2 mol/dm^3 hydrochloric acid.

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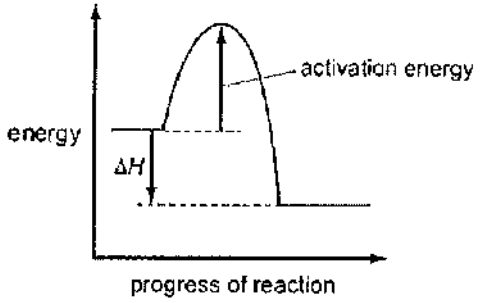
28 In the Haber process, a high yield of ammonia is favoured by conditions of high pressure and low temperature. However, in practice a high temperature is employed because at low temperature,

A ammonia decomposes back to its original reactant.
B the activation energy is too low.
C the catalyst is inactive.
D the reaction is too slow.

29 Which pollutant gas is produced by the decomposition of vegetation?

A CH_4 B CO C NO D SO_2

30 The energy profile for the forward direction of a reversible reaction is shown.



What is the sign of activation energy and the type of enthalpy change for the reverse reaction?

	sign of activation energy	enthalpy change
A	negative	endothermic
B	negative	exothermic
C	positive	endothermic
D	positive	exothermic

31 Which reaction does not involve either oxidation or reduction?

A $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$
B $Cu^{2+}(aq) + Zn(s) \rightarrow Cu(s) + Zn^{2+}(aq)$
C $CuO(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + H_2O(l)$
D $Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$

32 Dilute sulfuric acid is electrolysed using graphite electrodes.
Which statement is not true?

A Hydrogen ions gain electrons and are reduced.
B The concentration of the acid increases.
C The ratio of mass of hydrogen to oxygen gas produced is 1:8.
D The same products are obtained when concentrated aqueous hydrochloric acid is electrolysed.

33 Which of the following gas(es) can be removed by a catalytic converter?

I carbon monoxide
II sulfur dioxide
III nitrogen dioxide

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

34 In an electrolysis experiment, the same amount of charge deposited 32 g of copper and 13 g of chromium.

What was the charge on the chromium ion?

A 1+ B 2+ C 3+ D 4+

35 Which statement about fractional distillation of petroleum is correct?

A At each level in the fractionating column, only one compound is collected.
B The higher up the fractionating column, the greater the temperature.
C The molecules collected at the bottom of the fractionating column are the most flammable.
D The molecules reaching the top of the fractionating column have the smallest relative molecular mass.

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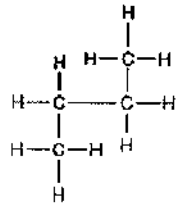
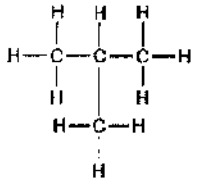
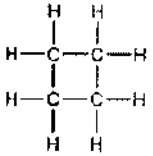
36 Four hydrocarbons structures are shown.



1



2



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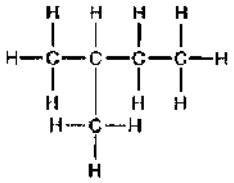


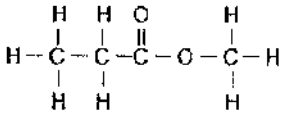
4

Which hydrocarbons are isomers of each other?

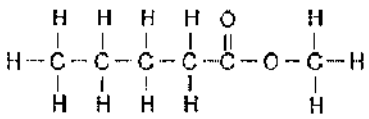
A 1 and 2
B 3 and 4
C 1, 2 and 3
D 1, 2 and 4

37 An ester was produced by the condensation reaction of methanol and butanoic acid.
Which structure represents the ester compound?

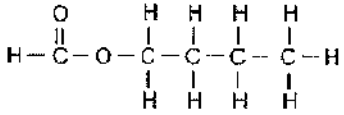
A



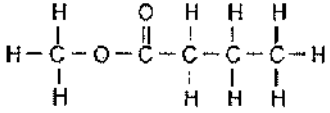
B



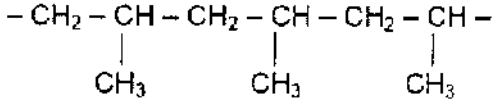
C



D



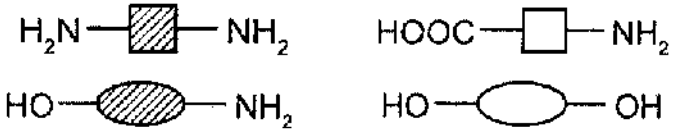
38 A polymer has the following structure:



What is the monomer?

A butene **B** butane **C** ethene **D** propene

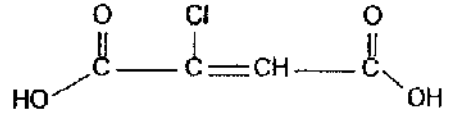
39 The diagrams show four monomers.



How many of these monomers could react with the molecule below to form a polymer?

A 1 **B** 2 **C** 3 **D** 4

40 The diagram below shows the structural formula of chloromaleic acid.



Which statement is true about chloromaleic acid?

A It can undergo a substitution reaction with halogens.
B It decolourises bromine solution in the absence of sunlight.
C It will react with magnesium to produce a gas that relights a glowing splint.
D It will turn litmus paper blue.

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15

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Name		Register No.	Class

BENDEMEER SECONDARY SCHOOL
2016 PRELIMINARY EXAMINATION 2
SECONDARY 4 EXPRESS
CHEMISTRY PAPER 2
5073/02

DATE : **23 Aug 2016**
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 **19**.

80

This document consists of **19** printed pages.

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

A1 For each of the following statements, select an element from Period 2 of the Periodic Table that best fits the description given.

(a) Its only oxidation state is 0.

..... [1]

(b) It is the strongest oxidising agent.

..... [1]

(c) It forms a pollutant during lightning activity.

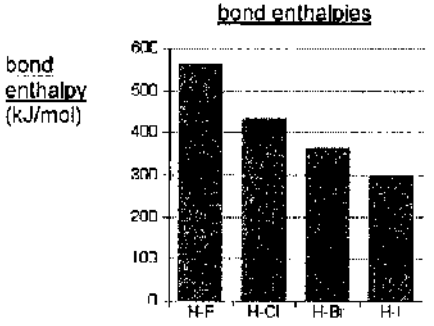
..... [1]

(d) It forms a compound used to reduce iron(III) oxide in haematite.

..... [1]

[Total: 4 marks]

A2 The bond enthalpy is the energy required to break or form a chemical bond. The bond enthalpy of some hydrogen halides are shown in the chart below.



(a) Describe the trend shown by the chart.

..... [1]

(b) **(i)** Which hydrogen halide will form the strongest acid?

..... [1]

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

.....

..... [2]

(c) (i) Hydrogen bromide can be produced by reacting hydrogen gas and bromine gas according to the following reaction:

$$H_2(g) + Br_2(g) \rightarrow 2HBr(g)$$

Some data on bond energies 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.

[1]

(ii) State whether the reaction is exothermic or endothermic, and explain your choice using ideas about bond breaking and bond forming.

.....

.....

.....

..... [2]

(iii) Draw an energy profile diagram for the production of hydrogen bromide. Your diagram should include the ethalpy change and activation energy of the energy of the reaction.

[2]
[Total: 9 marks]

A3 A student performed three experiments using three metals, iron, manganese and chromium. In the first experiment, he added the metals separately into dilute sulfuric acid. In the second experiment, he heated the metals in air. In the last experiment, he put strips of the metals in metal salt solutions.

Table 3.1 shows the results of the first two experiments.

Table 3.1

metal	reaction with sulfuric acid	reaction with air
iron	metal dissolves slowly with effervescence, a pale green solution is formed	burns in air to form dark brown iron(III) oxide
manganese	metal dissolves quickly with effervescence, a pale pink solution, manganese(II) sulfate, is formed	burns in air with an intense white light forming a red solid, manganese(II,III) oxide, Mn_3O_4
chromium	metal dissolves readily with effervescence, a violet solution, chromium(III) sulfate, is formed	burns in air to form green chromium(III) oxide, Cr_2O_3

(a) From the information above, state two properties of iron, manganese and chromium to show that they are transition metals.

.....

..... [2]

(b) Fig. 3.1 shows strips of manganese and chromium in iron(II) sulfate and manganese(II) sulfate solutions.

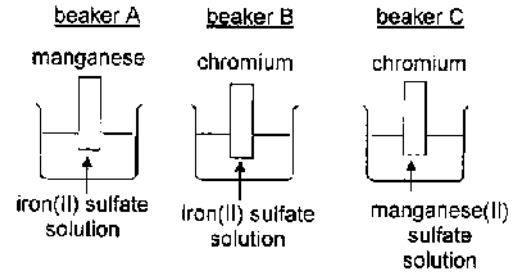

Fig 3.1

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State the observations you would expect in Table 3.2.

Table 3.2

beaker A	beaker B	beaker C

[3]

(c) Chromium ore is processed and purified into chromium(III) oxide. This is reacted very exothermically with aluminium to form chromium metal.

$$Cr_2O_3(s) + 2Al(s) \rightarrow Al_2O_3(s) + 2Cr(s)$$

Chromium metal is used to electroplate other metals like steel because of its anti–corrosion properties.

(i) Explain, in terms of oxidation states, why the extraction of chromium from chromium oxide is a redox reaction.

.....

.....

..... [2]

(ii) Explain why using chromium to electroplate steel is more effective than tin-plating?

.....

.....

..... [2]

[Total: 9 marks]

A4 People with kidney problems are advised against eating caramnola fruit, commonly known as starfruit, as it contains a significant amount of oxalic acid.
The concentration of oxalic acid is generally between 0.500 mol/dm^3 to 1.00 mol/dm^3.
The acid concentration in starfruit can be determined by performing an acid-base titration with sodium hydroxide solution.
(Assume that oxalic acid found in starfruit is dibasic and can be represented by H_2A.)

(a) A student suggested that 25.0 cm^3 of the oxalic acid from starfruit should be pipetted into a conical flask and titrated against 0.100 mol/dm^3 of sodium hydroxide solution.

(i) Based on the information provided, calculate the maximum volume of sodium hydroxide solution required for complete neutralisation of the oxalic acid.

[2]

(ii) Suggest why the student's procedure may not be appropriate using common laboratory apparatus.

..... [1]

(b) Oxalic acid contains 26.7% carbon and 2.20% hydrogen by mass. The rest is oxygen.

(i) Determine the empirical formula of oxalic acid.

[2]

(ii) The relative molecular mass of oxalic acid is 90.0.
Determine its molecular formula.

[1]

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(iii) A patient was advised by the doctor to consume not more than 0.05 g of oxalic acid per day. If a typical serving of starfruit contains 1.10×10^{-4} moles of oxalic acid, calculate the maximum number of starfruits the patient can eat a day.

[2]

[Total: 8 marks]

A5 An experiment was conducted to investigate the rate of reaction between calcium carbonate and dilute hydrochloric acid, by measuring the volume of gas evolved at regular time intervals.

(a) 15.0 g of calcium carbonate was reacted with 150 cm^3 of 2 mol/dm^3 of hydrochloric acid.

(i) Write the chemical equation for the reaction. Hence calculate the volume of carbon dioxide produced.

[3]

(ii) Hence, sketch a graph of volume of carbon dioxide gas produced against time. Label this graph as *Graph I*. Indicate the volume of carbon dioxide gas produced clearly on the graph.

[2]

(iii) In another experiment, the same mass of calcium carbonate was reacted with 150 cm^3 of 1 mol/dm^3 hydrochloric acid.
On the same axes as the graph in (a)(ii), sketch the graph that you would expect to obtain and label this graph as *Graph II*.
Indicate the volume of carbon dioxide gas produced clearly on the graph.
[1]

(iv) Explain the differences in the shapes of Graph I and II.

.....

.....

..... [2]

(b) Other than concentration of acid, give one other factor that would alter the rate of reaction and explain your reasoning in terms of collision theory.

.....

.....

.....

.....

..... [2]

[Total: 10]

A6 Alkynes are hydrocarbons containing carbon-carbon triple bond (C≡C). Table 6.1 and Table 6.2 show some properties of the first four members of the alkyne and alkene homologous series respectively.

Table 6.1

alkyne	molecular formula	boiling point / °C
ethyne	C_2H_2	- 84
propyne	C_3H_4	- 23
butyne	C_4H_6	8
pentyne	C_5H_8	40

Table 6.2

alkene	molecular formula	boiling point / °C
ethene	C_2H_4	- 104
propene	C_3H_6	- 48
butane	C_4H_8	- 6
pentene	C_5H_{10}	30

(a) (i) Deduce the general formula of the alkyne homologous series.

..... [1]

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(ii) Draw the full structural formula of the alkyne with 7 carbon atoms.

[1]

(b) (i) Describe the trend of the boiling points as the molecules become larger.

.....

[1]

(ii) Do alkenes or alkynes burn with a smokier flame? Explain your answer.

.....

.....

[1]

(iii) A very old organic Chemistry textbook has the following line.

> *....in general, the higher the relative molecular mass of the molecule, the higher the melting and boiling points of the compound due to the higher intermolecular forces of attraction.*

Use the data in the table to justify whether the statement is valid.

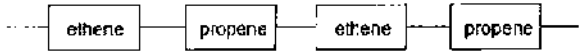
.....

.....

.....

[2]

(c) By polymerizing a mixture of ethene and propene monomers, a synthetic rubber, ethylene-propylene, can be made. One possible structure of the polymer is shown below:



(i) Propyne can react with a gas to form propene.
Write the chemical formula of the gas used to form propene.

.....

[1]

(ii) Give the full structural formula for the repeating unit in this polymer structure.

[2]

(iii) When the mixture of ethene and propene polymerises, it is unlikely to form the regular, repeating pattern. Explain why.

.....

.....

[1]

[Total: 10]

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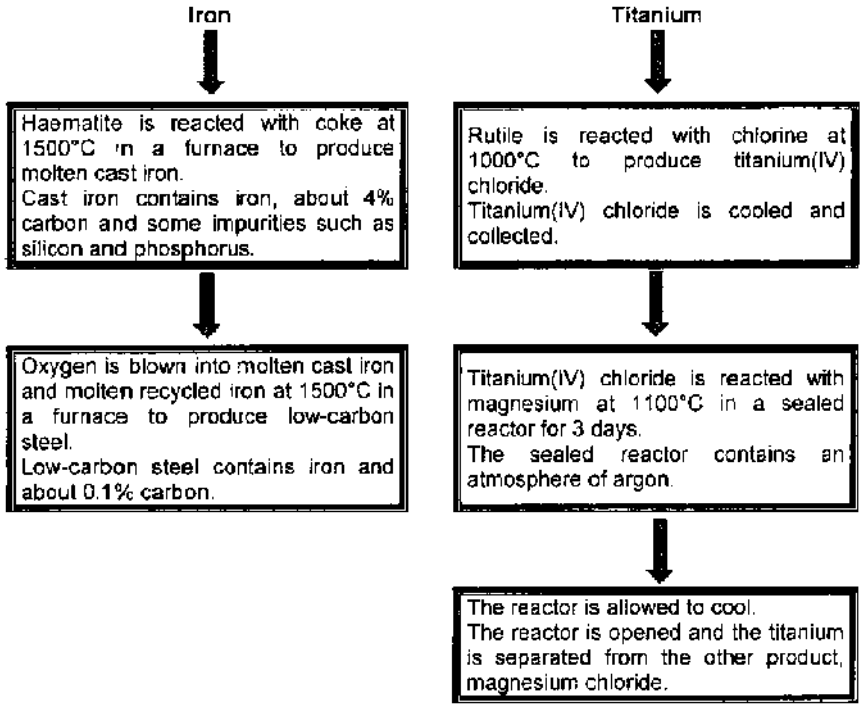
Section B

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.

B7 Iron is produced in the blast furnace using the ore haematite containing iron(III) oxide (melting point 1566°C) as one of the raw materials.

Titanium is produced from the ore rutile containing titanium dioxide (melting point 1843°C) which cannot be reduced by coke and hence requires a different method of extraction.



Iron blast furnaces produce about 20 000 tonnes of the metal per hour.
Titanium reactors produce about 1 tonne of the metal per day.

(a) Explain why the production of titanium requires "an atmosphere of argon"?

.....

..... [2]

(b) The melting point of iron(III) oxide is higher than the temperature in the blast furnace. Explain why iron(III) oxide could remain in molten state in the blast furnace.

.....

..... [1]

(c) Other than blowing oxygen into molten cast iron, lime (calcium oxide) is also added in the same furnace during the production of low-carbon steel.
Explain the purpose of lime in the furnace.

..... [1]

(d) There is less titanium than iron in the Earth's crust. Other than titanium's scarcity, explain why titanium costs much more than iron.

.....

.....

.....

..... [2]

(e) Explain why water is used to wash titanium at the last stage.

..... [1]

(f) Suggest the position of titanium in the Reactivity Series of Metals.
Explain your answer.

.....

.....

.....

..... [3]

(g) Draw a "dot-and-cross" diagram to illustrate the bonding in magnesium chloride.

[2]

[Total: 12 marks]

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B8 Fig 8.1 below shows an experimental set-up of a simple cell and an electrolytic cell. Both electrodes X and Y are made of graphite. The switch is then closed and reactions take place in both cells.

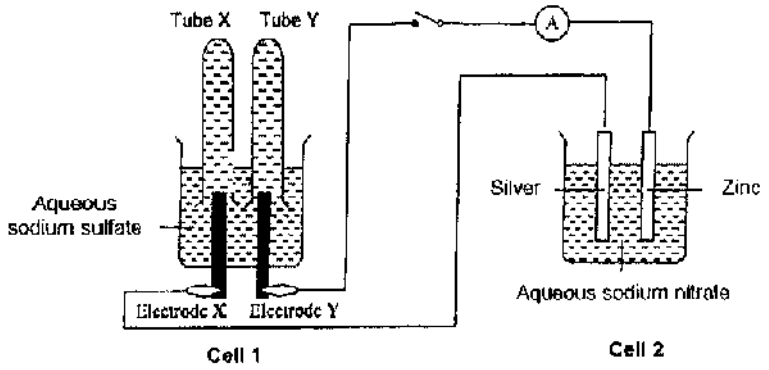

Fig. 8.1

(a) Write the ionic equations for the reactions which take place at the electrodes of Cell 1.

electrode X : ..... [1]

electrode Y : ..... [1]

(b) Shade the tubes in Fig. 8.2 to show the new levels of sodium sulfate solution after the switch is closed for a while. Your diagram should represent the relative volumes of gases collected in tube X and tube Y. Label clearly the gases collected in each tube.

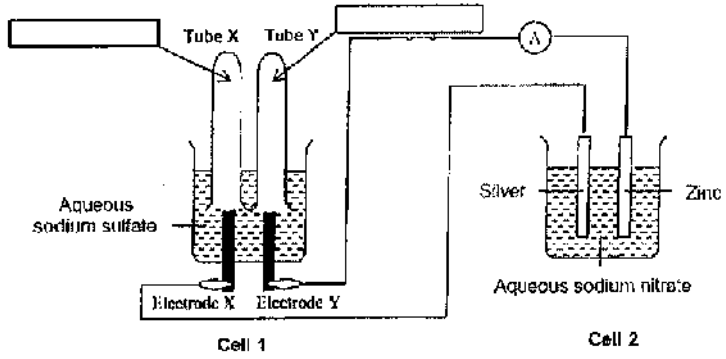

Fig. 8.2

[2]

(c) State and explain an observation that can be made in Cell 2 during the experiment.

Observation: ..... [1]

Explanation: ..... [1]

(d) Electrode X is then replaced by a copper rod. State an observation and explain your answer.

Observation: ..... [1]

Explanation: ..... [1]

[Total: 8]

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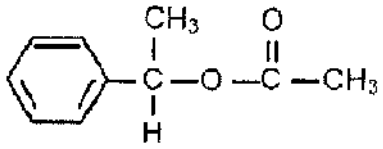
B9 Either

Perfumes usually contain three groups of compounds called the top note, the middle note and the end note.

(a) Top notes consist of small, light molecules that evaporate quickly. An example of a top note compound is styrallyl acetate as shown below:



(i) With reference to the structure of the compound, explain why it is likely to have a pleasant smell.

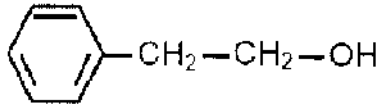
.....

..... [1]

(ii) Draw the structural formula of the alcohol and carboxylic acid used to make styrallyl acetate.

[2]

(b) The middle note compounds form vapours less rapidly than the top note compounds. A typical compound of the middle note is 2-phenylethanol. The structure of 2-phenylethanol is shown below:



(i) Describe a chemical test which would distinguish between the top note and the middle note compounds.

.....

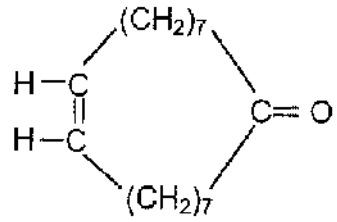
.....

..... [2]

(ii) Name and draw the full structural formula of the molecule formed in the positive test in **(b)(i)**.

[2]

(c) The end note compound of a perfume has a long lasting odour which stays with the user. An example of an end note compound is shown below.



(i) Explain why the end note compound is described as unsaturated.

.....

..... [1]

(ii) The end note compound undergoes hydrogenation reaction.
State the conditions that are essential for the hydrogenation reaction.

..... [1]

(iii) Iodine reacts with unsaturated compounds. The iodine value is a measure of how unsaturated a compound is. It is based on the mass, in grams, of iodine that reacts with 100 g of the compound.
If the relative molecular mass of the end note compound is 250, calculate the iodine value for the end note compound.

[1]

[Total: 10 marks]

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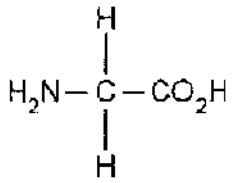
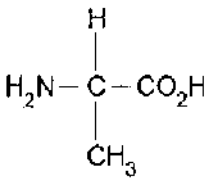
B9 OR

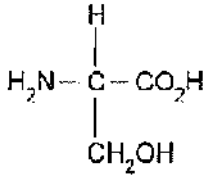
The silk of a spider's web is composed of polyamide chains which are mainly made from the amino acids, glycine. alanine and serine, with smaller amounts of four other amino acids.



glycine



alanine



serine

(a) Assuming the polyamide is made from repetitive sequences of –glycine–alanine–serine–, draw the structural formula of the repeat unit.

[2]

(b) The M_r of each polyamide chain is about 600 000.
Assuming the polyamide chain is made from equal amounts of the above three amino acids, calculate the average number of amino acids monomers in each polyamide chain.

[3]

(c) A student separates the other four amino acids by paper chromatography using two different solvents. The solvent front of solvent 1 takes five minutes to reach the end of the chromatogram while the solvent front of solvent 2 takes ten minutes.
Table 9.1 shows the R_f values she obtained for these amino acids.

Table 9.1

amino acid	R_f in solvent 1	R_f in solvent 2
A	0.2	0.5
B	0.0	0.4
C	0.8	0.9
D	0.3	0.4

(i) Which amino acid travels fastest in both solvents?

..... [1]

(ii) Suggest how the student can make the colourless amino acids become visible to the naked eye.

..... [1]

(iii) The student writes the following statements about the chromatography.

Conclusion: Solvent 2 gives a better separation than solvent 1.

Source of error: Duration of chromatography for solvent 2 is longer than for solvent 1.

Do you agree with the student? Explain your reasoning.

.....

.....

.....

.....

..... [3]

End of Paper

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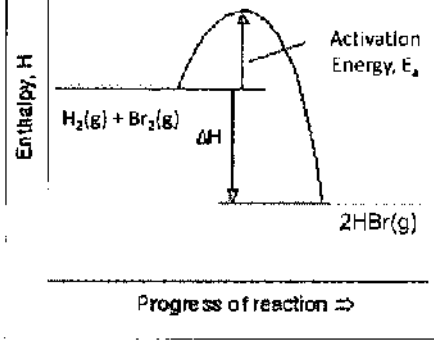
Answer Scheme

Section A

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

Section B

Qn	Answers	Marks
A1(a)	Neon	1m
(b)	Fluorine	1m
(c)	Nitrogen	1m
(d)	Carbon	1m
A2(a)	**Down the group**, the bond dissociation energy of the hydrogen halides **decreases**.	1m
(b)(i)	Hydrogen iodide.	1m
(ii)	HI **has the lowest bond enthalpy energy** *(ACCEPT: weakest bond)*, thus **it is easiest for it to ionize to form H⁺ ions.**	1m 1m
(c)(i)	Enthalpy change: +432 + 193 – 2(363) = -101kJ	1m
(ii)	**Exothermic** reaction. The energy **absorbed to break the H-H bonds and Br-Br bonds is lesser** than the **energy released to form the H-Br bonds.**	1m 1m
(iii)		2m
A3(a)	They have variable oxidation states. They form coloured compounds.	1m 1m
(b)	beaker A: Green solution turns pink. Grey deposits formed. beaker B: Green solution turns violet. Grey deposit formed. beaker C: No visible reaction. / Solution remains pink.	3m 1 m per box
(c)(i)	Cr has **decreased in oxidation state from +3 in Cr_2O_3 to 0 in Cr**, while Al has increased in **oxidation state from 0 in Al to +3 in Al_2O_3.** Since both reduction and oxidation have taken place, it is a redox reaction.	2m
(ii)	**Chromium is more reactive than iron** in steel and **will provide sacrificial protection for the iron** even when the **protective layer is**	2m

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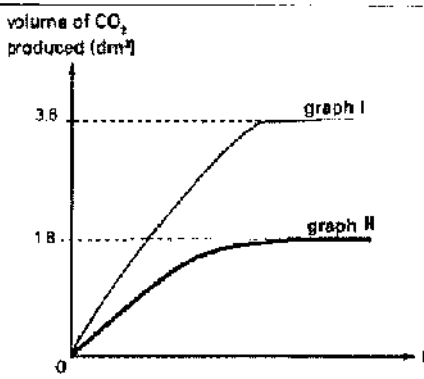
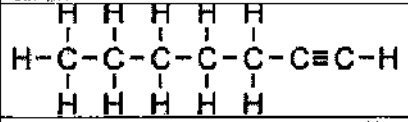
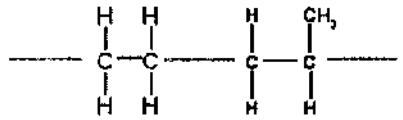
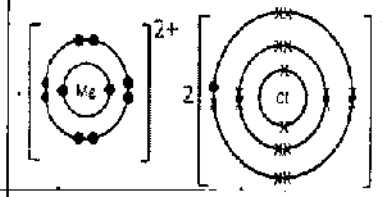
	scratched and exposed. However, **iron is more reactive then tin** and will corrode more when layer of tin is scratched and exposed.	
A4(a)(i)	$H_2A + 2NaOH \rightarrow Na_2A + 2H_2O$ C_A = 1.00 mol/dm^3, C_{NaOH} = 0.100 mol/dm^3, V_A = 25.0 cm^3	1m
	V_{NaOH} = 2 X 1 X 25 / 0.1 = **500 cm^3**	1m
(ii)	The volume of NaOH cannot be placed in the burette as the burette is usually able to hold a maximum volume of 50.0cm^3 only.	1m
(b)(i)	element / carbon / hydrogen / oxygen % / 26.7 / 2.20 / 71.1 Ar / 12 / 1 / 16 no. of moles / 2.225 / 2.2 / 4.444 ratio / 1.01 / 1 / 2.02 to nearest whole no. / 1 / 1 / 2 empirical formula = CHO_2	2m
(ii)	Molecular mass = 90 n = 90/ *Mr* (CHO_2) = 90/ (12 + 1 +32) **=2** Molecular formula of oxalic acid = **$H_2C_2O_4$ / $C_2H_2O_4$ / HOOCCOOH**	1m
(iii)	1 mole of oxalic acid = 90 g 1.10 X 10^{-4} moles of oxalic acid = 1.10 X 10^{-4} X 90 **=0.0099 g** No of starfruit = 0.05/0.0099 = 5.05 **=5** The patient can consume a maximum of 5 starfruits a day.	1m 1m
A5(a)(i)	$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$	1m
	moles of $CaCO_3$ = mass / molar mass = 15.0 / (40+12+48) = 0.15 mol moles HCl = molarity x vol = 0.15 x 2 = 0.30 mol (To demonstrate limiting reagent) $CaCO_3 : CO_2$ = 1 : 1 (allow ECF) Vol. of CO_2 = 0.15 x 24dm^3 = 3.60 dm^3	1m 1m

(ii) and (iii)	 Note: Graph II's **gradient must be less steep** and it **levels off at a later time**, as compared to Graph I.	1m for axis, label with units and values 1m for shape of graph I and II 1m for values of 1.8 and 3.6 dm^3
(iv)	Graph II has a **less steep gradient than graph I** as the hydrochloric acid used is of a **lower concentration**. Or Graph I has a **steeper gradient than graph II** as the hydrochloric acid used is of a **higher concentration**. However, the **volume of carbon dioxide obtained is halved in Experiment II** as the **number of moles of hydrochloric acid used is halved**. Or However, the **volume of carbon dioxide obtained is doubled in Experiment I** as the **number of moles of hydrochloric acid used is twice the amount of Experiment II**.	1m 1m
(b)	Temperature of acid / particle size of calcium carbonate. Increasing the temperature of acid will **increase the kinetic energy of reacting particles**. This will in turn **increase the frequency of effective collisions** and hence **increasing the rate of reaction**. Or Decreasing the particle size of calcium carbonate will **increase the surface area exposed for reacting particles to collide into**. This will in turn **increase the frequency of effective collisions** and hence **increasing the rate of reaction**.	 1m 1m 1m 1m

A5(a)(i)	C_nH_{2n-2}	1m
(ii)		1m
(b)(i)	As the molecules become larger, the boiling points increases.	1m
(ii)	Alkynes burn with a smokier flame because they have a higher percentage of carbon compared to alkenes.	1m
(iii)	Although ethyne (Mr = 26) has a relative molecular mass smaller than ethene (Mr = 28), the boiling point of ethyne is -84 °C whereas the boiling point of ethene is lower at -104 °C. The textbook is invalid as alkynes have higher boiling points even though it has smaller relative molecular mass.	1m 1m
(c)(i)	H_2	1m
(ii)		2m
(iii)	Some of the ethene or propene may self-polymerise to form poly(ethene) or poly(propene).	1m
Section B		
B7(a)	argon is used to create an unreactive / inert atmosphere as any oxygen would react with / air would oxidise magnesium / titanium.	1m 1m
(b)	The presence of **impurities such as silicon dioxide / sand lower the melting point of iron(III) oxide** and hence iron(III) oxide could melt at lower temperatures. *Accept: impurities such as silicon and phosphorus* OR The **energy released** from the **combustion of carbon/coke** results in **more heat / higher temperature in the blast furnace** for the iron(III) oxide to melt.	1m
(c)	To **react with acidic impurities such as silicon dioxide** and remove them as molten slag.	1m
(d)	Any two. 1. There are **more stages to manufacture** titanium thus less efficient / more energy are needed 2. **In one day, blast furnace** could produce (24 x 20000 =) **480000 tonnes of metal** while the **reactors** could only produce **1 tonne of metal** and hence **the rate of production is slower**. [student must extract the data on the quantities of metal produced to support the production rate is slower] 3. Blast furnace **uses coke/carbon** which **is abundant and cheaper than magnesium / Magnesium** used in reactor is **more expensive than coke/carbon** because it is extracted by **electrolysis**.	2m
(e)	To remove **soluble magnesium chloride** from titanium.	1m
(f)	**Titanium is below magnesium AND above zinc** in the reactivity series **Magnesium** could **displace titanium from titanium(IV) chloride** and hence magnesium is more reactive than titanium. **Titanium dioxide cannot be reduced by coke** but iron(III) oxide can be reduced by coke. Therefore, titanium is more reactive as it forms more stable compound than iron.	1m 1m 1m
(g)		2m
B8(a)	$4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e$	1m
	$2H^+(aq) + 2e \rightarrow H_2(g)$	1m
(b)	Tube X: oxygen Tube Y: hydrogen Drawing must depict ratio of O:H as 1:2	1m 1m
(c)	Observation : Size of zinc decreases OR bubbles seen at silver electrode Explanation : zinc, the more reactive metal, ionizes to form zinc ions OR Hydrogen ions accept electrons to form hydrogen gas	1m 1m
(d)	Observation: electrolyte will turn blue OR size of copper decreases. Explanation : Copper electrode (the anode) ionizes to form copper(II) ions which is blue, hence electrolyte turns blue OR copper electrode becomes smaller as copper ionizes	1m 1m

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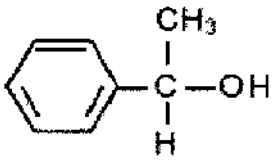
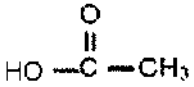
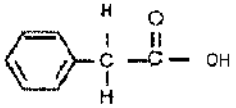
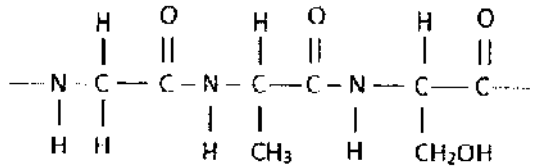
Either		
B9(a)(i)	The compound consists of a functional group named ester.	1m
(ii)	Alcohol  Carboxylic acid 	2m
(b)(i)	**Add acidified potassium manganate(VII) solution** to each sample of top note compound and middle note compound. If **the acidified** potassium manganate(VII) solution **turned from purple to colourless, the sample is middle note.** If **the** acidified potassium manganate(VII) solution remained purple, the sample is top note. OR **Add acidified potassium dichromate(VI) solution** to each sample, if the solution turned **from orange to green**, the sample is middle note or if the solution remained green, the sample is top note.	1m 1m
(ii)	2-phenylethanoic acid 	1m 1m
(c)(i)	The end note consists of carbon-carbon double bond.	1m
(ii)	Temperature of 200°C and the catalyst used is nickel	1m

(iii)	**1 mol of end note reacts with 1 mol of iodine.** No of mole of end note = 100/250 = 0.4 mol No of mole of iodine = 0.4 **mol** Mass of iodine =0.4 X 2 X127 =101.6 = 102 (3sf) **Iodine value is 101.6/102.**	1m
OR		
B9(a)	 1m for correct linkage. 1m for everything else.	2m
(b)	Mr of repeat unit = 215 Average no. of monomers = 600 000/215 X 3 = **8372.09 = 8372 or 8370 (3 s.f.)** Note: If Mr of glycine = 75; Mr of alanine = 89; Mr of serine = 105, and average no. of monomers = 600 000/269 X 3 = **6691.4 = 6691 or 6690** (3sf), then only 2m.	1m 2m
(c)(i)	C	1m
(ii)	Use a locating agent.	1m
(iii)	No, because solvent 2 does not give a better separation than solvent 1 **as B and D have identical Rf values** hence cannot be distinguished. Duration of chromatography is also **not a source of error**, because Rf **is a ratio** (of distance travelled by dye to distance travelled by solvent) / Rf is only dependent of solubility of component in a specific solvent./Rf values are not time dependent.	1m 1m 1m

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Bukit Batok Secondary School

GCE O Level Preliminary Examination

Sec 4 Express

CHEMISTRY **5073/01**
Paper 1 Multiple Choice **19 August 2016**
0930hr to 1030hr
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 13 printed pages.

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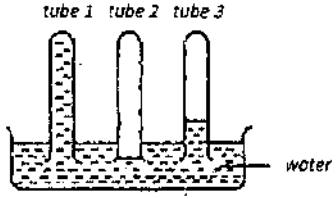
1. Which of the following is a compound?

   A. fluorine
   B. lithium
   C. petroleum
   D. sugar

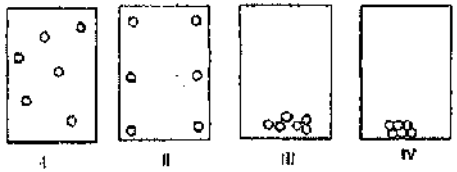
2. Three dry test tubes were filled with different gases and placed in a trough of water. The diagram shows what happens after some time.



   Which gases could the tubes have contained?

	Tube 1	Tube 2	Tube 3
A.	ammonia	carbon dioxide	hydrogen
B.	ammonia	hydrogen	carbon dioxide
C.	carbon dioxide	ammonia	hydrogen
D.	carbon dioxide	hydrogen	ammonia

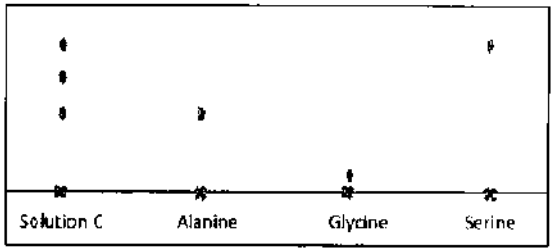
3. Substance X has a melting point of -95 °C and a boiling point of 56 °C. A metal tank contains substance X at 60 °C. The tank is cooled to 0 °C. Four arrangements of particles in the tank are shown below.



   Which diagrams best show the arrangements of particles of X in the tank at 60°C and at 0°C?

	at 60 °C	at 0 °C
A.	I	III
B.	I	IV
C.	II	III
D.	III	IV

4. A protein undergoes hydrolysis to form solution C. Chromatography was carried out on solution C, glycine, serine and alanine.



Which of the following about solution C can be deduced from the chromatogram?

A. Solution C contains alanine only.
B. Solution C contains glycine and serine.
C. Solution C does not contain serine.
D. Solution C does not contain glycine.

5. From which mixture can the underlined substance be obtained by adding water, stirring and filtering?

A. <u>ethanoic acid</u> and water
B. <u>copper (II) sulfate</u> and sodium chloride
C. <u>silver nitrate</u> and calcium chloride
D. <u>zinc carbonate</u> and sodium chloride

6. Which of the following ions contains the largest number of electrons?

A. O^{2-}
B. Cl^-
C. Na^+
D. Al^{3+}

7. The electronic structures of atoms P, Q and R are given below.

P: 2.1 Q: 2.8.6 R: 2.7

Which are the formulae of the compounds formed between
(i) P and Q
(ii) Q and R?

	P and Q	Q and R
A.	P_2Q	QR
B.	P_2Q	QR_2
C.	PQ	QR
D.	PQ_2	Q_2R

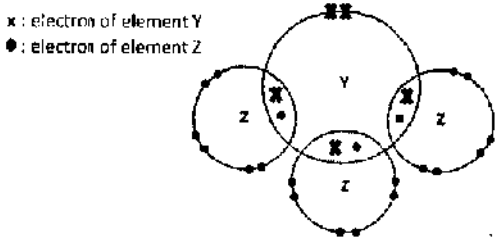
8. A compound X contains oxygen and one other element. Which one of the following properties of X indicates most clearly whether the bonds in X are ionic or covalent?

A. X has a high melting point.
B. X is almost insoluble in water.
C. X is a hard solid at room temperature.
D. X conducts electricity only when molten or in aqueous solution.

9. The formula of thallium carbonate is Tl_2CO_3 and that of sodium chlorite is $NaClO_2$. What is the formula of thallium chlorite?

A. Tl_2ClO_2
B. $TlClO_2$
C. $Tl(ClO_2)_2$
D. $Tl_2(ClO_2)_3$

10. The diagram shows the arrangement of electrons in the outer shells of the atoms in the compound YZ_3.



Which pair of elements could be Y and Z?

	Y	Z
A.	calcium	fluorine
B.	aluminium	nitrogen
C.	phosphorus	chlorine
D.	sulfur	chlorine

11. The elements, sodium and chlorine, in the third period of the Periodic Table show a gradual change in properties. Which of the following changes is **correct**?

A. Their melting points increase.
B. Their ability to gain electrons increase.
C. Their oxides change from acidic to basic.
D. Their chlorides change from covalent to ionic.

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12. 25.0 cm^3 sodium hydroxide solution in a conical flask was titrated with 0.1 mol/dm^3 hydrochloric acid in a burette. Which of the steps would cause the calculated concentration of sodium hydroxide to be lower than its true value?

    A. There are air bubbles in the burette.
    B. Record the final reading of burette before the indicator changes its colour.
    C. Rinse the burette with distilled water but not with 0.1mol/dm^3 hydrochloric acid.
    D. Wash the conical flask with distilled water before sodium hydroxide solution is pipetted into the flask.

13. On complete combustion, a certain mass of hydrocarbon gave 11.0 g of carbon dioxide and 9.0 g of water. What could the hydrocarbon be?

    A. CH_4
    B. C_2H_2
    C. C_2H_4
    D. C_2H_6

14. Which one of the following gases at room temperature and pressure does not occupy 12 dm^3?

    A. 6 g of helium
    B. 16 g of oxygen
    C. 14 g nitrogen
    D. 9 g of steam

15. A compound Y gave a gas when heated with an excess of aqueous sodium hydroxide. When no more gas was evolved, the resulting alkaline solution was heated with aluminium powder and the same gas was given off.

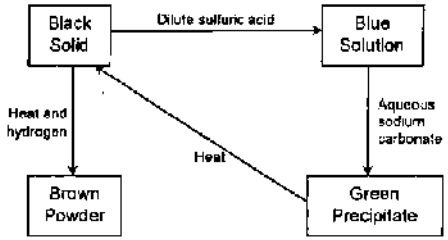
    Which of the following was compound Y?

    A. ammonium chloride
    B. sodium nitrate
    C. ammonium nitrate
    D. nitric acid

16. Which of the following methods can be used to distinguish between solid sodium carbonate and solid calcium carbonate?

    A. Add acidified barium nitrate to the solid.
    B. Add acidified aqueous silver nitrate to the solid.
    C. Heat the solid and test the gaseous product with limewater.
    D. Add dilute acid to the solid and test the gaseous product with limewater.

17. The reaction scheme below shows the reactions involving a metal and three of its compounds.



    What is the metal?

    A. copper
    B. iron
    C. lead
    D. zinc

18. Which of the following is **not true** of acids?

    A. They turn litmus from blue to red.
    B. Their aqueous solutions conduct electricity.
    C. They are generally formed by the action of water on the oxides of metals.
    D. They neutralize bases to yield salt and water only.

19. An element forms a hydroxide which dissolves in both acids and alkalis. What is this element likely to be?

    A. calcium
    B. iron
    C. sodium
    D. zinc

20. Which substance is **not** used to prepare magnesium sulfate by reaction of dilute sulfuric acid?

    A. magnesium carbonate
    B. magnesium chloride
    C. magnesium hydroxide
    D. magnesium oxide

21. Which element is always present with iron in mild steel?

    A. aluminium
    B. carbon
    C. copper
    D. tin

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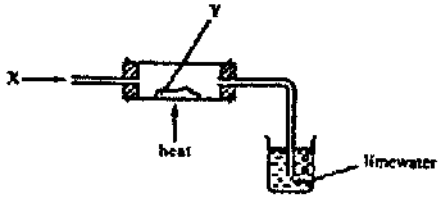
22. Hydrogen is produced by reaction of a metal A and a dilute acid. When the same gas was passed over an oxide of metal B, it reduced the metallic oxide to its metal in the presence of heat.

Which of the following substances would give these results?

	Metal A	Acid	Oxide of Metal B
1.	zinc	sulfuric acid	calcium oxide
2.	calcium	hydrochloric acid	lead (II) oxide
3.	iron	sulfuric acid	copper (II) oxide
4.	copper	hydrochloric acid	zinc oxide

A. 1, 2 and 3 are correct
B. 1 and 3 are correct
C. 2 and 3 are correct
D. 1 and 4 are correct

23. A gas X was passed over a hot solid Y using the apparatus in the diagram below.



What are gas X and solid Y?

	X	Y
A.	carbon dioxide	carbon
B.	carbon monoxide	copper
C.	carbon dioxide	copper (II) oxide
D.	carbon monoxide	copper (II) oxide

24. Which of the following is an example of a redox reaction?

A. $2Br_{(aq)} \rightarrow Br_{2(g)} + 2e$
B. $Na^{+}_{(aq)} + e^{-} \rightarrow Na_{(s)}$
C. $CuO_{(s)} + H_{2(g)} \rightarrow Cu_{(s)} + H_2O_{(g)}$
D. $CuCO_{3(s)} + H_2SO_{4(aq)} \rightarrow CuSO_{4(aq)} + H_2O_{(l)} + CO_{2(g)}$

25. In which of the following substances does nitrogen exhibit its highest oxidation state?

A. N_2
B. NO_2
C. N_2H_4
D. HNO_3

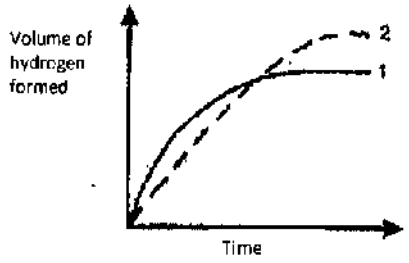
26. Which one of the following substances is present in the exhaust fumes and could contribute to the formation of acid rain?

A. carbon
B. lead (II) oxide
C. nitrogen
D. nitrogen dioxide

27. A solution can be decomposed using a powdered catalyst. What would be the effect on the rate of the decomposition and the volume of gas produced if an equal volume of water was added to the solution before the reaction began?

	Rate	Final volume of gas
A.	decreased	increased
B.	unchanged	decreased
C.	increased	increased
D.	decreased	unchanged

28. In the graph below, curve 1 was obtained by the reaction between 50 cm^3 of 1 mol/dm^3 sulfuric acid and excess zinc granules.



Which of the following changes would produce curve 2?

A. Increase temperature by 10 °C.
B. Adding the same amount of zinc powder instead of zinc granules.
C. Using 100 cm^3 of 1 mol/dm^3 sufuric acid instead 50 cm^3 of 1 mol/dm^3 sulfuric acid.
D. Using 100 cm^3 of 0.75 mol/dm^3 sulfuric acid instead of 50 cm^3 of 1 mol/dm^3 sulfuric acid.

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29. The energy required to break the following bonds are given in the table below.

Bond	Energy required to break bond / kJ/mol
F – F	158
H – H	436
H – F	556

Which of the following can be deduced from the information provided above?

A. The bonds in fluorine molecule is the strongest.
B. Hydrogen gas is more reactive than fluorine gas.
C. Hydrogen fluoride molecules are the least stable.
D. The energy produced when forming 1 mole of hydrogen fluoride from its elements is 259 kJ.

30. It was found that the heat required to evaporate 7.4 g of ethoxyethane $(C_2H_5)_2O$ was 2.6 kJ while that required to evaporate 4.6 g of ethanol was 3.9 kJ. From this evidence, which of the following would be the most correct conclusion?

A. The more carbon atoms there are in a molecule, the more difficult it is to evaporate the substance.
B. The molecules of ethoxyethane are held together more strongly than those of ethanol.
C. The molecules of ethanol are bound together more strongly than those of ethoxyethane.
D. The atoms in ethoxyethane molecules are more difficult to break apart than those in ethanol molecules.

31. During an electrolysis, 5.00 moles of electrons are passed through a molten aluminium salt, what is the maximum mass of aluminium formed at the cathode?

A. 16.2 g
B. 27.0 g
C. 45.0 g
D. 135.0 g

32. The copper heat-reflecting shields of some space rockets are gold plated using electroplating. Which electrodes and electrolytes will be used to gold-plate the heat shields?

	Negative electrode	Positive electrode	Electrolytes
A.	carbon	heat shield	gold compound
B.	heat shield	carbon	copper compound
C.	heat shield	gold	gold compound
D.	gold	heat shield	copper compound

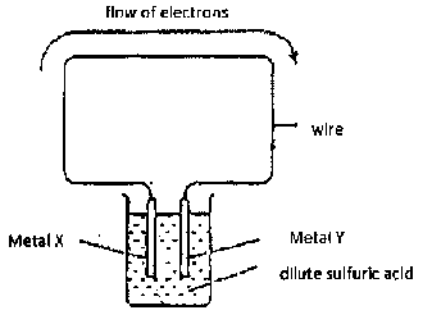
33. The following three solutions undergone electrolysis using inert electrodes.

Solution I concentrated sodium chloride
Solution II dilute potassium sulfate
Solution III silver nitrate

Which of the solution(s) produce oxygen gas at the anode?

A. I only
B. I and II only
C. II and III only
D. I, II and III

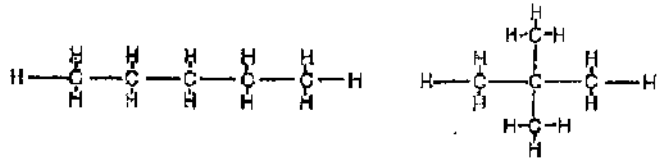
34. The diagram below shows a simple cell.



For which pair of metals would electrons flow as shown in the diagram?

	X	Y
A.	iron	zinc
B.	zinc	copper
C.	lead	magnesium
D.	zinc	magnesium

35. Which property is similar for the two organic compounds shown below?



A. melting point
B. structural formula
C. solubility in methylbenzene
D. composition by mass

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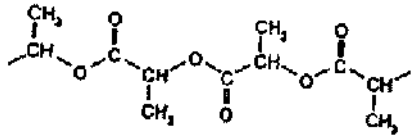
36. Ethanol is used in some after-shave lotions and deodorants. Which pair of properties makes it suitable for these uses?

    A. It is flammable and vaporises easily.
    B. It is flammable and mixes easily with water.
    C. It is a good solvent and vaporises easily.
    D. It is colourless and has a low freezing point.

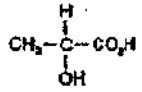
37. What happens when one mole of ethane is mixed in the dark at room temperature with six moles of chlorine gas?

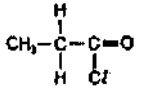
    A. There is no reaction.
    B. Only C_2Cl_6 are formed.
    C. C_2Cl_6 and HCl are formed.
    D. CH_3CH_2Cl and HCl are formed.

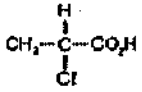
38. One form of biodegradable polymer used for 'plastic' bags has the following structure.

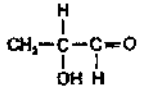


What could be the monomer for this polymer?

A 

C 

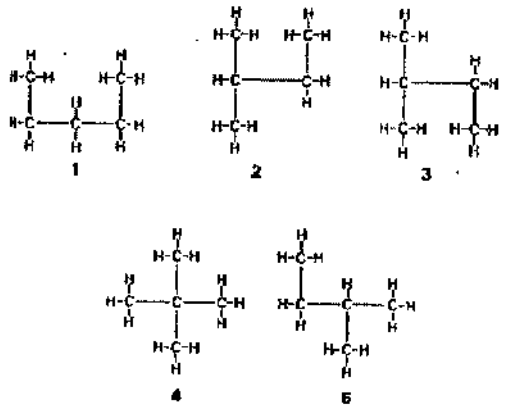
B 

D 

39. Which process is used to convert substance R to S?

	R	Process	S
A.	ester	addition polymerisation	terylene
B.	ethanol	neutralisation	ethanoic acid
C.	amino acids	condensation polymerisation	protein
D.	fats	condensation polymerisation	fatty acids and glycerol

40. Five structural formulas are shown below.



How many isomers are there?

A. 2
B. 3
C. 4
D. 5

- End of Paper 1 -

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The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac actinium 89 †															

*58-71 Lanthanoid series
†90-103 Actinoid series

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

Key: a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

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

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Name: ..... Index no: ..... Class: .....

Bukit Batok Secondary School

GCE O Level Preliminary Examination

Sec 4 Express

CHEMISTRY **5073/02**
Paper 2
11 August 2016
1115hr to 1300hr
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.

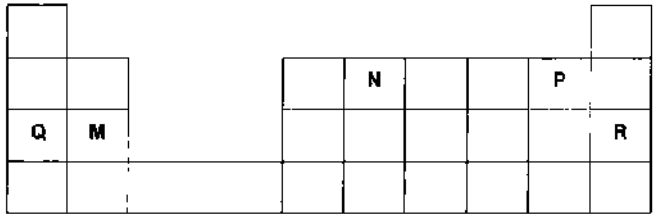
The use of an approved scientific calculator is expected, where appropriate

For Examiner's Use	
Section A	
Section B	
Total	

This document consists of **20** printed pages.

Section A [50 marks]
Answer all questions in this section in the spaces provided.

A1. A diagram of the Periodic Table is shown below.



Using the letters shown in the Periodic Table,

a. identify the element that forms giant covalent structures.

..... [1]

b. identify the element that does not form compounds.

..... [1]

c. identify the most reactive non-metal.

..... [1]

d. identify the elements that have the same number of shells.

..... [1]

e. Write the formula for the nitride of M.

..... [1]

[Total : 5 marks]

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A2. Element X is an alkali metal while element Y is a halogen which is yellow-green in colour.

a. When a small piece of X is placed in some aqueous copper (II) sulfate solution, it darts about and dissolves.

Describe two other changes that can be seen.

.....

..... [2]

b. When an excess of aqueous Y is added to aqueous potassium iodide, a brown solution and a black solid are obtained.

(i) Name the brown solution and the black solid.

Brown solution .....

Black solid ..... [2]

(ii) Explain the formation of the black solid other than the reddish brown solution.

.....

..... [1]

[Total : 5 marks]

A3. Human activities in recent centuries have released additional amounts of heat absorbing gases to the atmosphere.

Carbon dioxide is a greenhouse gas which has a greenhouse factor of 1. Other gases are given a greenhouse factor that compares their effect with carbon dioxide. The greenhouse effect increases as the factor value increases. The table gives some information of five main greenhouse gases.

Greenhouse gas	Greenhouse factor	Contribution to greenhouse effect / %	Current rate of increase in the air / %
CO_2	1	50	0.4
CH_4	30	18	1.0
N_2O	160	6	0.3
O_3	2000	12	1.5
CFCs	10000	14	2.0

a. Name the greenhouse gas that is only produced by human activities.

..... [1]

b. If equal volumes of each gas at room temperature were filled in separate gas jars and exposed to sunlight, which gas jar will show the highest rise in temperature?

..... [1]

c. Explain why living organisms cannot survive on Earth without the presence of greenhouse gases in the atmosphere.

.....

..... [1]

d. Explain why although carbon dioxide has the lowest greenhouse factor among the gases listed, its contribution towards global warming is the most significant.

.....

..... [1]

e. List a possible consequence of an increase in global warming.

.....

..... [1]

[Total : 5 marks]

A4. X, Y and Z are three different metals. The results of two experiments carried out using the metals or their oxides are recorded below.

Experiment	X	Y	Z
Adding the metal to water	Effervescence	No observable change	No observable change
Heating the metal oxide	No observable change	Metal produced	No observable change

a. Based on the above information, arrange the three metals in order of increasing reactivity, starting from least reactive metal.

..... [1]

b. An oxide of Y has the formula YO. When 1.08 g of this oxide is heated strongly, it decomposed completely to give 60.0 cm^3 of oxygen, measured at r.t.p.

(i) Write a balanced chemical equation for the decomposition of oxide of Y.

..... [1]

(ii) Calculate the relative atomic mass of Y.

[3]

[Total : 5 marks]

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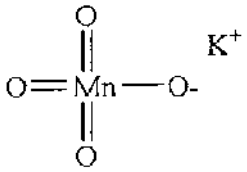
A5. Hydrogen peroxide (H_2O_2) can behave as an oxidising agent and a reducing agent.

a. Complete the table below to show the role of hydrogen peroxide as an oxidising or a reducing agent.

	Reaction of H_2O_2 with acidified $KMnO_4$	**Reaction of H_2O_2 with $FeSO_4$ solution**
Observation	Purple solution decolourised	Light green solution turned yellow
Role of H_2O_2		

[2]

b. Potassium manganate (VII), $KMnO_4$, has the following structure.



What is the total number of electrons surrounding the manganese atom?

..... [1]

c. Sulfur dioxide, an air pollutant is detected by bubbling the polluted air through an aqueous solution of potassium manganate (VII). A change in colour from purple to colourless confirms its presence. The ionic equation is shown below.

$$5SO_2 + 2MnO_4^- + 2H_2O \rightarrow 5SO_4^{2-} + 2Mn^{2+} + H^+$$

State two characteristics from this reaction which shows that manganese is a transition metal.

.....

.....

..... [2]

[Total : 5 marks]

A6. Le Chatelier's principle predicts that the highest yield of ammonia in the Haber process should occur at a high pressure and at a low temperature. In practice, however, these conditions are not used.

The table below shows the percentage yield of ammonia at different temperatures and pressures.

Temperature / °C	percentage yield of ammonia at equilibrium		
	200 atm	300 atm	400 atm
350	24	40	48
450	20	23	30
550	10	12	15

a. Construct a balanced chemical equation for the reaction in Haber process.

..... [1]

b. By referring to the table, state how the increase of pressure affects the percentage yield of ammonia at equilibrium.

.....

..... [1]

c. (i) Explain how the increase in temperature causes the percentage yield of ammonia to decrease at equilibrium.

.....

..... [1]

(ii) From this observation, deduce whether this the formation of ammonia is exothermic or endothermic.

..... [1]

d. Suggest why Le Chatelier's principle is not applied to Haber process in practice.

.....

.....

..... [2]

[Total : 6 marks]

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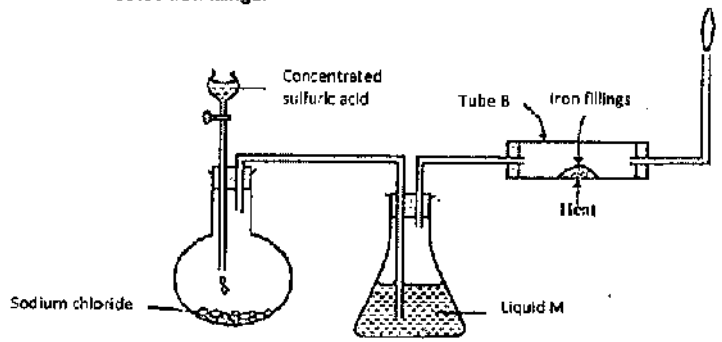
A7. The set-up below was used to prepare dry hydrogen chloride gas, and investigate its effect on heated iron fillings.



a. Name liquid **M**.

..... [1]

b. (i) What will be observed in tube **B**.

..... [1]

(ii) Write an equation for the reaction that occurs in tube **B**.

..... [1]

(iii) Why is the gas from tube **B** burnt?

.....

..... [1]

c. Explain the following observations with help of equation(s):

(i) a white precipitate is formed when hydrogen chloride gas is passed through aqueous silver nitrate.

.....

..... [1]

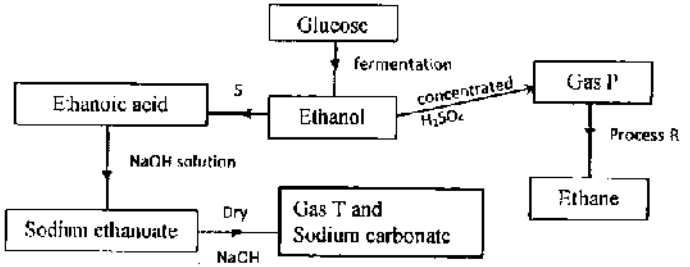
(ii) hydrogen chloride gas fumes in ammonia gas.

.....

..... [1]

[Total : 6 marks]

A8. Study the flow chart below and answer the questions that follow.



a. State any two conditions necessary for fermentation of glucose to take place.

.....

..... [1]

b. State one reagent that can be used to carry out process S.

..... [1]

c. Both gases P and T are hydrocarbons. Identify the gases:

P: .....

T: ..... [2]

d. How is sodium hydroxide kept dry during the reaction?

..... [1]

e. State another use of ethanol other than as an alcoholic drink.

..... [1]

f. Another alcohol is butanol. Draw the structure of butan-2-ol.

[1]

[Total : 7 marks]

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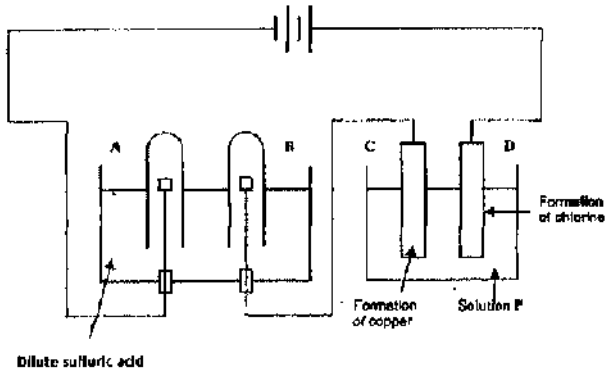
A9. The diagram below shows an experiment in which an electric current is being passed through dilute sulfuric acid and solution P.



a. After electrolysis for 30 minutes at a constant current, 200 cm^3 of gas is collected in the test-tube at electrode A.

(i) Predict the volume of gas at electrode **B**.

..... [1]

(ii) Why would steel not be a suitable material for electrode B?

.....

..... [1]

b. (i) Identify solution P.

..... [1]

(ii) Write half equations for both electrodes C and D.

.....

..... [2]

(iii) A few drops of Universal indicator solution was added to the electrolyte close to electrode D. Universal indicator turned blue then decolourised. Explain this observation.

.....

..... [1]

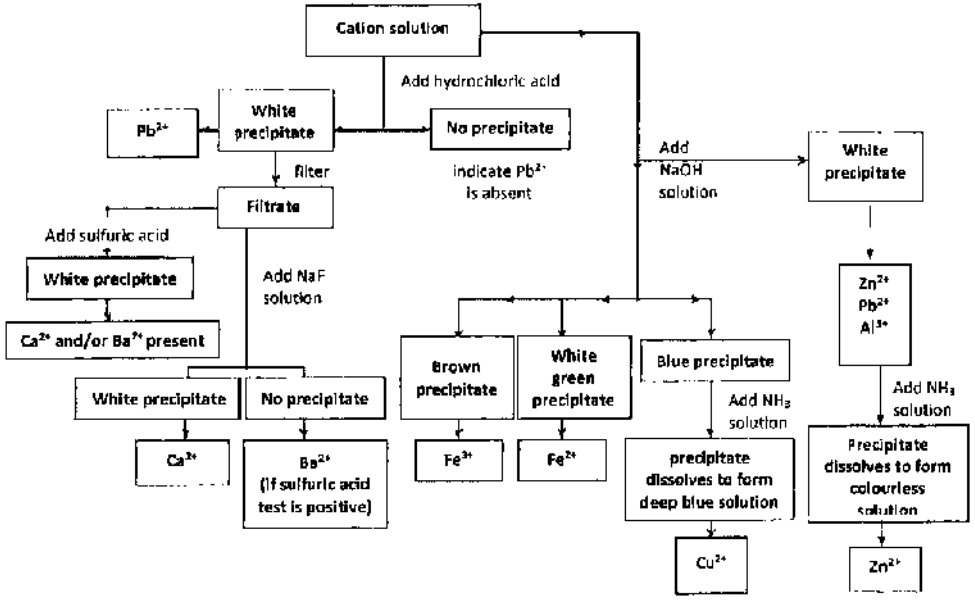
[Total : 6 marks]

- End of Section A -

Section B [30 marks]
Answer all **three** questions from this section.
The last question is in the form of either/or and only one of the alternatives should be attempted.

B10.
A precipitation reaction refers to the formation of an insoluble salt when two solutions containing soluble salts are combined. The insoluble salt that is produced is known as the precipitate, hence the reaction's name.

Precipitation reactions are used to determine the presence of various ions in solution. The following flow chart shows how different cations can be identified through the formation of precipitates.



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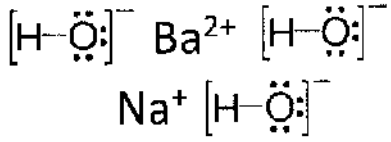
Barium hydroxide and sodium hydroxide are alkali solutions which can be used in precipitation reactions. They have the following structures.



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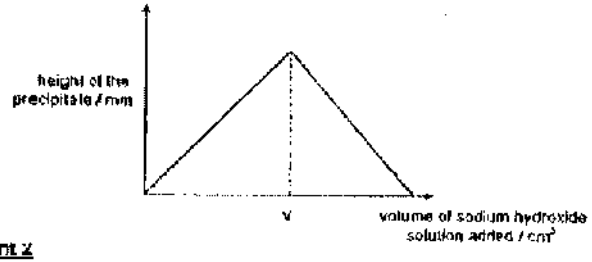
A student performed a series of experiment involving precipitation reaction.

Experiment 1

0.5 cm^3 of sodium hydroxide was added to a test tube containing an unknown salt solution. The height of the precipitate formed in the test tube was plotted against the volume of sodium hydroxide added.



Experiment 2

A study of a precipitation reaction between barium hydroxide and dilute sulfuric acid was conducted.

The reaction tubes containing different volumes of barium hydroxide, a strong base, and dilute sulfuric acid is as stated in the table. Precipitation occurs in all the reaction tubes and after 20 minutes, the height of the precipitate in each tube is measured and recorded in the table below.

Reaction tube	1	2	3	4	5	6
Volume of 0.50 mol/dm^3 of barium hydroxide used / cm^3	5.0	5.0	5.0	5.0	5.0	5.0
Volume of 1.0 mol/dm^3 of dilute sulfuric acid used / cm^3	1.0	1.5	2.0	2.5	3.0	3.5
Height of precipitate / cm	2.5	3.0	3.5	4.0	4.0	

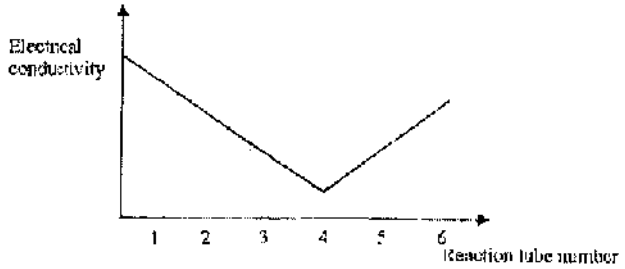
Table 1

To each tube, two drops of an indicator are added. The colour change of this indicator is shown as follows:

pH	Colour
< 8.2	colourless
8.2 to 13.0	pink
> 13.0	colourless

Table 2

The electrical conductivity of each reaction tube is recorded. The graph is seen below.



a. Draw a dot-and-cross diagram to show the bonding in a hydroxide ion.

[2]

b. (i) State the formula of a possible cation in the unknown salt solution in **Experiment 1**.

.....[1]

(ii) Some cations produced white precipitate when sodium hydroxide is added to their solutions. Describe how these cations can be distinguished from one another.

.....

.....

.....

.....[2]

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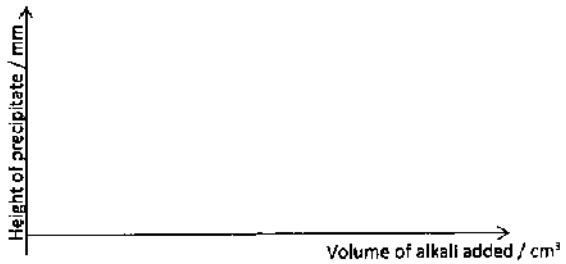
(iii) The student added sodium hydroxide into copper (II) sulfate solution.
Complete the diagram to show the variation of the height of the precipitate as the alkali was gradually added.



[1]

c. (i) Give the name of the precipitate and the **other** product formed when barium hydroxide is added to dilute sulfuric acid in **Experiment 2**.

..... [1]

(ii) What is the colour formed in Reaction tube 1 and 5 when the indicator is added?

Reaction tube 1 .....

Reaction tube 5 ..... [1]

(iii) Predict the height of the precipitate in the reaction tube 6 in centimetres (cm).
Explain your answer.

.....

..... [1]

(iv) Using the conductivity graph given, explain fully the shape of the graph.

.....

.....

.....

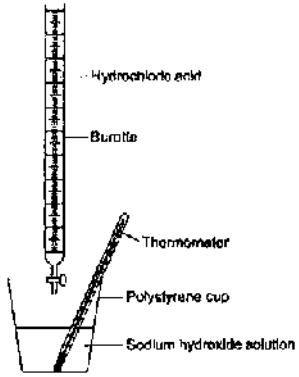
.....

.....

..... [3]

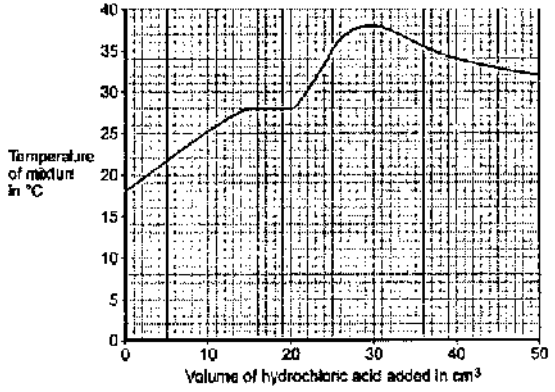
[Total : 12 marks]

B11.
A student investigates the energy released when hydrochloric acid completely neutralises sodium hydroxide solution. The student uses the apparatus shown in the diagram below.



The student:
- measures 25 cm^3 sodium hydroxide solution into a polystyrene cup
- fills a burette with hydrochloric acid
- measures the temperature of the sodium hydroxide solution
- adds 5 cm^3 hydrochloric acid to the sodium hydroxide solution in the polystyrene cup
- stirs the mixture and measures the highest temperature of the mixture
- continues to add 5 cm^3 portions of hydrochloric acid, stirring and measuring the highest temperature of the mixture after each addition.

The student has plotted a graph of the results.
The graph line has been incorrectly drawn by including an anomalous result.
The graph is shown below.



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a. (i) Suggest a cause for the anomalous result when 20 cm^3 of hydrochloric acid is added.

.....

..... [1]

(ii) Suggest the true value of the temperature of the anomalous point.

Temperature = ... °C [1]

(iii) What was the total volume of the mixture when the maximum temperature was reached?

Total volume of the mixture = ... cm^3 [1]

(iv) Calculate the overall temperature increase in this experiment.

[1]

(v) Use your answers to (a)(iii) and (a)(iv) and the equation to calculate the energy released in the reaction. Assume the volume in cm^3 is equivalent to the mass of solution in grams.

Equation: $Q = mc\Delta T$
where: Q = energy released; m = mass of solution (g); c = 4.2 (J per g per °C);
ΔT = change in temperature (°C)

[2]

b. The student did the experiment again, starting with 50 cm^3 of sodium hydroxide solution instead of 25 cm^3.

Explain why this would make no difference to the overall temperature increase.

.....

.....

..... [2]

[Total : 8 marks]

B12 Either

a. Polyethene is formed from addition polymerisation of many monomers of ethene.

(i) Draw the structural formula of polyethene.

[1]

(ii) Determine the number of $H_2C{=}CH_2$ monomeric units, n, in one molecule of polyethene with molar mass of 40 000 g. Hence, how many carbon atoms are present in one molecule of polyethene.

n = ...

number of carbon atoms in polymer = ... [3]

(iii) 'Out of sight, out of mind'.
Do you agree with this statement when it comes to the disposal of plastic waste?

.....

.....

..... [2]

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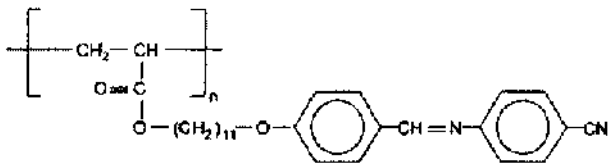
b. The structure of a liquid crystal polymer is shown below.



(i) Explain why the above polymer is produced through addition polymerisation and not condensation polymerisation.

.....

..... [1]

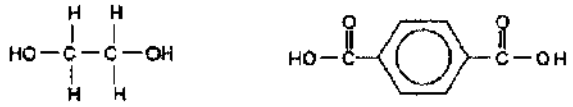
(ii) Describe a chemical test to distinguish the monomer of the liquid crystal from an organic compound with chemical formula C_4H_{10}.

.....

.....

..... [2]

c. Dacron is an example of a polymer that is formed by condensation polymerisation. Below is the structural formula of the two monomers that are used to prepare Dacron.



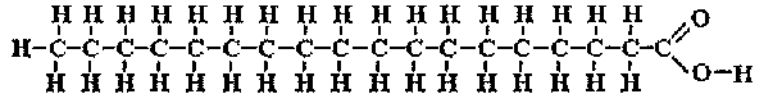
Draw the full structural formula of the repeating unit in Dacron.

[1]

[Total : 10 marks]

B12 Or

The diagram represents a saturated fatty acid molecule.



a. (i) Give the structure of the functional group that indicates the fatty acid is a carboxylic acid.

[1]

(ii) State the structural difference between a saturated fatty acid and a polyunsaturated fatty acid.

.....

.....

..... [2]

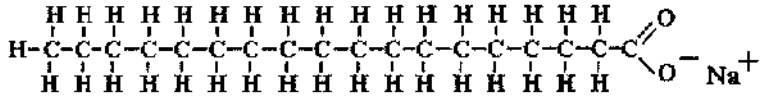
(iii) Describe a chemical test to distinguish between a saturated and a polyunsaturated fatty acid.

.....

.....

..... [2]

b. The diagram represents a soap particle, an ion. It can be considered to consist of two parts – the head and the long tail.



Long tail ***Head***

(i) Suggest how this soap is made from the fatty acid in (a).

.....

..... [1]

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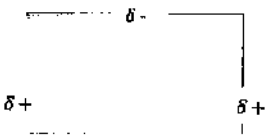
(ii) A water molecule has very slight charges ($\delta+$ and $\delta-$), as shown below.



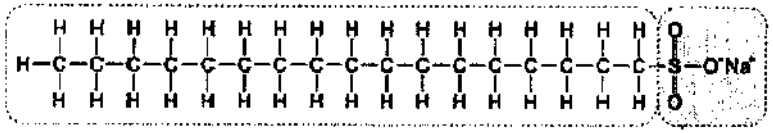
Would the head or tail of the soap particle be able to dissolve in water?
Explain your answer.

.....

.....

..... [2]

c. The diagram represents a soapless detergent particle.



(i) The hydrocarbon chain of this detergent comes from an alcohol.
Give the chemical formula of the alcohol used.

..... [1]

(ii) Suggest a problem that will arise with the use of this soapless detergent.

..... [1]

[Total : 10 marks]

- End of Paper 2 -

The Periodic Table of the Elements

Group I	II	III	IV	V	VI	VII	0
1 H Hydrogen 1							4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4	11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12	27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac † Actinium 89															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

*58-71 Lanthanoid series
†90-103 Actinoid series

Key: a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

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Bukit Batok Secondary School
Sec 4 Express 2016
Chemistry 5073

PRELIMINARY EXAMINATIONS – ANSWERS

Paper 1 : Multiple Choice Questions

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

13

$C_xH_y \rightarrow CO_2 + H_2O$
11.0g 9.0g

no of moles of CO_2 = 11 ÷[12+2(16)] = 0.250mol
no of moles of H_2O = 9 ÷ [2(1) + 16] = 0.500mol

0.250mol of CO_2 and 0.500mol of H_2O are produced
1mol of CO_2 and 2mol of H_2O are produced
$C_xH_y \rightarrow CO_2 + 2H_2O$
To balance the equation, $C_xH_y = CH_4$
$CH_4 \rightarrow CO_2 + 2H_2O$

14

(A) no of moles of He = 6 ÷ 4 = 1.50mol
volume of He = 1.50mol x 24dm^3 = 36dm^3
(B) no of moles of O_2 = 16 ÷ 2(16) = 0.50mol
volume of O_2 = 0.50mol x 24dm^3 = 12dm^3
(C) no of moles of N_2 = 14 ÷ 2(14) = 0.50mol
volume of N_2 = 0.50mol x 24dm^3 = 12dm^3
(D) no of moles of steam (H_2O) = 9 ÷ [2(1)+16] = 0.50mol
volume of H_2O = 0.50mol x 24dm^3 = 12dm^3

25

(A) N_2 (B) NO_2 (C) N_2H_4 (D) HNO_3
0 *+4 -2* *-2 +1* *+1 +5 -2*
-2 -2 *+1* -2
+1 -2
+1

29

$F_2 + H_2 \rightarrow 2HF$
ΔH_{break} = (+158kJ) + (+436kJ) = +594kJ
ΔH_{form} = 2(-556kJ) = -1112kJ
$\Delta H_{overall}$ = (+594kJ) + (-1112kJ) = -518kJ

To form 2moles of HF, 518kJ of energy is released
To form 1mole of HF, 518 ÷ 2 = 259kJ of energy is released.

31

$Al^{3+} + 3e^- \rightarrow Al$
5mol mass?

3mol of electrons produced 1mol of Al
5mol of electrons produced 5÷3 = 1.67mol of Al

Mass of Al = 1.67mol x 27 = 44.9g = 45.0g

Paper 2 Section A

1a. N 1m
1b. R 1m
1c. P 1m
1d. Q, M, R or N, P 1m
1e. M_3N_2 (*not nitrate*) 1m

2a. Blue precipitate formed. 1m
Effervescence. 1m
No displacement as reaction of alkali metal is too fast

2bi. Brown solution – Iodine *solution*
Black solid – Iodine *crystals*

2bii. **Excess** Iodine produced which cannot be dissolved in potassium chlorice solution formed. *(solid I_2 will dissolve unless in excess)* 1m

3a. Chlorofluorocarbon (NAMEIII) 1m
3b. Chlorofluorocarbon / CFCs 1m

3c. Greenhouse gases trapped heat to keep Earth warm. Without them, Earth will be too cold for survival. 1m

3d. There is highest volume of carbon dioxide in the atmosphere compared to the other gases listed. 1m
OR
It contributes the highest percentage to greenhouse effect.

3e. Ice caps melts, rise in sea level causes flooding to low lying lands.
Increase in temperature causes low crops yield. any 1m
Increase in temperature causes erratic weather changes.

4a. Y < Z < X 1m
4bi. $2YO \rightarrow 2Y + O_2$ 1m

4bii. $2YO \rightarrow 2Y + O_2$
1.08g *60.0cm^3*

no of moles of O_2 = 60.0cm^3 ÷ 24000cm^3 = 0.00250mol 1m

1mol of O_2 is produced by 2mol of YO
0.00250mol of O_2 is produced by 0.00500mol of YO

M_r of YO = 1.08g ÷ 0.00500mol = 216 1m
Atomic Mass of Y = 216 – 16 = ***200*** 1m

5a.

	Reaction of H_2O_2 with acidified $KMnO_4$	Reaction of H_2O_2 with $FeSO_4$ solution
Role of H_2O_2	Reducing Agent	Oxidising Agent

each 1m total 2m

5b. **14** 1m

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5c.	Manganese formed coloured compounds. Manganese has varied oxidation states.	1m 1m
6a.	$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$	eqn 1m no need symbols
6b.	At same temperature, yield increases as pressure increases.	1m
6ci.	As temperature increases, ammonia molecules formed gained heat energy to break the N-H bonds thus causing the equilibrium to move to the left, resulting in lower yield / decomposed to N_2 and H_2.	1m
6cii.	Exothermic	1m
6d.	High pressure is not applied as it will make the reaction dangerous and maintenance of machinery costly.	1m
	Low temperature is not used as it will make the reaction too slow.	1m
7a.	**Concentrated** sulfuric acid (as drying agent)	1m
7bi.	Green solid formed ($FeCl_2$) / white solid formed	1m
7bii.	$2HCl + Fe \rightarrow FeCl_2 + H_2$	1m
7biii.	Hydrogen gas is produced and it is flammable.	1m
7ci.	Silver chloride, an insoluble solid is formed. $Ag^+_{(aq)} + Cl^-_{(aq)} \rightarrow AgCl_{(s)}$	both 1m
7cii.	Ammonium chloride is formed. $HCl + NH_3 \rightarrow NH_4Cl$	both 1m
8a.	Use of yeast Temperature at 37°C Airtight condition Stop production when ethanol reaches 15%	Any 2 1m
8b.	Acidified potassium manganate (VII)	1m
8c.	P : ethene T : methane	1m 1m
8d.	Use of calcium oxide	1m
8e.	As a solvent As an antiseptic React with carboxylic acids to form esters	any 1m

8f.		1m
9ai.	$100cm^3$	1m
9aii.	Oxygen is produced at electrode B which can oxidise iron in steel. OR Iron in steel can react with sulfuric acid.	1m
9bi.	Concentrated copper (II) chloride	
9bii.	Electrode C : $Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)}$ Electrode D : $2Cl^-_{(aq)} \rightarrow Cl_{2(g)} + 2e^-$	1m 1m
9biii.	Presence of hydroxide (OH^-) ions turned Universal Indicator blue and presence of chlorine gas (Cl_2) bleached the indicator.	both 1m

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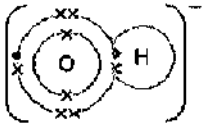
Paper 2 Section B

10a. 

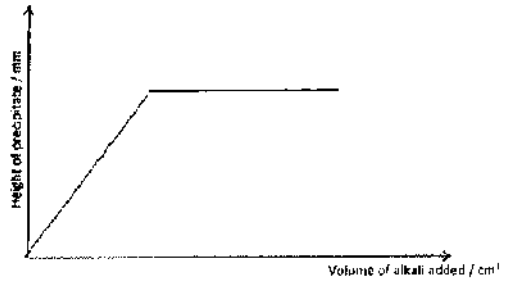
share 1m
other e-, bracket, charge 1m

10bi. Zn^{2+} / Pb^{2+} / Al^{3+} any 1m

10bii. Add excess aqueous ammonia to the respective cation solutions / white precipitate formed.
The one that dissolved contain Zn^{2+} ion. 1m

Add hydrochloric acid to the respective cation solution.
The one that formed white precipitate contain Pb^{2+} ion. 1m

The white precipitate which does not dissolve in excess aqueous ammonia and the cation solution which does not form white precipitate when hydrochloric acid is added contains Al^{3+} ion. +1m

10biii. 

1m

10ci. Barium sulfate, water both 1m

10cii. Tube 1 – colourless / pink
Tube 5 - colourless both 1m

10ciii. 4.0cm
Barium hydroxide (alkali) is used up, sulfuric acid is in excess.
Reaction stops. both 1m

10civ. Electrical conductivity decreases from tube 1 to 4 because as more sulfuric acid is used, more ions are removed to from the precipitate. 1m

There is still some conductivity at the maximum production of precipitate (tube 4) because of water, a weak electrolyte, is present. 1m

Conductivity increases again from tube 5 to 6 as excess acid is added will contribute to more ions present for conductivity. 1m

11ai. • added less than $20cm^3$ of acid
• read/record a lower temperature
• failure to stir
• heat loss
any 1m

11aii. 32 -33°C 1m

11aiii. Total volume = $25cm^3$ (alkali) + $30cm^3$ (acid) = ***55cm³*** 1m

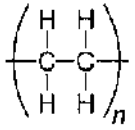
11aiv. Overall temperature increase = 38°C – 18°C = ***20°C*** 1m

11av. Q = mcΔT values 1m
= 55 x 4.2 x 20 = ***4620J*** / ***4.62kJ*** *(ecf if aiii, aiv is wrong)* ans 1m

11b. $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$ *optional*
There is twice volume of alkali, twice as much energy is released when more O-H bonds (in water molecules) are formed. 1m

But since there is also twice as much water that is produced, energy is absorbed by the water as the water is being heated. 1m

B12 Either

ai.  1m

aii. Mr of ethene monomer C_2H_4 = 2(12) + 4(1) = 28 1m
no of monomers in the polymer, n = 40 000 ÷ 28 = ***1429*** or ***1430*** 1m

Each monomer has 2 carbon atoms
Number of carbon atoms in polymer = 1428.6 x 2 = ***2857*** 1m

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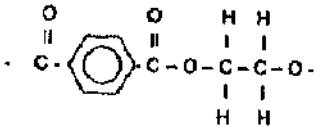
aiii. Plastic waste are not able to decompose because they are non-biodegrable. *They cannot be broken down by bacteria.* 1m

They remain buried in landfills for a long period of time, hence more land is needed as landfill instead of land being used for more constructive purposes *eg to grow crops for the population.* 1m

bi There is no amide or ester linkage in the polymer structure. 1m

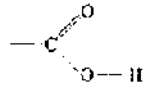
bii. With the liquid crystal monomer, reddish brown aqueous bromine decolourised. 1m
With C_4H_{10}, reddish brown aqueous bromine remains. 1m

c.



B12 Or

ai.



1m

aii. Saturated fatty acid has C - C bond only whereas polyunsaturated fatty acid contains C = C 1m

Polyunsaturated fatty acid contains many C = C bonds in its molecule. 1m

aiii. Add aqueous bromine to saturated fatty acid, aqueous bromine remains brown. 1m

Add aqueous bromine to polyunaturated fatty acid, brown aqueous bromine remains decolourised. 1m

bi. React fatty acid with an alkali eg sodium hydroxide. 1m

bii. The head.
The head has a negative charge on COO^- which can be attracted to the hydrogen atoms which are the positively charge end of water molecule. -ve 1m +ve of H_2O 1m

ci. $C_{17}H_{35}OH$ 1m

cii. The long chain molecule takes a longer time to break down which can cause foaming when they are discharged into river and stream. 1m

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PRESBYTERIAN HIGH SCHOOL

CHEMISTRY **5073/1**

Paper 1 Multiple Choice

31 August 2016 **Wednesday** **1 hour**

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2016 SECONDARY FOUR EXPRESS
PRELIMINARY EXAMINATION

INSTRUCTIONS TO CANDIDATES:

DO NOT OPEN THIS QUESTION PAPER 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 register number 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.

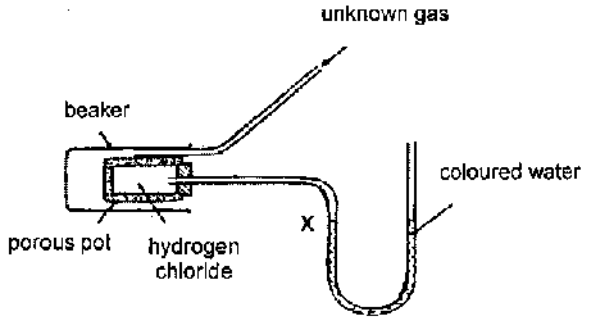
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

A copy of the Periodic Table is printed on page 21.

Setter: Miss Cynthia Lim

This question paper consists of 21 printed pages (including this cover page) and 1 blank page.

1 A beaker of unknown gas was placed over a porous pot containing hydrogen chloride as shown.



Over a period of time, which unknown gas would cause the water level at X to rise and then return to X?

A argon
B hydrogen
C nitrogen
D oxygen

2 Caffeine is a white solid that melts at 235 °C.

A quantity of impure caffeine is found contaminated with sugar. The solubility of caffeine and sugar in the two solvents are listed in the table.

substance	solubility in water	solubility in propanone
caffeine	moderate	high
sugar	high	nil

The following steps could be carried out to obtain pure caffeine from a mixture of caffeine and sugar.

I add excess water
II filter the mixture
III add excess propanone
IV cool and crystalline
V heat the filtrate

In which order should the steps be carried out?

A I, II, IV and V
B I, II, V and IV
C III, II, V and IV
D III, II, IV and V

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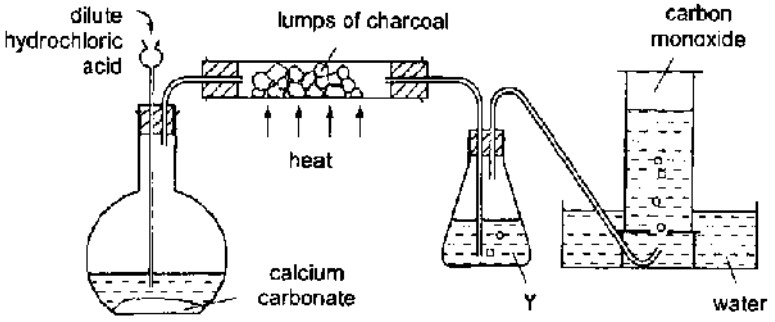
3 The diagram shows the apparatus used to obtain carbon monoxide.



What is the main purpose of Y?

A to dry the gas
B to prevent water being sucked back on to the hot carbon
C to remove carbon dioxide from the gas
D to remove hydrogen chloride from the gas

4 An isotope of element A has 17 protons and 20 neutrons in its nucleus. Which symbol is correct for the ion of A?

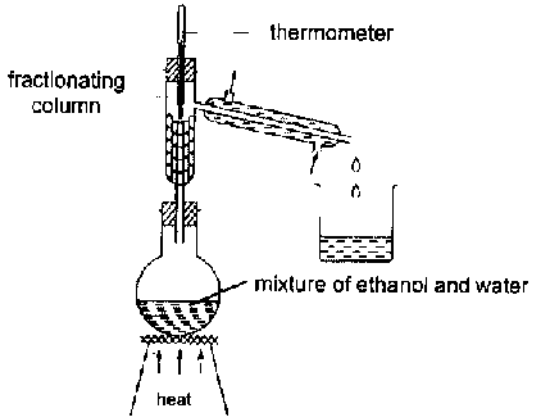
A $^{20}_{17}A^{+}$

B $^{37}_{17}A^{+}$

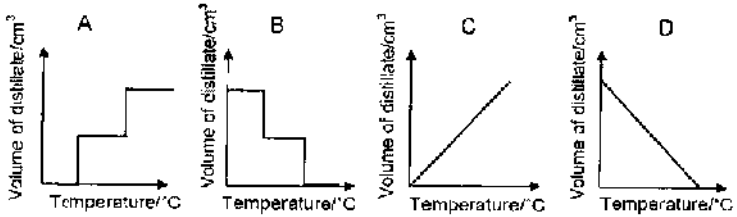
C $^{20}_{17}A^{-}$

D $^{37}_{17}A^{-}$

5 A student sets up the following apparatus to separate ethanol (boiling point 78 °C) and water (boiling point 100 °C).



Which graph correctly shows the relationship between total volume of distillate plotted against temperature?



6 The table below shows some of the physical properties of substances **P**, **Q**, **R** and **S**.

substance	melting point / °C	boiling point / °C	electrical conductivity		solubility in water
			solid state	liquid state	
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 Substance **P** is a simple molecular compound with weak covalent bonds.
B Substance **Q** is an ionic compound with mobile electrons in the liquid state.
C Substance **R** is a macromolecule with immobile electrons held by strong electrostatic forces.
D Substance **S** is a macromolecule with mobile electrons.

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7 Element X has n protons and forms ions with a charge of 2-.
Element Y has (n + 3) protons.

Which of the following correctly shows the structure and formula of a compound formed between elements X and Y?

A a covalent compound YX_2
B a covalent compound Y_2X
C an ionic compound YX_2
D an ionic compound Y_2X

8 Brass is an alloy of zinc (30%) and copper (70%). Which of the following correctly describes the atoms in a sample of molten brass?

	copper atoms	zinc atoms
A	close together and vibrating vigorously	close together and vibrating vigorously
B	close together and moving at random	widely spaced and moving at random
C	widely spaced and vibrating vigorously	close together and vibrating vigorously
D	widely spaced and vibrating vigorously	widely spaced and moving at random

9 When a 2.31 g sample of oxide of nitrogen was analysed, it was found to contain 0.68 g of nitrogen.

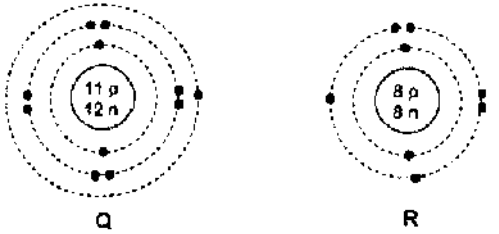
What is the empirical formula of the oxide of nitrogen?

A NO
B N_2O
C NO_2
D N_2O_4

10 Which of the following will produce 1.0 mol of carbon dioxide on complete combustion?

A 0.25 mol of ethanol
B 0.5 mol of ethene
C 1.0 mol of propane
D 1.5 mol of graphite

11 The diagram below shows the atoms of two elements, Q and R.



What is the percentage by mass of element Q in the compound formed between Q and R?

A 25.8%
B 41.8%
C 59.0%
D 74.2%

12 $C_2H_5OH + 2[O] \rightarrow CH_3COOH + H_2O$

The chemical equation shows the reaction of 2.30 g of ethanol mixed with an excess of aqueous potassium manganate(VII).

The reaction mixture was then warmed for one hour. The desired organic product was then collected by distillation. The yield of the product was 60.0%.

What mass of product was collected?

A 1.32 g
B 1.38 g
C 1.80 g
D 3.20 g

13 Which property generally decreases when going across a period of the Periodic Table from Group I to Group VII?

A the acidity of the oxides of the elements
B the number of electrons in the valence shell
C the reducing power of an element
D the tendency of the elements to form negative ions

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14 Three experiments are carried out to determine the reactivity of three unknown halogens. The ionic equations of the three experiments are shown below.

$$Z^-(aq) + Y_2(aq) \rightarrow \text{no reaction}$$
$$X^-(aq) + Z_2(aq) \rightarrow \text{no reaction}$$
$$2Y^-(aq) + X_2(aq) \rightarrow 2X^-(aq) + Y_2(aq)$$

Predict the reactivity of the halogens in **decreasing** order

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

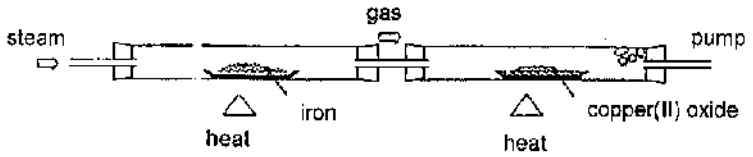
15 The properties of some elements, W, X, Y and Z in Period 3 are shown in the table below.

element	W	X	Y	Z
appearance at room temperature	grey solid	yellow solid	grey solid	yellow green gas
reaction with cold water	extremely violent reaction	no reaction	vigorous reaction	slow reaction
nature of oxide	reacts with acids	reacts with bases	reacts with both acids and bases	reacts with bases

Which of the following shows the arrangement of these elements in the Periodic Table in increasing order of group number?

A W, X, Y, Z
B W, Y, X, Z
C Y, W, X, Z
D Z, X, Y, W

16 Which of the following is **not** a product of the reaction sequence below?



A copper
B iron(II) oxide
C oxygen
D water vapour

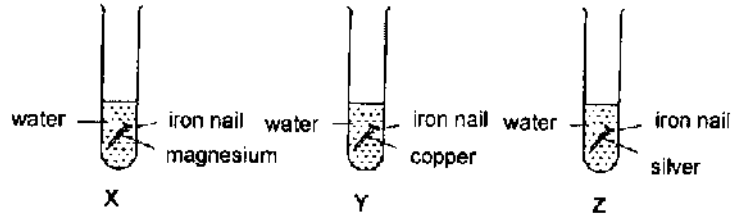
17 The table shows the results of adding weighed pieces of nickel metal in salt solutions of metals W, X, Y and Z.

salt solution of metal	initial mass of nickel / g	mass of nickel after 15 min / g
W	6.0	5.0
X	6.0	5.5
Y	6.0	4.5
Z	6.0	6.0

Which of the following statements is correct?

A Metal W is higher than metal X in the reactivity series.
B Metal Y can displace metal Z from its salt solution.
C Metal Y is higher than nickel in the reactivity series.
D Z could be nickel(II) chloride solution.

18 Three experiments are set up to investigate the sacrificial protection of iron. The iron nails are coated with some other metals as shown below.



In which test tube(s) will the iron nail rust?

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

19 The water from hot springs near the Ebeko volcano in the Pacific Ocean has a very low pH.

What does the low pH indicate about the water from the hot springs?

A It has equal concentrations of H^+ and OH^- ions.
B It has equal numbers of positive and negative ions.
C It has high concentrations of H^+ ions.
D It has no detectable H^+ or OH^- ions.

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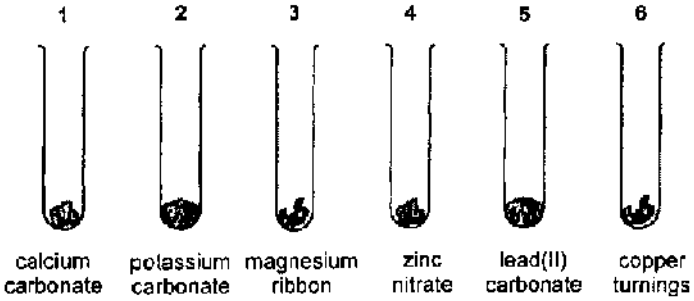
20 Dilute sulfuric acid was added to the test tubes shown below. Some of them had no visible reaction while some of them reacted quickly, giving off a gas. However, some of them fizzed at first and then stopped after a short time.



In which test tubes reaction lasted for a short time only?

A test tubes 1 and 5
B test tubes 1, 2 and 5
C test tubes 3 and 4
D test tubes 2 and 6

21 When sodium carbonate is dissolved in water, carbonic acid and sodium hydroxide are formed

$$Na_2CO_3\,(aq) + 2H_2O\,(l) \rightarrow H_2CO_3\,(aq) + 2NaOH\,(aq)$$

Carbonic acid decomposes on standing to form CO_2 gas and H_2O.

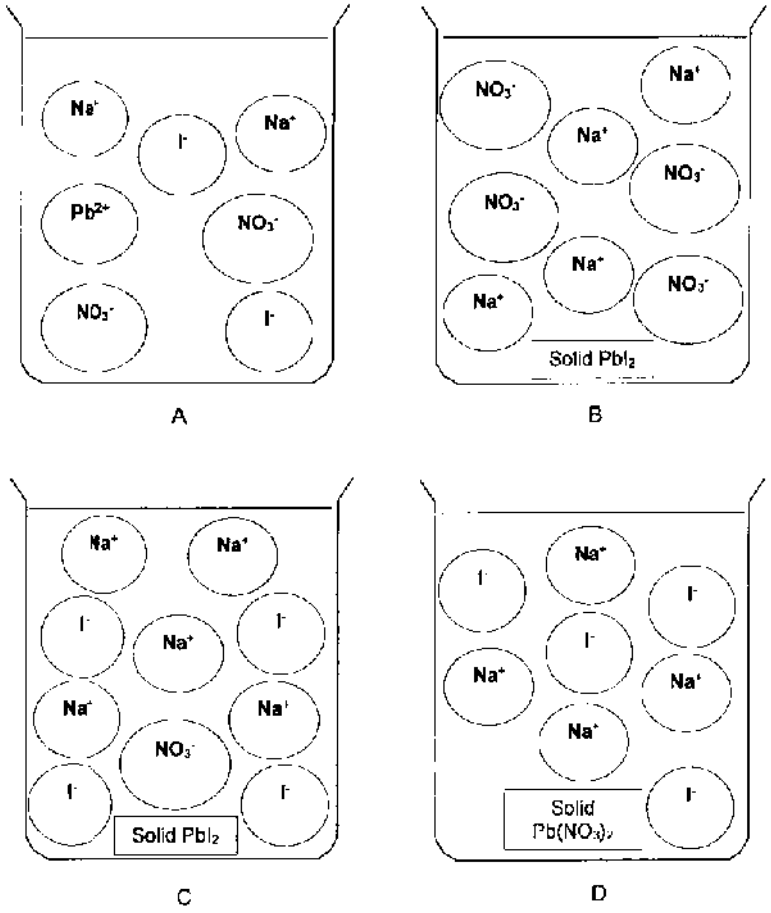
The table below shows the results of tests on the solution of sodium carbonate. Which results are correct?

	pH of solution when sodium carbonate is dissolved in water	reaction of sodium carbonate with calcium nitrate solution
A	3	white precipitate
B	3	no reaction
C	12	white precipitate
D	12	no reaction

22 A 0.331 g sample of solid lead(II) nitrate is dissolved in water and then added to 125 cm^3 of 0.100 mol/dm^3 sodium iodide solution. Assume there is no change in volume of the solution, the chemical reaction takes place according to the following chemical equation.

$$Pb(NO_3)_2\,(aq) + 2NaI\,(aq) \rightarrow PbI_2\,(s) + 2NaNO_3\,(aq)$$

Which of the diagram below **best** represents the results after the mixture has reacted as completely as possible?



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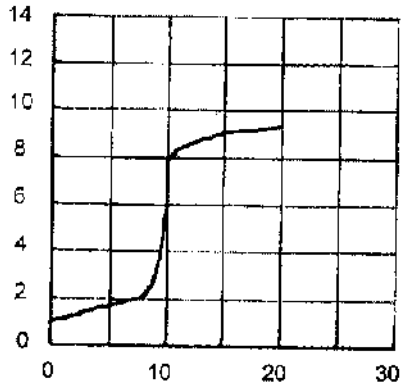
23 Different indicators change colour over different pH ranges and it is important to choose the correct indicator to obtain an accurate result in a titration.

indicator	pH range for the colour change	colour	
		lower pH	higher pH
indigo carmine	11.6 to 14.0	blue	yellow
methyl red	4.2 to 6.3	red	yellow
methyl violet	0.3 to 3.0	yellow	violet
phenolphthalein	8.2 to 10.0	colourless	pink

If aqueous ammonia is added to hydrochloric acid, the following graph is obtained, which shows the change of pH with the volume of aqueous ammonia added.



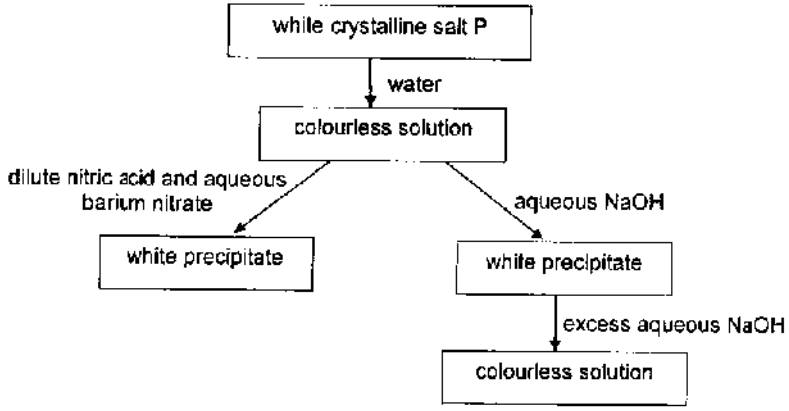
Which of the indicators below would be the best choice to use in the titration?

A indigo carmine
B methyl red
C methyl violet
D phenolphthalein

24 Which statement is true about the Haber Process?

A Increasing the pressure to be above 200 atm will speed up the reaction but cause yield to be low.
B Increasing the temperature to above 450 °C will speed up the reaction but cause the yield to be low
C Nitrogen is obtained from the cracking of petroleum.
D Unreacted gases produced are released into the atmosphere.

25 The diagram shows a reaction scheme.



What is the identity of salt P?

A aluminium chloride
B lead(II) sulfate
C zinc chloride
D zinc sulfate

26 Separate samples of hydrogen peroxide are added to aqueous potassium iodide and to acidified potassium manganate(VII). The iodide ions are oxidised and the manganate(VII) ions are reduced. What colour changes are seen?

	potassium iodide	acidified potassium manganate(VII)
A	brown to colourless	colourless to purple
B	brown to colourless	purple to colourless
C	colourless to brown	colourless to purple
D	colourless to brown	purple to colourless

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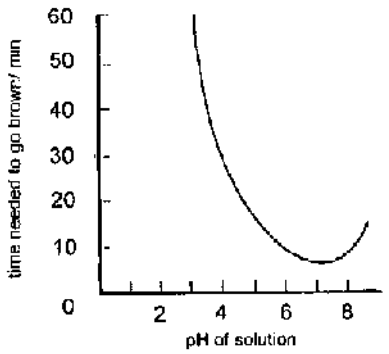
27 Pieces of apples usually go brown when they are left in air for a few minutes. In food processing factories, it is important to stop this browning. The graph shows how browning is controlled by the pH of a solution.



In a laboratory experiment, cut apples are contained in special solutions to stop browning. Which one of these solutions is the best solution to prevent browning of the apples?

A aqueous ammonia
B ethanol
C nitric acid
D propanoic acid

28 The heat-reflecting shields of some space rockets are gold-plated using electrolysis.

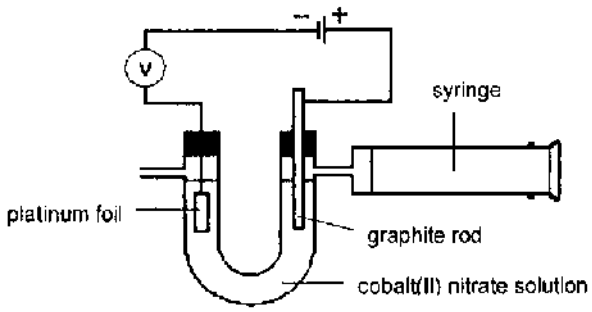
Which electrodes and electrolyte would be used to gold-plate the heat shield?

	negative electrode	positive electrode	electrolyte
A	carbon	heat shield	gold compound
B	gold	heat shield	copper compound
C	heat shield	carbon	copper compound
D	heat shield	gold	gold compound

29 In two separate electrolysis experiments, the same quantity of electricity deposited 16 g of copper from copper(II) nitrate solution and 6 g of titanium. What was the charge on titanium ion?

A 1+
B 2+
C 3+
D 4+

30 A dilute solution of cobalt(II) nitrate was electrolysed in the apparatus shown.



During electrolysis, a grey solid formed on the platinum foil and bubbles of gas appeared around the graphite rod. The gas was collected in the syringe. The gas collected was able to relight a glowing wooden splint.

Which of the following statements are correct?

I Cobalt(II) ions are higher in the electrochemical series than hydrogen ions and are thus preferentially discharged to form grey cobalt metal.

II Hydroxide ions are discharged to form oxygen gas which then reacts with graphite to form carbon dioxide.

III The solution left behind is nitric acid.

IV After a period of time, hydrogen ions are found at higher concentrations and are thus discharged to form hydrogen gas at the graphite rod.

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

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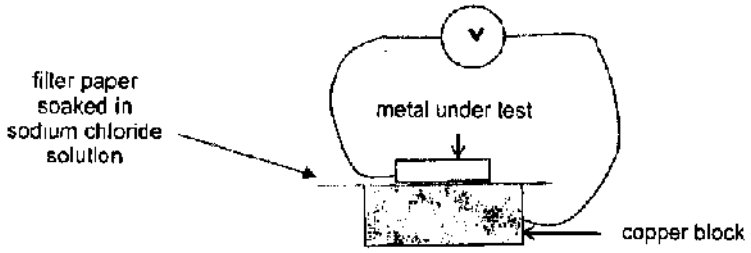
31 The apparatus shown below was used to compare the reactivity of metals **P**, **Q**, **R** and **S**.



In each test, the voltmeter reading was recorded in the table shown below.

metal under test	direction of electron flow in external circuit	voltage recorded / V
P	P to Cu	+0.87
Q	Cu to Q	-1.20
R	R to Cu	+1.58
S	S to Cu	+0.36

What is the correct order of the metals in **decreasing** reactivity (most reactive to least reactive)?

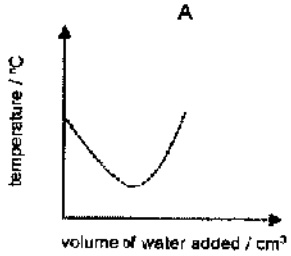
A **P, Q, R, S**
B **Q, S, P, R**
C **R, P, S, Q**
D **R, S, Q, P**

32 Which statement is true about the hydrogen-oxygen fuel cell?

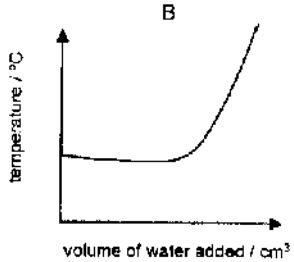
A Hydrogen gas is oxidised at the negative electrode to form water.
B Hydrogen gas is reduced at the negative electrode to form water.
C Oxygen gas is oxidised at the negative electrode to form hydroxide ions.
D Oxygen gas is reduced at negative electrode to form hydroxide ions.

33 When ammonium chloride is dissolved in water, weak forces of attractions are formed between the ions and water molecules. Which graph best represents the observed temperature change?

A



B



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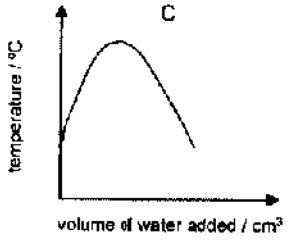
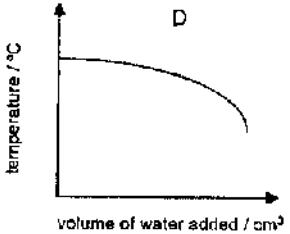


D



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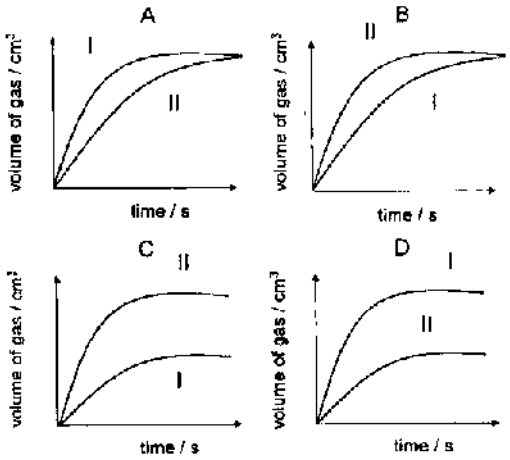
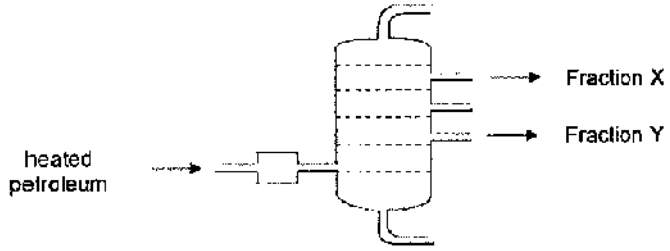
34 In two separate experiments, magnesium carbonate was reacted with an excess of dilute acid. The following shows the different conditions used in each experiment, with all other conditions being identical in both experiments.

Experiment I: 0.05 dm^3 of 1.0 mol/dm^3 of hydrochloric acid
Experiment II: 0.05 dm^3 of 1.0 mol/dm^3 of sulfuric acid

Which graph correctly represents the results of the two experiments?



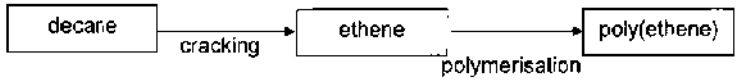
35 The diagram shows the fractional distillation of petroleum.



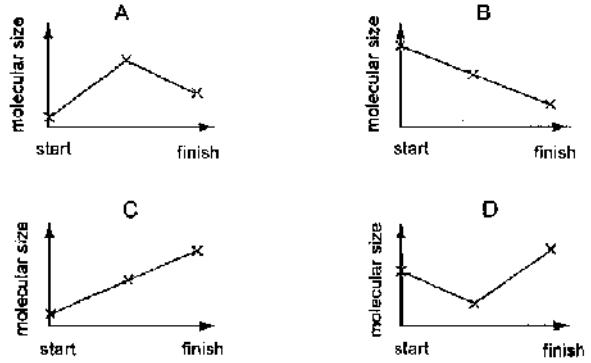
Which of the following comparisons are correct about fractions X and Y?

	X burns more easily than Y	X has a lower boiling point than Y
A	yes	no
B	yes	yes
C	no	no
D	no	yes

36 Poly(ethene) can be manufactured by the process below.



Which graph shows the change in molecular size during this process?



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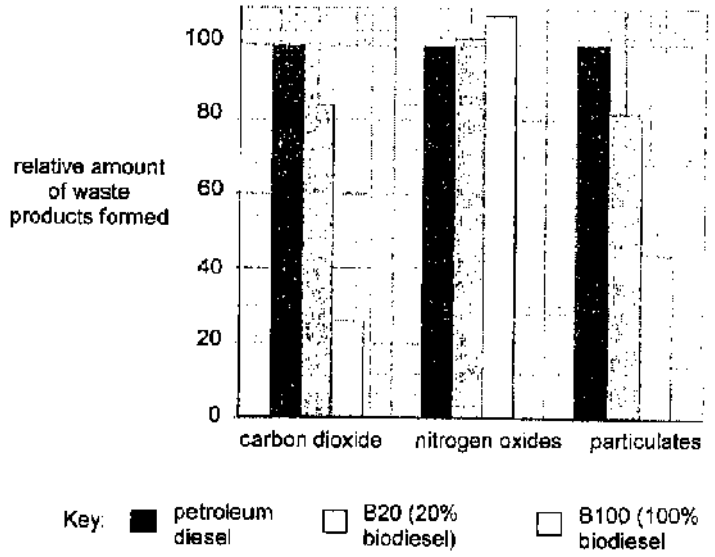
For Questions 37 and 38, refer to the information below.

Biodiesel can be mixed with petroleum diesel to make a fuel for cars.

The bar chart compares the relative amounts of waste products made when three different types of diesel fuel burn in a car engine.



37 From the graph, it can be seen that biodiesel releases carbon dioxide but some scientists claim that biodisel is a carbon neutral fuel.

What is the basis for this argument?

A Biodiesel is not a carbon compound.
B Biodiesel produces less carbon dioxide when it burns.
C Plants release carbon dioxide in respiration.
D Plants take up carbon dioxide as they photosynthesise.

38 Which of the following is one disadvantage of using fuel with a high percentage of biodiesel?

A It could increase global warming.
B It could increase the amount of acid rain.
C It is non-biodegradable.
D It is non-renewable.

39 The reaction between a carboxylic acid, $C_xH_yCO_2H$, and an alcohol, $C_nH_{2n+1}OH$, produces an ester.

How many hydrogen atoms does one molecule of the ester contain?

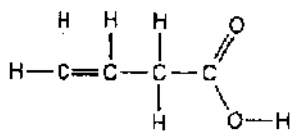
A y + 2n
B y + 2n + 1
C y + 2n + 2
D y + 2n + 3

40 The table shows the results of tests carried out on compound X.

test	result
aqueous bromine added	decolourised
sodium carbonate added	colourless gas evolved

Which formula represents compound X?

A



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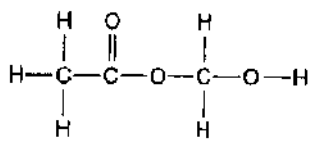

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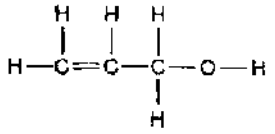

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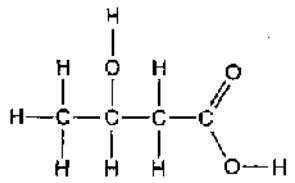

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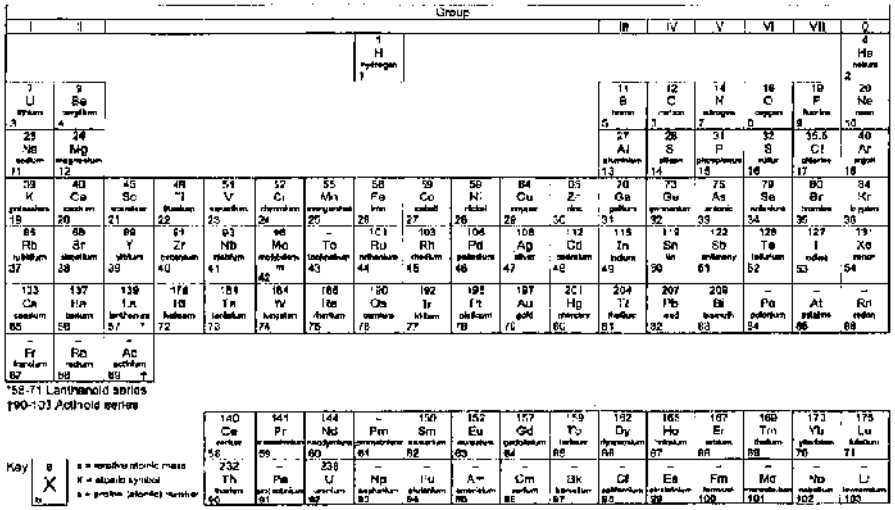
The Periodic Table of the Elements



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PRESBYTERIAN HIGH SCHOOL

SCIENCE DEPARTMENT

Subject: Chemistry
Level: 4 Express
Setter: Miss Cynthia Lim

Exam: Prelim
Year: 2016

MARKING SCHEME

Paper 1 (40 marks)

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
A	C	C	D	A	D	D	B	C	B
Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
D	C	C	B	B	C	B	D	C	A
Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30
A	C	B	B	D	D	D	D	D	B
Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38	Q39	Q40
C	A	A	B	B	D	D	B	B	A

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PRESBYTERIAN HIGH SCHOOL

CHEMISTRY **5073/2**

Paper 2

29 August 2016 **Monday** **1 hour 45 minutes**

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2016 SECONDARY FOUR EXPRESS PRELIMINARY EXAMINATION

INSTRUCTIONS TO CANDIDATES

Write your class, register number and name on all the work you hand in.
Write in dark blue or black pen
Do not use 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.

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 Periodic Table is printed on page 22.

Setter: Miss Cynthia Lim

For Examiner's Use	
Section A	
Section B	
Total	

This question paper consists of **22** printed pages (including this cover page) and **0** blank page.

Section A (50 marks)
Answer all questions.
Write your answers in the spaces provided.

1 Carbon-14 is an isotope of carbon used to determine the age of organic materials through a process called carbon dating.

(a) How does a carbon-14 atom differ from a carbon-12 atom?

.....

..... [1]

(b) After undergoing radioactive decay, a sample of carbon contained 80% of carbon-12 and 20% of carbon-14. Calculate the relative atomic mass of carbon in this sample.

[2]

[Total: 3]

2 Fig. 2 shows the variation in the melting point of the elements in Period 3.

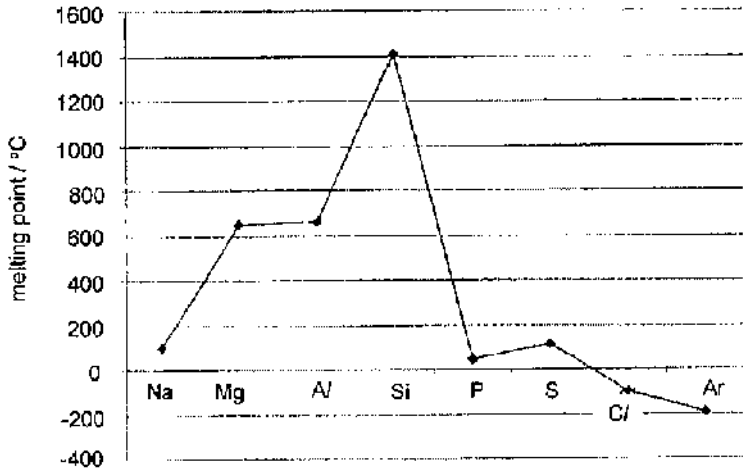

Fig. 2

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(a) Which element in Period 3 has the lowest melting point? Explain, in terms of structure and bonding, why this element has a low melting point.

.....

.....

.....

..... [2]

(b) Which element in Period 3 has the highest melting point? Explain, in terms of structure and bonding, why this element has a high melting point.

.....

.....

.....

..... [2]

(c) (i) Draw a 'dot and cross' diagram for the compound formed between sodium and sulfur. Show only the valence electrons.

[2]

(ii) Explain why, the compound formed between sodium and sulfur, cannot conduct electricity in the solid state, but able to when it is in molten or aqueous state.

.....

.....

..... [2]

[Total: 8]

3 Sodium hypochlorite solution, NaC*l*O, commonly known as bleach, is frequently used as a disinfectant. When heated, sodium hypochlorite decomposes to form sodium chlorate(V), $NaClO_3$ and sodium chloride.

(a) Construct a balanced chemical equation when sodium hypochlorite is heated.

..... [1]

(b) Explain, in terms of oxidation states, why the above reaction is a redox reaction.

.....

.....

..... [2]

(c) When sodium hypochlorite dissolves in water, oxygen gas and chlorine gas are produced.

Explain why oxygen gas is detected first.

.....

.....

..... [2]

[Total: 5]

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4 (a) Alkenes can be hydrogenated, under appropriate conditions, to form alkanes.

The energy profile for the hydrogenation of ethene at room temperature and pressure with substance **X** is shown in Fig. 4.1.

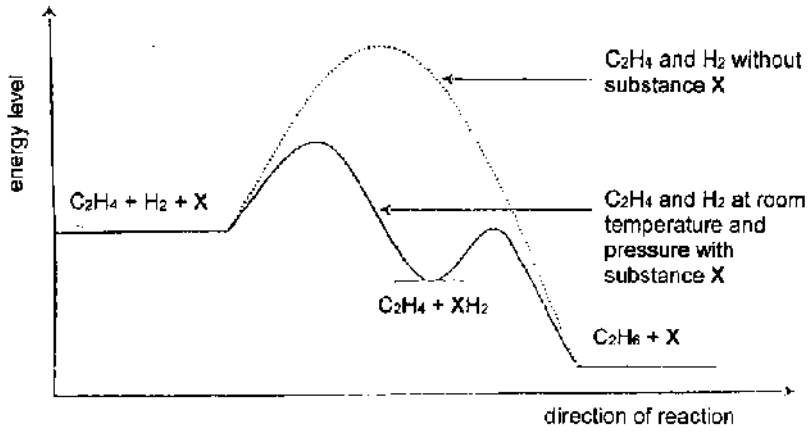

Fig. 4.1

On the same axes, the energy profile for the hydrogenation of ethene under the same conditions but without substance **X** is also shown.

(i) State the role of substance **X** and explain how it affects the rate of reaction.

.....

..... [2]

(i) On Fig. 4.1, draw arrows to represent the enthalpy change, ΔH, as well the activation energy, E_a, for the reaction with substance X. [1]

PLEASE TURN OVER TO THE NEXT PAGE

(iii) Table 4 gives the bond energies of some bonds.

bond	bond energy / kJmol^{-1}
C-C	350
C=C	600
C-H	410
H-H	440

Table 4

Calculate the enthalpy change, ΔH, for the hydrogenation of ethene.

$$C_2H_4 + H_2 \rightarrow C_2H_6$$

[2]

(iv) Based on your answer in a (III), explain in terms of bond breaking ard bond forming whether the hydrogenation of ethene is an exothermic or endothermic reaction.

.....

.....

.....

..... [2]

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(b) Hydrogenation of alkenes is used to make margarine. Fig. 4.2 shows how margarine is produced by saturating vegetable oils which are high in polyunsaturates.

$$n(C_2H_2) + n(H_2)\,(g) \rightarrow n(C_2H_4)$$

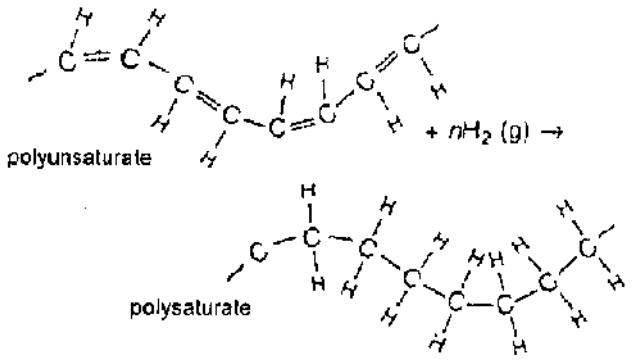

Fig. 4.2

(i) If a polyunsaturated is shaken with aqueous bromine, what would you expect to observe and explain why.

.....

..... [2]

(ii) Are saturated vegetable oils more or less dense than unsaturated ones? Explain your answer.

.....

..... [1]

(iii) Explain whether it is advisable to completely saturate the vegetable oils.

.....

..... [1]

[Total:11]

5 Duralumin is an alloy of aluminium. It is made from a mixture of aluminium and copper andwas first used as rigid airship frames.

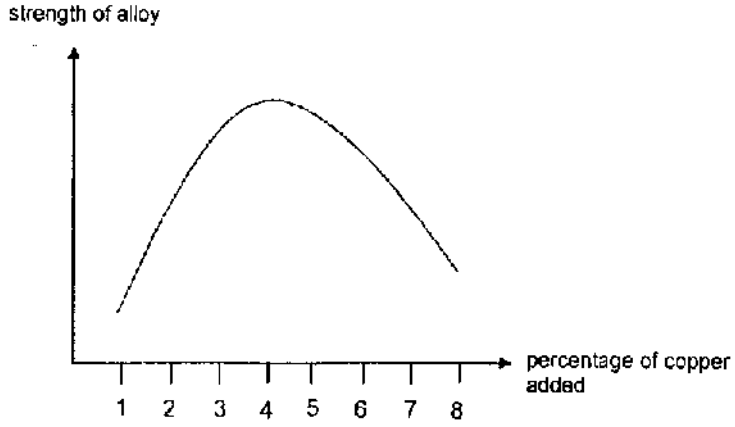

Fig. 5.1

(a) With reference to Fig. 5.1. state the optimum percentage of copper that shouldbe added to produce the strongest alloy.

..... [1]

(b) (i) Explain why duralumin is strong enough to be used as airship frames.

.....

.....

.....

.....

..... [3]

(ii) Suggest why this alloy of aluminium, containing copper, is more prone to corrosion.

.....

..... [1]

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(iii) Explain how the addition of a high-purity aluminium surface layer to the sheets of duralumin helps to overcome the corrosion issue.

.....

.....

..... [2]

(c) Why is it more costly to extract aluminium from its oxide as compared to copper of the same mass?

.....

.....

..... [2]

[Total: 9]

6 (a) Strontium metal can be obtained by the electrolysis of molten strontium bromide, using the apparatus shown in Fig. 6.1.

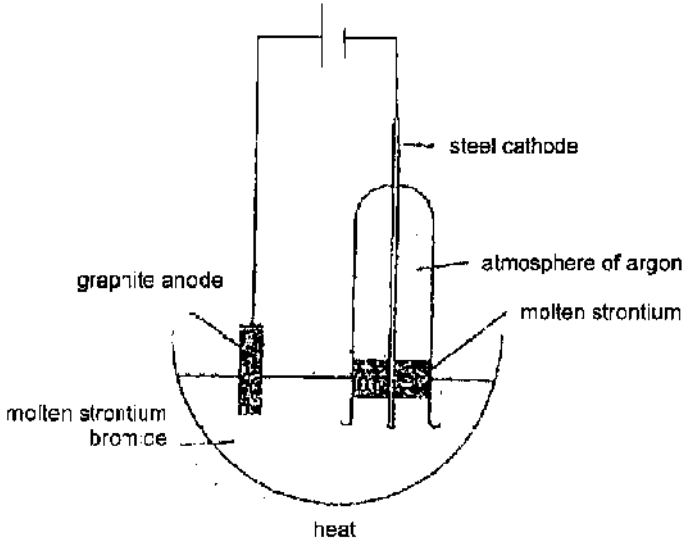

Fig. 6.1

(i) Write the half equations for the electrode reactions at the anode and cathode.

.....

..... [2]

(ii) Explain why strontium is unable to be extracted from the electrolysis of aqueous strontium bromide.

.....

..... [1]

(b) An electrolysis experiment is carried out as shown in Fig. 6.2.
P and Q are copper electrodes while R and S are silver electrodes.

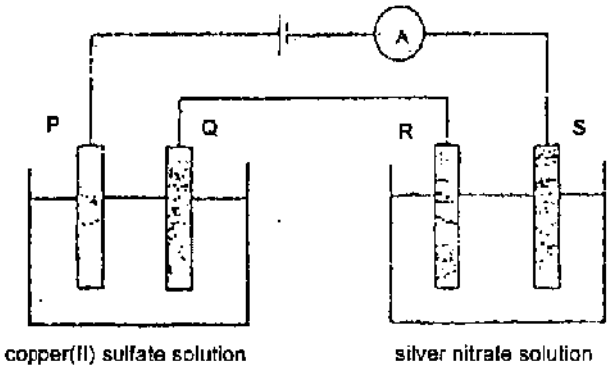

Fig. 6.2

(i) At which electrode would the mass increase faster? Explain your answer.

.....

.....

.....

..... [2]

(ii) P and Q are then replaced with platinum electrodes and gas bubbles are observed. Explain why this gas does not appear when P and Q are copper electrodes.

.....

.....

.....

..... [2]

[Total: 7]

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7 The fractional distillation of crude oil yields many fractions. One of the fractions is paraffin. Butane is an example of an organic molecule found in this fraction. Butane can undergo cracking to produce hydrogen and a useful small alkene.

(a) Draw a branched-chain isomer of butane.

[1]

(b) Construct an equation for the above cracking process.

..... [1]

(c) The Gulf of Mexico oil-spill disaster released large volumes of crude oil into the sea. Biosurfactants were used to reduce the massive oil-spill pollution. The use of industrial chemicals to treat hydrocarbon-polluted site can lead to further contamination due to by-products formed. Biosurfactants can be conveniently produced from yeast and bacteria.

State two advantages of using biosurfactants as compared to industrial chemicals.

.....

..... [2]

[Total: 4]

8 Plumbers sometimes use acids to remove the surface layer of rust from sinks.

A plumber uses dilute hydrochloric acid and dilute sulfuric acid of the same concentration to remove two samples of rust of equal mass.

(a) State and explain which acid would give the plumber a faster rate of removal of the rust.

.....

.....

..... [2]

(b) The plumber tried using ethanoic acid of the same concentration to remove another sample of rust. However, the results were not as effective. Explain the results obtained.

.....

..... [1]

[Total: 3]

PLEASE TURN OVER TO THE NEXT PAGE

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Section B (30 marks)
Answer **three** questions.
Question **11** is in the form of an **Either/Or** question.
Only **one** part should be answered.

9 The element platinum is an expensive metallic element with proton number 78 and electronic configuration of 2.8.18.32.17.1.

Platinum melts at 17770 °C and is three times the density of iron. It is very corrosion resistant as it does not react with air or water and is not affected by common acids even at high temperature.

Platinum can form several compounds. One of which is platinum(II) chloride, a brown crystalline solid which is insoluble in water. Another compound is platinum(IV) chloride, a brown-red powder which dissolves in water to give a red solution.

The main uses of platinum are summarised in Fig. 9.1.

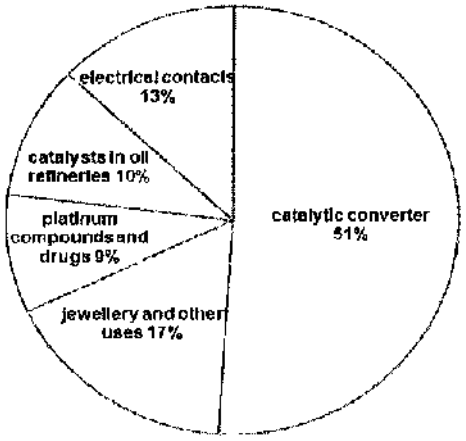

Fig. 9.1

Source: JGR Briggs Chemistry Insights

Platinum, palladium and rhodium are metals found to exhibit outstanding catalytic properties which have led to their use in catalytic converters installed in motor vehicles.

Table 9 below illustrates the relative abundance and the annual production of these three metals.

metal	relative abundance in earth crust / parts per million	annual production / tonne
platinum	0.0063	24
palladium	0.0037	30
rhodium	0.0007	3

Table 9

Source 1: Wikipedia – Abundance of elements in Earth's crust
Source 2: http://www.stillwaterpalladium.com/historyoverview.html

(a) What percentage of platinum is used as catalysts? [1]

(b) What change would you expect in the pie chart if a cheap substitute were found to replace platinum in car exhausts? Give a reason to your answer. [1]

(c) State one property of platinum, other than electrical conductivity, that explains its use in electrical contacts. [1]

(d) Platinum belongs to the transition metals section in the Periodic Table. State two properties from the above account which show why platinum should be placed in this section of the Periodic Table. [2]

(e) Some chemists place platinum in one of the main groups (Group I, II etc). Which group do you think platinum should be placed in? Explain your answer. [2]

(f) (i) Platinum(IV) chloride decomposes upon heating to produce a choking gas which bleaches blue litmus paper and another product.

Write a chemical equation for this decomposition. [1]

(ii) Deduce, with reasoning, the position of platinum in the reactivity series. [2]

(g) Using the information from Table 9, which of the three metals are the highest and lowest in demand to be used as auto catalyst? Explain your answers. [2]

[Total: 12]

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10 The table below shows a study of a precipitation reaction between dilute sulfuric acid and aqueous barium hydroxide.

The reaction tubes contained different volumes of barium hydroxide and dilute sulfuric acid as stated in Table 10. To each tube, two drops of methyl orange indicator were added. Precipitation occurred in all the reaction tubes and after 20 minutes, the height of the precipitate in each tube was measured and recorded.

reaction tube	1	2	3	4	5	6
volume of 0.500 mol/dm^3 barium hydroxide /cm^3	5.0	5.0	5.0	5.0	5.0	5.0
volume of 1.00 mol/dm^3 sulfuric acid /cm^3	1.0	1.5	2.0	2.5	3.0	3.5
Height of precipitate /cm	2.5	3.0	3.5	4.0	4.0	

Table 10

(a) Construct an ionic equation for the precipitation reaction. [1]

(b) State the observations made in reaction tube 1. [1]

(c) (i) Predict the height of the precipitate in reaction tube 6. [1]

(ii) Explain your answer to c (i). [1]

(d) The electrical conductivity of each reaction tube was measured. Sketch a graph of electrical conductivity (y-axis) against the reaction tube number (x-axis) for the experiment. [1]

(e) A student tried to prepare two salts, barium sulfate and sodium nitrate, using the method described in the paragraph below.

Aqueous barium nitrate was mixed with aqueous sodium sulfate and the precipitate of barium sulfate was obtained through filtration. The residue was dried in an oven.

The filtrate was heated until the solution was saturated. Crystals of sodium nitrate were formed when the saturated solution was cooled.

(i) State one omission in the preparation of barium sulfate. [1]

(ii) Explain why the student could not obtain pure crystals of sodium nitrate using the method described above. [1]

(iii) Name a suitable method to prepare pure crystals of sodium nitrate. [1]

[Total: 8]

11 **EITHER**

Methyl cyanopropenoate is an active ingredient in superglue. Superglue is a very strong adhesive used to fasten materials like wood together. The structure is shown in Fig. 11.1.

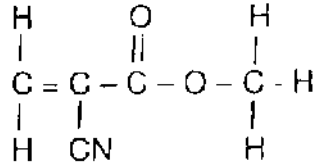

Fig. 11.1

Superglue polymerises when exposed to moisture in air. This causes the glue to set.

(a) State two functional groups of super glue. [1]

(b) Suggest the type of polymerisation that superglue undergoes. [1]

(c) Draw the repeating unit of the polymer formed. [1]

(d) (i) Methyl cyanopropenoate can be made from an acid and an alcohol. Draw the structural formulae of both molecules. [2]

(ii) The alcohol named in d(i) and an acid chloride can also be used to synthesise methyl cyanopropenoate. A by-product of hydrogen chloride gas is produced in this reaction.

Draw the structure of the acid chloride. [1]

(e) Kevlar is another polymer that is used for making bulletproof vests, army helmets and 'puncture-proof' tyres. Kevlar is also used in the protective clothing worn by firefighters.

Kevlar is made by condensation polymerisation from two different monomers shown in Fig. 11.2. It forms linkages similar to nylon.

Fig. 11.2

(i) Define condensation polymerisation. [2]

(ii) Draw the structural formula of the repeat unit of Kevlar. [2]

[Total: 10]

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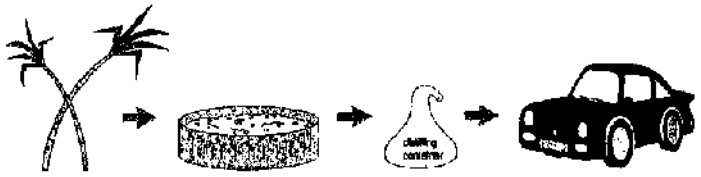
11 **OR**

Read the following article and answer the questions.

Production of ethanol fuel

In Brazil, the ethanol is produced from sugar cane. The sugar cane grows quickly and so can be replaced quickly. The sugar is extracted as a juice by crushing the sugar cane with rollers. The fibrous part of the cane is dried and used as a fuel to provide heat for the fractional distillation stage.

After filtering, the juice is allowed to ferment to make a dilute solution of ethanol. This is then distilled to obtain the alcohol which is used as the fuel. Nowadays, about 90% of all new cars solid in Brazil use ethanol as a fuel.



sugar cane | sugar is fermented | fermented mixture is fractionally distilled to give pure ethanol | ethanol used a fuel

(a) Describe how fermentation is carried out in the laboratory. [2]

(b) Explain why the fermentation reaction only takes place within a narrow temperature range. [1]

(c) Brazil has very little crude oil but has plenty of land suitable for growing sugar cane. Give two advantages of using ethanol as a fuel for cars in Brazil. [2]

(d) In order to get more land, some of the Amazon jungle must be cut down. Suggest two problems this will cause. [2]

(e) Ethanol produced by this process becomes sour when exposed to air for a few days. Briefly explain how the ethanol solution becomes sour. [2]

(f) Name another method used to produce ethanol on a large scale. [1]

[Total:10]

END OF PAPER

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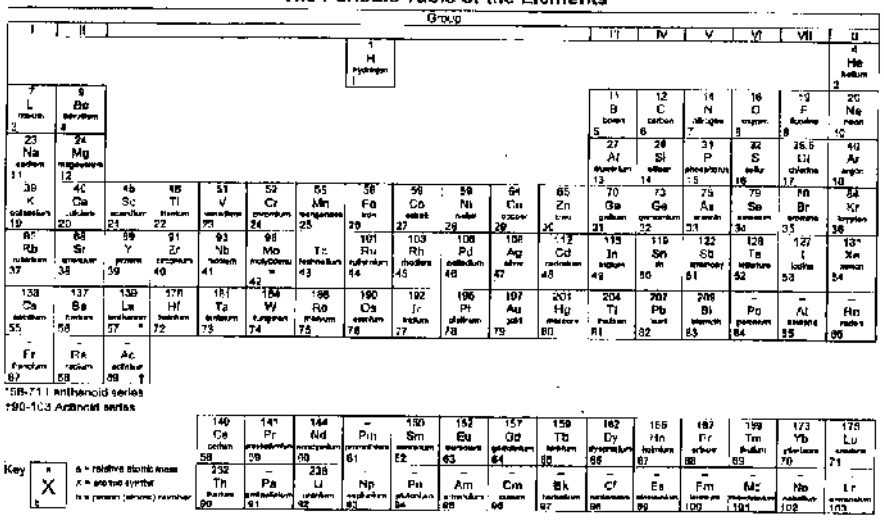
The Periodic Table of the Elements



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PRESBYTERIAN HIGH SCHOOL

SCIENCE DEPARTMENT

Subject: Chemistry **Exam: Prelim**
Level: 4 Express **Year: 2016**
Setter: Miss Cynthia Lim

MARKING SCHEME

Section A (50 marks)

Qn	Scoring Points	Sub-total	Total
1a	Carbon-14 atom has 2 more neutrons than carbon12 atom	1	
b	80/100 x 12 + 20/100 x 14 = 12.4	1 1	3
2a	Argon; Small amount of energy is required to overcome the weak (Van der Waals) forces holding the discrete atoms together Accept: monatomic atom	1 1	8
b	silicon; large amount of energy is required to overcome the strong and numerous covalent bonds between atoms in a giant covalent structure	1 1	
c(i)	correct number of electrons; correct charges	1 1	
(ii)	in solid state, ions are held in fixed positions, thus not mobile; in molten or aqueous state, the ions are mobile to act as electrical carriers	1 1	
3a	$3NaClO \rightarrow NaClO_3 + NaCl$	1	
b	NaClO is reduced as oxidation state of Cl decreases from +1 in NaClO to -1 in NaCl; NaClO is oxidised as oxidation state of Cl increases from +1 in NaClO to +5 in $NaClO_3$	1 1	6
c	Oxygen gas has a smaller molecular mass (M_r = 32) than chlorine gas (M_r = 71); thus diffuses faster OR chlorine gas is very soluble in water; oxygen gas is less soluble in water	1 1	
4a(i)	Catalyst; Provides an alternative pathway of lower activation energy	1 1	
(ii)	Enthalpy change: single arrow pointing from energy level of reactants down to energy level of products Activation energy: singe arrow pointing from energy level of reactants up to peak of curve	1	11

(iii)	Energy absorbed in bond breaking = + (600 + 4 x 410 + 440) = + 2680 kJ Energy released in bond forming = - (350 + 6 x 410) = - 2810 kJ 1 mark awarded for energy absorbed and energy released Enthalpy change = +2680 + (-2810) = -130 kJ ecf for working	1 1	
(iv)	exothermic; more energy released in forming C-C and C-H bonds in ethane; than energy absorbed in breaking C=C and C-H bonds in ethene and H-H bonds in H_2 ecf	1 1	
b(i)	reddish brown aqueous bromine decolourises / turns colourless rapidly; contains carbon-carbon double bonds (C=C)	1 1	
(ii)	more dense, saturated vegetable oils have more hydrogen atoms, thus having a larger molecular mass	1	
(iii)	not advisable, margarine will be too hard	1	
5a	4%	1	
b(i)	Contains atoms of different sizes / copper atoms are of different size; Disrupt orderly layered arrangement of aluminium atoms; Layers of aluminium atoms unable to slide over one another when a force is applied	1 1 1	9
(ii)	Aluminium is more reactive than copper, thus corrode in place of copper	1	
(iii)	Aluminium coated with a layer of non-porous aluminium oxide; Prevents aluminium to come in contact with oxygen from air	1 1	
c	Electrolysis is used to extract aluminium from its molten compound, more expensive as used a lot of electricity; Copper extracted using reduction of its oxide with carbon, carbon is cheaper	1 1	
6a(i)	Cathode: Sr^{2+} (l) + 2e- → Sr (l) Anode: 2Br (l) → Br_2 (g) + 2e-	1 1	
(ii)	Strontium is too reactive to be discharged at the cathode, instead H^+ ions are selectively discharged to form hydrogen gas	1	7
b(i)	S; Silver is deposited since 1 mol of silver is 108 g	1 1	

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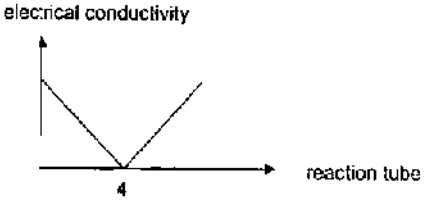
(ii)	Copper anode dissolves to form Cu^{2+} ions; Oxygen gas is produced at platinum electrode since Pt is inert	1 1	
7a	Correct structure	1	
b	$C_4H_{10} \rightarrow 2C_2H_4 + H_2$ OR $C_4H_{10} \rightarrow C_4H_8 + H_2$	1	4
c	Biodegradable. renewable	1 1	
8a	Sulfuric acid; Dibasic acid as it dissociates to form 2 mol of H^+ per acid molecule as compared to HCl that dissociates to form 1 mol of H^+ per acid molecule	1 1	3
b	Ethanoic acid is a weak acid that partially dissociates / ionizes to produce fewer H^+ ions	1	
	Section B (30 marks)		
9a	51 + 10 = 61%	1	
b	Percentage of platinum used as catalytic converter will decrease; Using platinum will incur high cost as platinum is an expensive metal	1	
c	High melting point; corrosion resistant	1	
d	Forms coloured compounds; High melting point; variable oxidation states (any 2)	2	12
e	Group I; Has one valence electron / has one outer shell electron (refer to electronic configuration)	1 1	
f(i)	$PtCl_4 \rightarrow PtCl_2 + Cl_2$ OR $PtCl_4 \rightarrow Pt + 2Cl_2$	1	
(ii)	Below copper; Does not react with acids just like copper;	1 1	
g	Reject: low in reactivity series; does not react with air or water and is not affected by common acids even at high temperature Highest in demand: palladium; Highest amount produced though not highest amount left in earth crust; Lowest in demand: rhodium; Lowest amount in earth crust thus lowest amount produced	1 1	
10a	$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$	1	
b	Tube 1: Yellow [alkaline – excess $Ba(OH)_2$]	1	
c(i)	4.0 cm	1	8

(ii)	The height of precipitate has become constant after reaction tube 4. This shows that reaction is complete/all the hydroxide ions are used up/ barium hydroxide is the limiting reagent	1	
d		1	
e(i)	Rinse residue with distilled water	1	
(ii)	After filtration, besides aqueous sodium nitrate, the filtrate may contain unreacted aqueous barium nitrate and aqueous sodium sulfate. Hence, the crystal formed may not be pure sodium nitrate.	1	
(iii)	titration	1	
11	**EITHER**		
a	Alkene and ester	1	
b	Addition polymerisation	1	
c	correct repeating unit	1	10
d(i)	1 mark each for one correct structure	2	
(ii)	Correct structure of acid chloride	1	
e(i)	Process by which many monomer molecules join together to form a macromolecule; with elimination of small molecules like water	1 1	
(ii)	Shows amide linkage; Overall correct structure showing continual chain	1 1	
	OR		
a	yeast is added to sugar/glucose solution; in the absence of oxygen and at 37°C	1 1	
b	enzyme produced by yeast will be denatured under too high temperature or the yeast is sensitive to temperature changes.	1	10
c	Ethanol is a cleaner fuel as compared to petrol when burnt; Ethanol is a renewable resource	1 1	
d	Global warming; Extinction of animals	1 1	

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e	ethanol is oxidized by oxygen in the air in the presence of bacteria; to become ethanoic acid which is sour.	1 1	
f	addition of steam to ethene / hydration of ethene	1	

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Candidate Name: _____

Class:	
Index No:	

Chong Boon Secondary School

Preliminary Examination 2016
Secondary 4 Express
Chemistry

Paper 1 **5073**

31 August 2016 (Wednesday)	1 hour

Additional Materials : Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Do not open this booklet 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 and index number 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 instructions on the Answer Sheet very carefully.

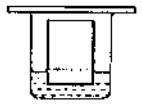
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 20.
The use of an approved scientific calculator is expected, where appropriate.

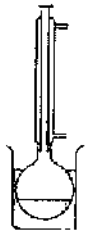
The total mark for this paper is 40.

For Examiner's Use
40

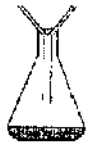
1 Chloroform is an organic liquid that is used as an industrial solvent in dry-cleaning. It does not mix with water.

Which apparatus can be used to separate a mixture of chloroform and water?

A 

B 

C 

D 

2 Sodium nitrate can be separated from chalk using four processes below.

Which of the following shows the **correct** order in which the processes should be used?

A dissolving, evaporation, crystallisation, filtration

B dissolving, filtration, evaporation, crystallisation

C filtration, crystallisation, evaporation, dissolving

D filtration, evaporation, crystallisation, dissolving

3 Four balloons are each filled with a different gas and left under room temperature for several days. The four gases used to fill the balloons are carbon monoxide, helium, hydrogen and nitrogen.

Which balloon will deflate the fastest?

A balloon with carbon monoxide

B balloon with helium

C balloon with hydrogen

D balloon with nitrogen

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4 The melting points of four pure substances, W, X, Y and Z, are given below.

substance	melting point / °C
W	80
X	82
Y	85
Z	89

An impure sample of an unknown solid melts over a temperature range of 83 °C to 88 °C.

From the given information, we can infer that the unknown solid is most likely to be

A W.

B X.

C Y.

D Z.

5 An element K has a nucleon number of 45. The ion, K^{3+}, contains 18 electrons.

How many neutrons are there in an atom of K?

A 18

B 21

C 24

D 45

6 The structure of metals consists of positive ions in a 'sea of mobile electrons'.

Which statement correctly describes what happens to the particles in the metallic heating element of an electric kettle when the kettle is switched on?

A Electrons move in both directions in the heating element.

B Electrons move in one direction and the positive ions move in the opposite direction in the heating element.

C Electrons move in one direction only in the heating element.

D Positive ions move in one direction only in the heating element.

7 Which statement describes the arrangement of particles of sodium hydroxide in water?

A Ions are widely spaced and they move randomly.

B Ions are widely spaced but they do not move.

C Molecules are closely packed and they move randomly.

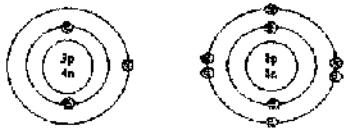
D Molecules are widely spaced and they move randomly.

8 The table shows some properties of diamond and graphite.

Which of the following gives the correct reason for the property?

	property	reason
A	diamond cuts glass	the bonds in glass are stronger than those in diamond
B	diamond is a hard substance	there are many ionic bonds in diamond
C	graphite is a lubricant	there are weak bonds between graphite layers
D	graphite conducts electricity	graphite contains mobile ions

9 The diagrams show the structures of two atoms of the elements L and M respectively.



L M

What is the mass of 1 mole of the compound formed by L and M?

A 11 g

B 12 g

C 23 g

D 30 g

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10 Naphthalene is the main ingredient of mothballs. It contains 93.75% of carbon and 6.25% of hydrogen.

If the relative molecular mass of naphthalene is 128, what is its molecular formula?

A CH

B C_5H_4

C $C_{10}H_8$

D $C_{10}H_{10}$

11 0.20 moles of an element E was combined with an excess of element F and produced 15.6 g of a compound EF_2.

What could be the electronic configurations of E and F?

	E	F
A	2,2	2,8,7
B	2,4	2,8,6
C	2,8,1	2,8,6
D	2,8,8,2	2,7

12 Hydrogen sulfide burns in an excess of oxygen according to the equation below.

$$2H_2S(g) + 3O_2(g) \rightarrow 2H_2O(g) + 2SO_2(g)$$

What is the volume of gases produced if 18 dm^3 of hydrogen sulfide are burnt completely in an excess of oxygen at room temperature and pressure?

A 18 dm^3

B 24 dm^3

C 36 dm^3

D 48 dm^3

13 When 25.0 cm^3 of sodium hydroxide is added to 50.0 cm^3 of sulfuric acid, neutralisation occurs.

Which of the following statements is true?

A Sodium hydroxide is four times as concentrated as sulfuric acid.

B Sodium hydroxide is of the same concentration as sulfuric acid.

C Sodium hydroxide is twice as concentrated as sulfuric acid.

D Sulfuric acid is twice as concentrated as sodium hydroxide.

14 A pure hydrocarbon is used in bottled gas and heating.

When 10 cm^3 of the hydrocarbon is burned in 70 cm^3 of oxygen, the final gaseous mixture contains 30 cm^3 of carbon dioxide and 20 cm^3 of unreacted oxygen. All gaseous volumes are measured under identical conditions.

What is the chemical formula of the hydrocarbon?

A C_2H_6

B C_3H_8

C C_3H_6

D C_4H_{10}

15 Which of the following statements about oxides is true?

A Carbon monoxide will react with aqueous sodium hydroxide to form a salt and water.

B Copper(II) oxide will react with dilute sulfuric acid to give a blue solution.

C Nitrogen dioxide is a neutral oxide.

D Zinc oxide dissolves readily in water to form an alkaline solution.

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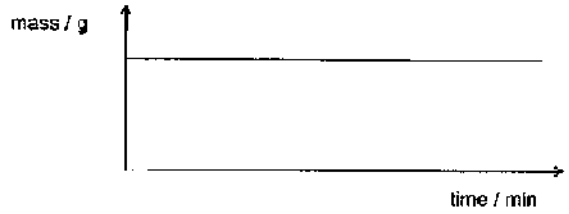
16 Two substances are reacted in a conical flask placed on an electronic balance.
The mass of the conical flask and its contents are recorded at regular intervals and the results are shown in the graph below.



Which of the following could be the two substances?

A aqueous sodium hydroxide and aqueous ammonium nitrate

B aqueous silver nitrate and dilute hydrochloric acid

C calcium carbonate and dilute sulfuric acid

D dilute nitric acid and magnesium

17 When a student mixed two solutions he recorded the following observations:

'no effervescence, solution changes colour, no precipitate forms'

The student must have mixed

A dilute nitric acid and lead(II) carbonate.

B sodium hydroxide solution and dilute sulfuric acid.

C potassium chloride solution and silver nitrate solution.

D warmed dilute hydrochloric acid and iron(II) oxide.

18 Some information on three indicators is given below.

indicator	colour in strongly acidic solution	pH at which colour changes	colour in strongly alkaline solution
bromocreosol green	yellow	4.8	blue
methyl red	red	5.2	yellow
thymolphthalein	colourless	9.9	blue

What is the colour seen when each indicator is added to pure water?

	bromocreosol green	methyl red	thymolphthalein
A	blue	red	colourless
B	blue	yellow	blue
C	blue	yellow	colourless
D	yellow	red	blue

19 Separate samples of hydrogen peroxide are added to aqueous potassium iodide and to acidified potassium manganate(VII). The iodide ions are oxidised and the manganate(VII) ions are reduced.

What are the colour changes seen?

	potassium iodide	acidified potassium manganate(VII)
A	brown to colourless	orange to green
B	brown to colourless	purple to colourless
C	colourless to brown	orange to green
D	colourless to brown	purple to colourless

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20 Which of the following shows the electronic configuration of a strong reducing agent?

A 2, 1

B 2, 8

C 2, 8, 6

D 2, 8, 7

21 Jarosite has the molecular formula $KFe_3(OH)_6(SO_4)_2$.

What is the oxidation state of iron in the mineral?

A +2

B -2

C +3

D -3

22 Excess zinc is added into a solution containing magnesium nitrate and copper(II) chloride. After the reaction, the mixture is filtered.

Which of the following cations would be present in the filtrate?

A Cu^{2+}, Mg^{2+}

B Cu^{2-}, Zn^{2+}

C Mg^{2+}, Zn^{2+}

D Mg^{2+}, Zn^{2+}, Cu^{2-}

23 Which reaction in the blast furnace is an acid-base reaction?

A $C + CO_2 \rightarrow 2CO$

B $C + O_2 \rightarrow CO_2$

C $CaO + SiO_2 \rightarrow CaSiO_3$

D $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

24 Which of the following combinations of type of electrode used, electrolyte and products at the electrode is correct?

	type of electrode	electrolyte	product at the anode	product at the cathode
A	carbon	concentrated hydrochloric acid	chlorine	hydrogen
B	carbon	aqueous sulfuric acid	sulfur	hydrogen
C	copper	aqueous copper(II) sulfate	oxygen	copper
D	platinum	aqueous copper(II) sulfate	hydrogen	copper

25 During the electrolysis of an aqueous solution of a cerium salt, 70 g of cerium is deposited at the cathode by 2 moles of electrons.

What is the formula of the cerium ion?
(A$_r$ of Ce = 140)

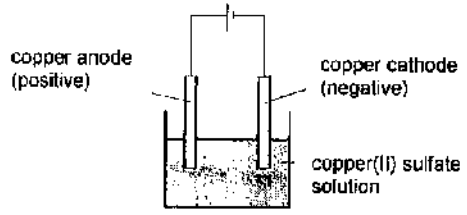
A Ce^{+}

B Ce^{2+}

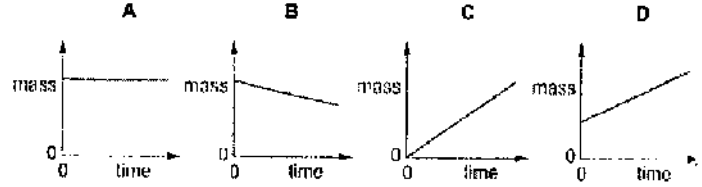
C Ce^{3+}

D Ce^{4-}

26 The diagram shows the electrolysis of aqueous copper(II) sulfate using copper electrodes.



Which graph shows how the mass of the cathode changes during electrolysis?



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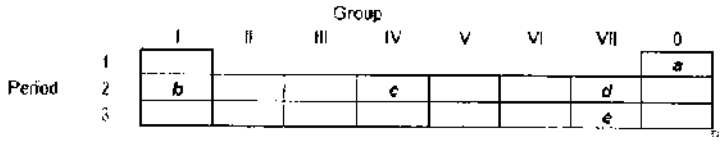
27 A part of the Periodic Table is shown below.



Which of the following statements is correct?

A **c** forms an ionic compound with **d**.

B **e** is a strong oxidising agent.

C The metallic character of the Period 2 elements increases from **b** to **d**.

D The outermost electron shell of an atom **a** is an octet structure.

28 Which of the following changes in the properties of the halogens is **not** correct?

	chlorine → bromine → iodine
A	darker in colour
B	decrease in melting point
C	decrease in rate of diffusion
D	increase in density

29 Rubidium, Rb, is an element in the same group of the Periodic Table as lithium, sodium and potassium.

Which statement about rubidium is correct?

A It can be cut easily.

B It can be produced during the electrolysis of aqueous rubidium chloride.

C It forms an insoluble hydroxide.

D It reacts slowly with water at room temperature.

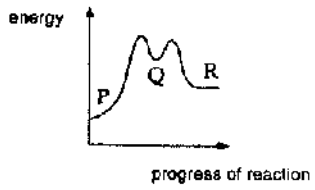
30 In the conversion of compound **P** into compound **R**, it was found that the reaction proceeded by forming compound **Q**, which could be isolated, as an intermediate.
The steps involved are:

P → **Q** ΔH = negative

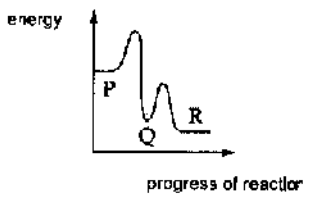
Q → **R** ΔH = positive

Which of the following energy diagrams represents the conversion of compound **P** into compound **R**?

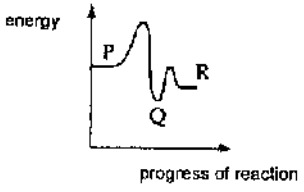
A



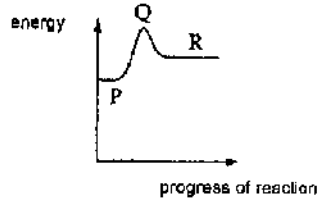
B



C



D



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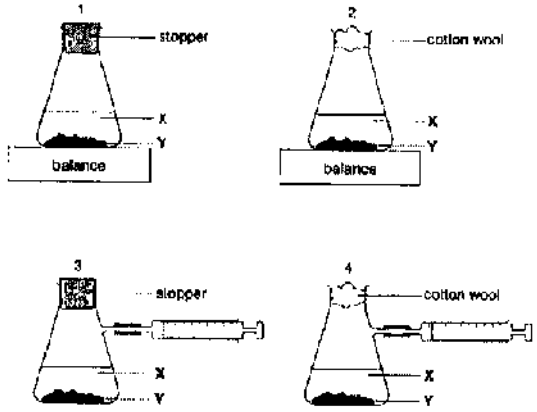
31 A liquid **X** reacts with solid **Y** to form a gas.

Which two diagrams show suitable methods for investigating the speed of the reaction?



A 1 and 3

B 1 and 4

C 2 and 3

D 2 and 4

32 A reaction takes place in two stages:

Stage 1
$S_2O_8^{2-}(aq) + 2I^-(aq) + 2Fe^{2+}(aq) \rightarrow 2SO_4^{2-}(aq) + 2I(aq) + 2Fe^{3+}(aq)$

Stage 2
$2SO_4^{2-}(aq) + 2I^-(aq) + 2Fe^{3+}(aq) \rightarrow 2SO_4^{2-}(aq) + I_2(aq) + 2Fe^{2+}(aq)$

Which ion is the catalyst in the reaction?

A $Fe^{2+}(aq)$

B $I^-(aq)$

C $SO_4^{2-}(aq)$

D $S_2O_8^{2-}(aq)$

33 Sulfur dioxide and carbon dioxide are gases which affect the atmosphere and the environment.

In what way do these gases affect the environment?

	sulfur dioxide	carbon dioxide
A	acid rain	depletion of ozone layer
B	acid rain	global warming
C	global warming	depletion of ozone layer
D	global warming	acid rain

34 The following statements concern the fuel cell

I. Hydrogen reacts with oxygen to generate electricity.
II. The hydrogen is obtained from fractional distillation of air.
III. The reaction at the negative electrode is
$O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$

How many statement(s) is/are correct?

A All three statements are correct.

B None of the statements is correct.

C Only one statement is correct.

D Two statements are correct.

35 Propanal CH_3CH_2CHO is a member of a homologous series called the alkanals.

From the chemical formula of propanal, we can conclude that the general formula of alkanal is

A $C_nH_{2n}CHO$

B $C_nH_{3n}CO$

C $C_nH_{2n+1}CHO$

D $C_nH_{2n+1}CH_2OH$

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36 Which of the following compounds do not have any isomers?

A butane

B chloropropane

C propanol

D propene

37 Linolenic acid, $C_{18}H_{30}O_2$, is an unsaturated monocarboxylic acid found in sunflower oil.

Calculate the number of moles of hydrogen gas needed to completely convert 3 moles of linolenic acid to a saturated compound.

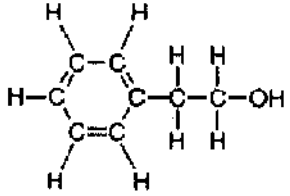
A 3

B 6

C 9

D 18

38 One substance responsible for the fragrance of roses is 2-phenylethanol.
The structure of the molecule is shown below.



Which statement about this molecule is incorrect?

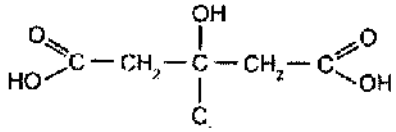
A It can be oxidised by acidified potassium manganate(VII) solution.

B It can decolourise aqueous bromine at room temperature.

C It can undergo condensation polymerisation to form a polyester.

D It is an unsaturated molecule.

39 The structure of citric acid is shown below.



How many moles of sodium hydroxide is needed to neutralise one mole of citric acid?

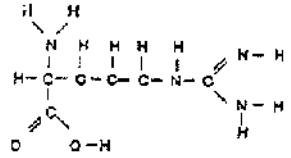
A 1

B 2

C 3

D 4

40 The structure of arginine, an amino acid, is shown below.



Which of the following statements about arginine is true?

A It forms a polymer with the same linkage as terylene.

B It forms an addition polymer with other arginine molecules.

C It only forms carbon dioxide and water when it undergoes combustion.

D It reacts with magnesium to form hydrogen gas.

End of Paper

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The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	64 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	– Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La lanthanum 57 *	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	– Po polonium 84	– At astatine 85	– Rn radon 86
– Fr francium 87	– Ra radium 88	– Ac actinium 89 †															

*58-71 Lanthanoid series
†90-103 Actinoid series

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	– Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	162 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	– Pa protactinium 91	238 U uranium 92	– Np neptunium 93	– Pu plutonium 94	– Am americium 95	– Cm curium 96	– Bk berkelium 97	– Cf californium 98	– Es einsteinium 99	– Fm fermium 100	– Md mendelevium 101	– No nobelium 102	– Lr lawrencium 103

Key: a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

The volume of one mole of any gas is 24 dm³ at room temperature and

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Candidate Name: _____

Class:	
Index No:	

Chong Boon Secondary School
Preliminary Examination 2016
Secondary 4 Express
Chemistry

Paper 2 **5073**

15 September 2016 (Thursday) | **1 hour 45 minutes**

Additional Materials : NIL

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write your name, class and index number on the cover sheet.
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 either/or.
Answer all questions in the spaces provided.

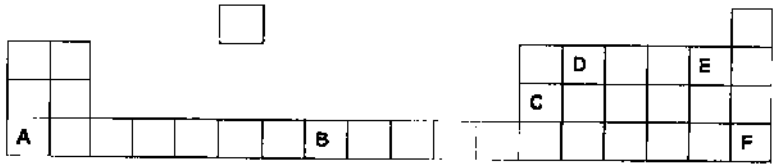
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 24.
The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use
80

Section A

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

A1 The position of six elements in the first four periods of the Periodic Table, represented by letters, **A**, **B**, **C**, **D**, **E** and **F** are shown below.



Select from the letters, **A** to **F**, the element that best fit the following characteristics.
The elements, **A** to **F**, can be used once, more than once or not at all.

(a) A monatomic element.

.....[1]

(b) An element which is the strongest oxidising agent.

.....[1]

(c) An element which can be used as a catalyst in chemical reactions.

.....[1]

(d) An element which forms an oxide that reacts with both an acid and a base.

.....[1]

(e) An element that reacts with **E** to form a compound which has a high melting point.

.....[1]

(f) An element which forms coloured compounds.

.....[1]

[Total: 6]

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A2 Between the 13th and the 19th Century, artists used a green pigment called Verdigris. They made the pigment by hanging copper foil over boiling vinegar, an aqueous solution of ethanoic acid.

(a) During the preparation of Verdigris, copper atoms, oxygen molecules and hydrogen ions combine to form copper(II) ions and water.
Write the ionic equation, with state symbols, for this reaction.

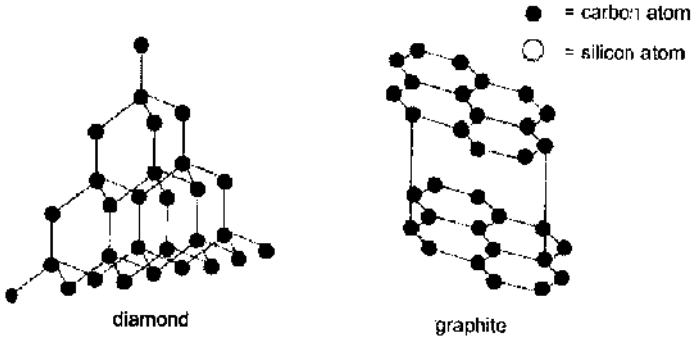
.....[2]

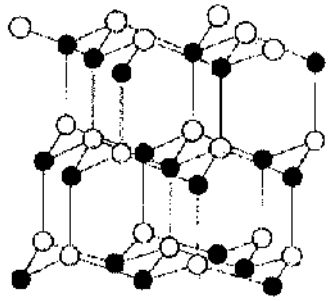
(b) Verdigris has the formula $[Cu(CH_3CO_2)_2]_2.Cu(OH)_2.xH_2O$.
It has a relative formula mass of 552.
Calculate the value of **x** in the formula.

[2]

[Total: 4]

A3 The structures of diamond, graphite and silicon carbide are shown below.





silicon carbide

(a) Suggest the formula for diamond, graphite and silicon carbide.

.....

.....[2]

(b) Expain why graphite conducts electricity but silicon carbide does not.

.....

.....

.....

.....[2]

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A3 (c) Silicon carbide has a very high melting point.

Explain in terms of structure and bonding, why silicon carbide has a very high melting point.

.....

.....

.....

.....[2]

(d) When a 1.20 g sample of **graphite** is completely burnt in oxygen, 4.40 g of carbon dioxide are produced.
What mass of carbon dioxide is made when a 1.20 g sample of **diamond** is completely burnt in oxygen?

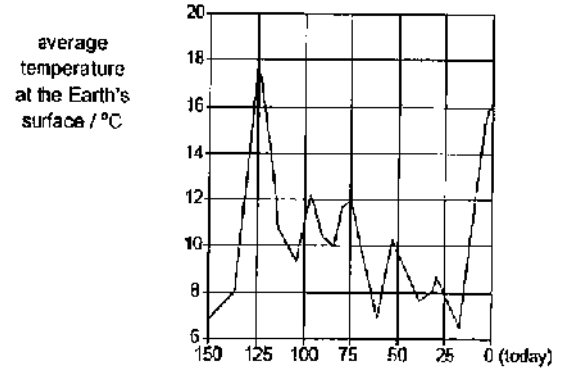
[1]

[Total: 7]

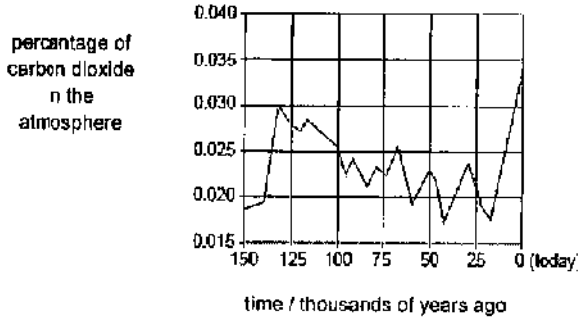
A4 Graph 1 shows how the average temperature of the Earth's surface may have changed over the last 150 thousand years.

Graph 2 shows how the percentage of carbon dioxide in the atmosphere may have changed over the last 150 thousand years.

Graph 1



Graph 2



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A4 **(a)** Carbon dioxide is a greenhouse gas. Scientists think that an increase in the greenhouse gases will result in global warming.

(i) Explain how graphs 1 and 2 support this statement.

.....

.....[1]

(ii) Describe **two** consequences of global warming.

.....

.....

.....

.....[2]

(iii) Draw a 'dot and cross' diagram for carbon dioxide. Show the outer electrons only.

[2]

(b) Chlorofluorocarbons, CFCs, are also greenhouse gases.
Describe how the presence of CFCs in the upper atmosphere increases the amount of ultra-violet light reaching the Earth's surface.

.....

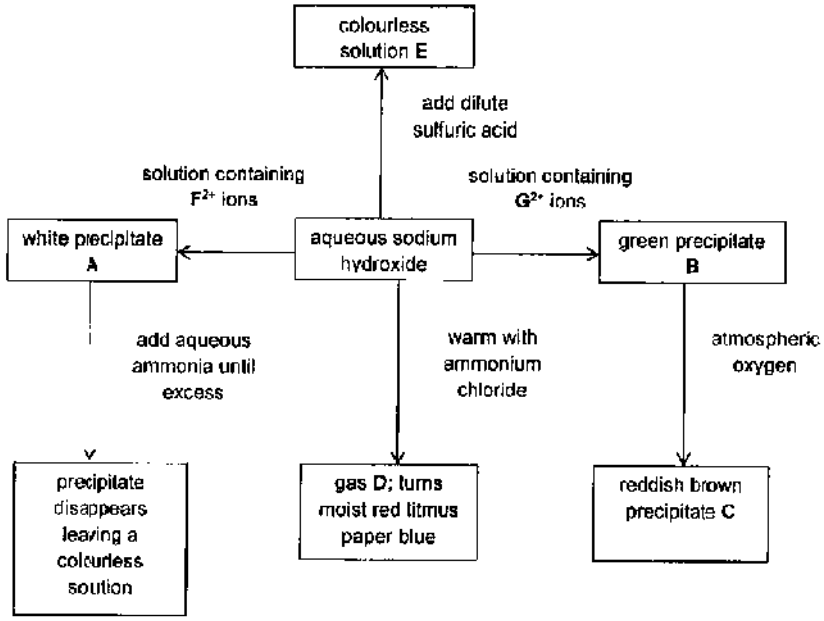
.....

.....

.....[2]

[Total: 7]

A5 The diagram shows some of the properties and reactions of the substances **A**, **B**, **C**, **D** and **E** and ions F^{2+} and G^{2+}.



(a) Suggest identities for the substances **A**, **B**, **C**, **D** and **E** and ions F^{2+} and G^{2+}.

A .....

B .....

C .....

D .....

E .....

F^{2+} .....

G^{2+} .....

[7]

(b) Write a chemical equation for the reaction between aqueous sodium hydroxide and ammonium chloride.

.....[1]

[Total: 8]

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A6 (a) Zinc alloys are widely used in making aircraft parts and racing car engines.

The table shows some incomplete information about a zinc alloy that contains the elements, zinc, magnesium and zirconium.

element	moles in 400 g of alloy / mol	mass of 400 g of alloy / g
magnesium	0.22	5.28
zinc		
zirconium (Period 5 element)	0.044	

(i) Using the information provided, complete the table.

Show your working below.

[2]

(ii) Explain why the zinc alloy is stronger than the pure metal.

.....

.....

.....

.....

.....[2]

A6 (b) A student investigates the temperature changes when three metals, P, Q and R were added to zinc sulfate solution.

0.40 g of each metal was added to a test tube containing zinc sulfate solution and the maximum temperature of the mixture was measured and recorded.

The table shows the results obtained by the student.

metal	initial temperature / °C	maximum temperature / °C
P	29.0	29.0
Q	30.0	33.5
R	28.5	34.5

The student concludes that the order of reactivity of the metals is as follows:

most reactive **Q** **R** **P** zinc → least reactive

Do you agree with the student's conclusion? Explain your reasoning.

.....

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.....

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.....

.....

.....[3]

[Total: 7]

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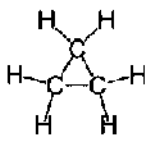
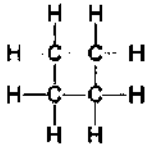
A7 The structures of cyclopropane and cyclobutane are the first two members of the homologous series cycloalkanes.
The prefix 'cyclo' refers to the close rings of carbon atoms.



cyclopropane



cyclobutane

(a) Members of a homologous series have a general formula.

(i) Deduce the general formula for the cycloalkanes.

.....[1]

(ii) State one difference in physical property between cyclopropane and cyclobutane.

.....

.....[1]

(b) In the presence of ultraviolet light, cyclopropane reacts with chlorine gas.

Give the full structural formula of two of the organic products formed when cyclopropane reacts with chlorine gas in the presence of ultraviolet light.

[2]

A7 (c) Draw the full structural formula of an isomer of cyclopropane.

[1]

[Total: 5]

A8 The table below shows the colours of manganese in different oxidation states.

ion	colour	oxidation state of manganese
MnO_4^-	purple	
Mn^{2+}	pink	+2
MnO_4^{2-}	green	
MnO_2	black	

(a) Fill in the missing oxidation state of manganese in the table. [1]

(b) When solid manganese(II) nitrate, $Mn(NO_3)_2$, is heated, the products are solid manganese(IV) oxide, MnO_2, and a brown gas, NO_2.

(i) Write a balanced chemical equation, including state symbols, for the reaction.

.....[2]

(ii) State the observations when manganese(II) nitrate is heated

.....

.....[1]

(iii) Using the change in oxidation state, explain whether manganese in manganese(II) nitrate is oxidised or reduced.

.....

.....

.....[2]
[Total: 6]

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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.

B9 The information below is about the extraction of zinc.

The method of extraction of zinc has changed as different ores containing the element has been discovered and as technology has improved.

Extraction Process 1

In the earliest process, calamine (impure zinc carbonate) was heated with charcoal in earthenware pots. This two-stage process gives a low yield of zinc.

$$ZnCO_3(s) \rightarrow ZnO(s) + CO_2(g)$$

$$ZnO(s) + C(s) \rightarrow Zn(s) + CO(g)$$

Extraction Process 2

A new two-stage process was developed using zinc sulfide ores. All of the waste gases from this process were released into the atmosphere.

$$2ZnS(s) + 3O_2(g) \rightarrow 2ZnO(s) + 2SO_2(g)$$

$$ZnO(s) + C(s0 \rightarrow Zn(s) + CO(g)$$

Extraction Process 3

This uses the electrolysis of aqueous solutions of aqueous solutions of very pure zinc sulfate. The first step in this process is the same as the first step in Extraction Process 2. The second step uses sulfuric acid made from the SO_2 collected in the first step. The third step involves the electrolysis of zinc sulfate solution, using reactive electrodes, to form pure zinc.

$$2ZnS(s) + 3O_2(g) \rightarrow 2ZnO(s) + 2SO_2(g)$$

$$ZnO(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2O(g)$$

$$ZnSO_4(aq) \rightarrow Zn(s)$$

B9 **(a)** A student made the following comment on the extraction of zinc:

"Extraction Process 1 is better than Extraction Process 2 because it produces a higher yield of pure zinc".

Assuming that 1 kg of zinc carbonate and zinc sulfide has been used in Extraction Process 1 and Extraction Process 2, explain, using chemical calculations, whether the student's comment is correct.

.....

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.....[2]

(b) Suggest, with reasons, which of the three extraction processes is the most environmentally friendly. You should consider the effects of the products of the extraction processes on man and the environment.

.....

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.....[2]

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B9 (c) Zinc sulfate solution is electrolysed in Extraction Process 3.

(i) Write an ionic half-equation for the reaction occurring at the anode.

.....[1]

(ii) A factory replaced zinc sulfate solution with molten zinc chloride.
Explain why this is done, giving your reasoning with relevant ionic half-equation.

.....

.....

.....

.....

.....[2]

(iii) Suggest why molten zinc chloride may not be a good choice to replace aqueous zinc sulfate solution.

.....

.....[1]

(d) Zinc metal has a high melting point and thus, it exists as a solid at room temperature and pressure.
With the aid of a diagram to show the bonding in zinc, explain why zinc has a very high melting point.

.....

.....

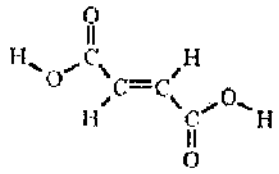
.....

.....

.....

.....[3]
[Total: 11]

B10 Furamic acid is a colourless solid used in food and beverages to provide a fruity taste.
The structural formula of furamic acid is shown below.



The formula of furamic acid can be represented by $HO_2CCH=CHCO_2H$.

(a) A solution of furamic acid reacts with aqueous sodium hydroxide.
Using the formula, write a balanced chemical equation for the reaction between furamic acid and aqueous sodium hydroxide.

.....[1]

(b) On complete combustion, furamic acid forms two products.
Write the balanced chemical equation for the combustion of furamic acid.

.....[1]

(c) (i) Describe what is observed when aqueous bromine is added to a solution of furamic acid.

.....

.....[1]

(ii) Draw the full structural formula of the product formed in (c) (i).

[1]

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B10 **(d)** Furamic acid can undergo addition polymerisation.

(i) Explain what is meant by the term *addition polymerisation*.

.....

.....[1]

(ii) Draw the full structural formula of the repeating unit of the polymer formed.

[1]

(iii) A sample of the polymer was analysed and found to have an average relative molecular mass of 11600.
How many carbon atoms are present in an average chain?

[2]

(iv) Polymers are widely used today.
State one problem caused by the disposal of polymers.

.....

.....[1]

[Total: 9]

EITHER

B11 Hydrogen-oxygen fuel cells are used to generate electricity.
The overall reaction in a hydrogen-oxygen fuel cell is shown below.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

The reaction is *exothermic*.

(a) Explain the meaning of the term *exothermic*.

.....

.....[1]

(b) Explain, in terms of the energy changes associated with bond breaking and bond forming, why the reaction is exothermic.

.....

.....

.....

.....[2]

(c) A hydrogen-oxygen fuel cell uses 1500 dm^3 of hydrogen measured at room temperature and pressure.
Calculate the volume of oxygen, measured at room temperature and pressure, used by the fuel cell.
[one mole of any gas at room temperature and pressure occupies a volume of 24 dm^3.]

[2]

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B11 **(d)** The electrode reactions in an oxygen-hydrogen fuel cell are shown below.

Equation 1 $O_2(g) + 2H_2O(l) + 4e \rightarrow 4OH^-(aq)$

Equation 2 $H_2(g) + 2OH^-(aq) \rightarrow 2e^- + 2H_2O(l)$

Explain why the reaction in a fuel cell involves both oxidation and reduction.

.....

.....

.....

.....[2]

(e) State the common sources of hydrogen and oxygen for the fuel cell.

.....

.....[1]

(f) State one advantage and one disadvantage of using an oxygen-hydrogen fuel cell.

.....

.....

.....

.....[2]

[Total: 10]

OR

B11 **(e)** Ammonia is manufactured by the Haber process.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 \qquad \Delta H = -92.4 \text{ kJ/mol}$$

The table below shows how the percentage yield of ammonia at equilibrium varies with both temperature and pressure.

pressure / atm	% yield at 200 °C	% yield at 300 °C	% yield at 400 °C	% yield at 500 °C
40	72	34	13	5
100	81	51	25	10
200	86	63	36	18
300	88	69	40	24

(i) Describe how, and explain why, the percentage yield of ammonia at equilibrium changes with temperature.

.....

.....

.....

.....[2]

(ii) Describe how, and explain why, the percentage yield of ammonia at equilibrium changes with pressure.

.....

.....

.....

.....[2]

(iii) Explain how using a catalyst in the Haber process has an economic advantage.

.....

.....

.....

.....[2]

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B11 **(b)** Ammonia is used to manufacture nitric acid by a two-stage process.

Stage 1 Ammonia is converted to nitrous oxide.

$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g) \quad \Delta H = -92.4$ kJ/mol

Stage 2 Nitrous oxide is converted to nitric acid.

$4NO(g) + 2H_2O(g) + 3O_2(g) \rightarrow 4HNO_3(aq)$

(i) It is possible to find out whether the reaction in Stage 1 has completed by following the pH changes during the reaction.
Samples of gas are taken from the reaction vessel at intervals and bubbled through water to form a solution. The pH of each solution is measured.
Explain why the measured pH changes during the reaction.

.....

.....

.....

.....

.....

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.....

.....[3]

(ii) Use the equations in the two stages to construct an overall equation for the conversion of ammonia to nitric acid.

.....[1]

[Total : 10]

End of Paper

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The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	64 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	– Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La lanthanum 57 *	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	– Po polonium 84	– At astatine 85	– Rn radon 86
– Fr francium 87	– Ra radium 88	– Ac actinium 89 †															

*58-71 Lanthanoid series
†90-103 Actinoid series

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	– Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	162 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	176 Lu lutetium 71
232 Th thorium 90	– Pa protactinium 91	238 U uranium 92	– Np neptunium 93	– Pu plutonium 94	– Am americium 95	– Cm curium 96	– Bk berkelium 97	– Cf californium 98	– Es einsteinium 99	– Fm fermium 100	– Md mendelevium 101	– No nobelium 102	– Lr lawrencium 103

Key: a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

The volume of one mole of any gas is 24 dm³ at room temperature and

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PAPER 1 (40 marks)

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

PAPER 2

SECTION A: STRUCTURED QUESTIONS [50 MARKS]

Question		Marking Scheme	Marks	Total	Marker's comments
A1	(a)	F	1	6	
	(b)	E	1		
	(c)	B	1		
	(d)	C	1		
	(e)	A / B	1		
	(f)	B	1		
A2	(a)	$2Cu(s) + O_2(g) + 4H^+(aq) \rightarrow 2Cu^{2+}(aq) + 2H_2O(l)$ correct formulae of reactants and products [1] balanced and state symbols [1]	2	4	
	(b)	Mr of $[Cu(CH_3CO_2)_2]_2.Cu(OH)_2$ = 462 [1] $x = \frac{90}{18}$ = 5 [1]	2		
A3	(a)	Diamond : C Graphite . C Silicon carbide : SiC 1 mistake – minus 1 m	2	7	
	(b)	Graphite has free / delocalized / mobile electrons [1] Silicon carbide does not have free / delocalized / mobile electrons [1]	2		

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	(c)		SiC has many strong / covalent bonds. [1] A large amount of energy is required to break these bonds. [1]	2		
	(d)		4.40 g	1		
A4	(a)	(i)	Graphs show a trend that high percentage of CO_2 occurs with high temperatures.	1		
		(ii)	Melting of polar ice / rise in sea level / desertification / decrease in crop yields / extreme climate changes / rapid evaporation of water from Earth's surface causing the CO_2 dissolved in the oceans to be released into the atmosphere, adding to the greenhouse effect 1 m each answer any 2 answers	2	7	
		(iii)	 All dots only (1 m) No double bond (0)	2		
	(b)		In the presence of UV radiation, CFCs decompose to form chlorine atoms. [½] Chlorine atoms react with ozone molecules in the stratosphere to form chlorine oxide and oxygen, thus destroying the ozone layer. [1] Harmful UV radiation reaches the Earth through holes in the ozone layer. [½]	2		

A5	(a)		A = zinc hydroxide / $Zn(OH)_2$ B = iron(II) hydroxide / $Fe(OH)_2$ C = iron(III) hydroxide / $Fe(OH)_3$ D = ammonia / NH_3 E = sodium sulfate / Na_2SO_4 F^{2+} = Zn^{2+} / zinc ion G^{2+} = Fe^{2+} / iron(II) ion each answer 1 m	7	8	
	(b)		$NaOH + NH_4Cl \rightarrow NaCl + NH_3 + H_2O$	1		
A6	(a)	(i)	Mass of Zr = 0.044 x 91 = 4.00 g Mass of zinc = 400 – 5.28 – 4.00 = 390.72 g Moles of Zn = $\frac{390.72}{65}$ = 6.01 mol 1 mistake minus 1m	2	7	
		(ii)	In an alloy the atoms of the different metals have different sizes / regular arrangement of atoms in the pure metal is disrupted [1] Atoms of different sizes cannot slide over each other easily when a force is applied. [1] Hence, zinc alloy is stronger than the pure metal.	2		

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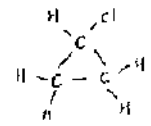
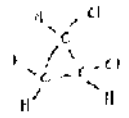
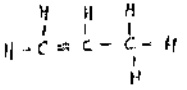
A6	(b)		Order of reactivity should be **R Q zinc P** R produces the highest temp rise; it should be the most reactive. [1] Q produced a larger temp rise than P but smaller than R; its reactivity should be between R and P. [1] P did not produce any temp rise / P did not displace zinc from its solution; P should be less reactive than zinc [1]	3		
A7	(a)	(i)	C_nH_{2n} n denotes the no. of carbon atoms n = 3,4,5,....	1	5	
		(ii)	bp and mp of cyclopropane is lower than cyclobutane / cyclopropane is less viscous than cyclobutane / cyclopropane is more flammable than cyclobutane (any answer)	1		
	(b)		 [1]  [1] or other chlorine substituted products	2		

A8	(c)			1		
	(a)		MnO_4^- +7 MnO_4^{2-} +6 MnO_2 +4 All correct	1		
	(b)	(i)	$Mn(NO_3)_2$ (s) → MnO_2 (s) + $2NO_2$ (g) Balanced equation [1] state symbols [1]	2	6	
		(ii)	Pink $Mn(NO_3)_2$ turns black (MnO_2) with brown gas (NO_2) evolved	1		
		(iii)	Mn in $Mn(NO_3)_2$ is oxidised,	1		
			as the oxidation state of manganese increased from +2 in $Mn(NO_3)_2$ to +4 in MnO_2.	1		
B9	(a)		Process 1 Moles of $ZnCO_3$ = $\frac{1000}{125}$ = 8.0 mol Mass of Zn = 8.0 x 65 = 520 g [1] Process 2 Moles of ZnS = $\frac{1000}{97}$ = 10.3 mol Mass of Zn = 10.3 x 65 = 669.5 g [1] Process 1 does not produce a higher yield than process 2.	2	11	

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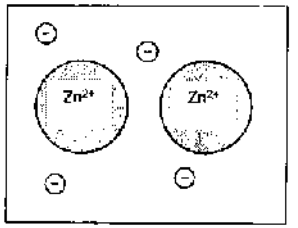
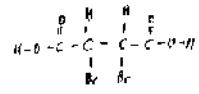
B9	(b)		Process 3. (with at least one reason) SO_2 is used to make sulfuric acid. [1] No CO is produced, unlike processes 1 and 2. CO causes headaches / fatigue /breathing difficulties / death / Reduces ability of haemoglobin to transport oxygen SO_2 from process 2 may irritate the eyes / lungs / Cause breathing difficulties / Inflammation of the lungs (bronchitis) / Reacts with water in the atmosphere to form acid rain, which corrodes buildings and harms aquatic life and plants Any answer [1] Do not accept : no air pollutant is released to the environment.	2		
	(c)	(i)	Anode: $4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e^-$	1		
		(ii)	When molten zinc chloride is used, Zn^{2+} is discharged to form molten zinc. [1] Cathode : $Zn^{2+}(l) + 2e^- \rightarrow Zn(l)$ [1]	2		
		(iii)	At the anode: $2Cl^-(l) \rightarrow Cl_2(g) + 2e^-$ The chlorine gas produced reacts with the carbon electrodes to form CCl_4 [1] <u>Or:</u> A high amount of energy is required to maintain the molten zinc chloride, increasing the cost of production of zinc. [1]	1		

B9	(d)		 [1] Orderly arrangement of zinc ions No. of delocalised electrons proportional to the charge of zinc Strong electrostatic attraction between the positively charged ions and negative electrons [1] large amount of energy needed to break the strong bonds [1]	3		
B10	(a)		$HO_2CCH{=}CHCO_2H + 2NaOH \rightarrow NaO_2CCH{=}CHCO_2Na + 2H_2O$	1		
	(b)		$C_4H_4O_4 + 3O_2 \rightarrow 4CO_2 + 2H_2O$	1		
	(c)	(i)	Reddish brown aqueous bromine is decolourised / turns colourless	1		
		(ii)		1		

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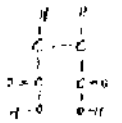
B10	(d)	(i)	Addition polymerization occurs when unsaturated monomers join together without losing any molecules or atoms.	1	
		(ii)		1	
		(iii)	M_r furamic acid = 116 No. of molecules = $\frac{11600}{116}$ = 100 [1] No. oc carbon atoms = 100 x 4 = 400 [1]	2	
		(iv)	Polymers are non-biodegradable and can cause a build-up of land waste / Produce poisonous gases when burnt / clog up rivers and drains (any answer)	1	

Either B11					10
	(a)		Reaction that releases heat / releases energy / energy given out is greater than energy absorbed / reaction mixture gets hot any answer [1]	1	
	(b)		Bond breaking takes in energy / is endothermic and bond forming releases energy / is exothermic [1] More energy is released from the formation of O-H bonds in H_2O than energy taken in from breaking H-H bond in H_2 and O=O bond in O_2. [1]	2	
	(c)		Vol of O_2 = $\frac{1500}{2}$ [1] = 750 dm^3 [1]	2	
	(d)		First equation involves reduction since electrons are gained / oxygen is reduced because it gains electrons / oxygen is reduced because its oxidation number decreases from 0 in O_2 to -2 in OH^-. [1] Second equation involves oxidation since electrons are lost / hydrogen is oxidised because it loses electrons / hydrogen is oxidised because its oxidation number increases from 0 in H_2 to +1 in H_2O. [1]	2	
	(e)		Cracking of large alkane molecules Electrolysis of water / Reaction between alkanes and steam any answer	1	

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B11	(f)		Advantage – directly converts chemical energy into electrical energy / more energy efficient / makes no pollutants / doesn't release harmful gases / uses a renewable resource [1] Disadvantage – storage problems associated with hydrogen or oxygen / hydrogen explosive / pressurised tanks needed / pollution problems on disposal of fuel cell / pollution problems while manufacturing fuel cells [1]	2		

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OR B11						
	(a)	**(i**	The percentage yield of ammonia decreases with increasing temperature. **[1]** Forward reaction is exothermic / Increasing temperature favours backward reaction. [1]	2	10	
		(ii	Percentage of ammonia at equilibrium increases with increasing pressure. [1] Increasing pressure favours the forward reaction **[1]**	2		
		(iii)	Catalyst speeds up the reaction / lowers activation energy. **[1]** Shortens the production or manufacturing time / Lowers energy costs / less energy is used **[1]**	2		
	(b)	**(i)**	Ammonia is an alkaline gas, while oxygen, nitrogen monoxide and water vapour are neutral gases. [1] ammonia gas is gradually used up and as the products are neutral, the pH decreases. [1] When pH value remains constant at 7, it indicates that ammonia gas is used up completely for reaction and left with all the neutral gases. [1]	3		
		(ii)	$NH_3 + 2O_2 \rightarrow HNO_3 + H_2O$	1		

中正中学 (义顺)
CHUNG CHENG HIGH SCHOOL (YISHUN)

Preliminary Examinations (2016)
Secondary Four Express

Candidate Name		Register No.	Class

CHEMISTRY

5073/01

Paper 1 Multiple Choice

Date: 31 August 2016

Duration: 1 hour

Additional Materials: OTAS

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number in the spaces at the top of this page and 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 OTAS provided.

Information for Candidates

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 2.
The use of an approved scientific calculator is expected, where appropriate.

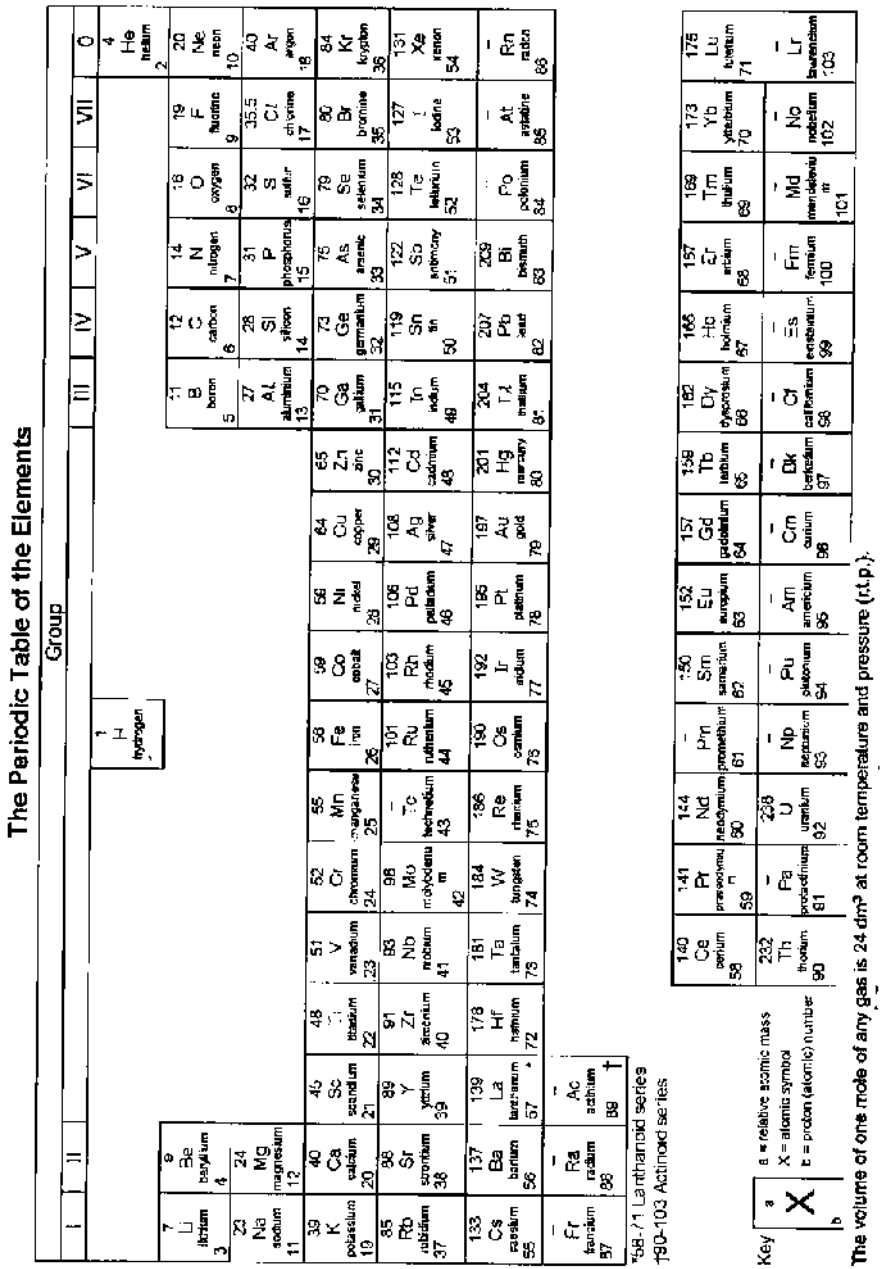
The total marks for this paper is 40.

Setter: Mr Lim Wee Keong

This document consists of 17 printed pages, INCLUDING the cover page.

[Turn over

The Periodic Table of the Elements



The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

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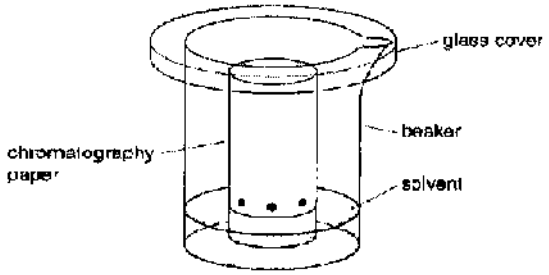
1 Amino acids are colourless and can be separated and identified by chromatography as shown.

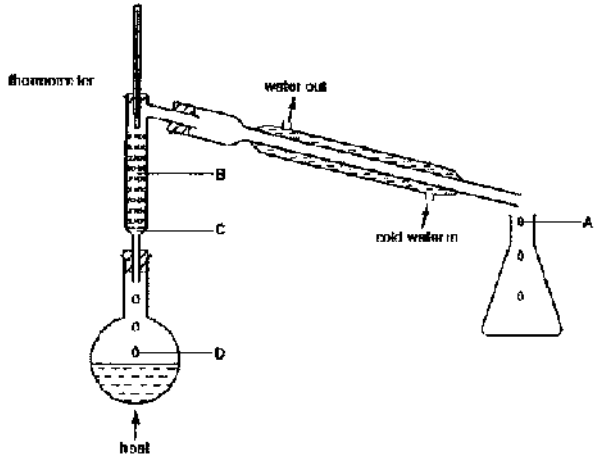


What additional apparatus and/or chemical is/ are required to calculate the Rf value of the amino acids present in a mixture?

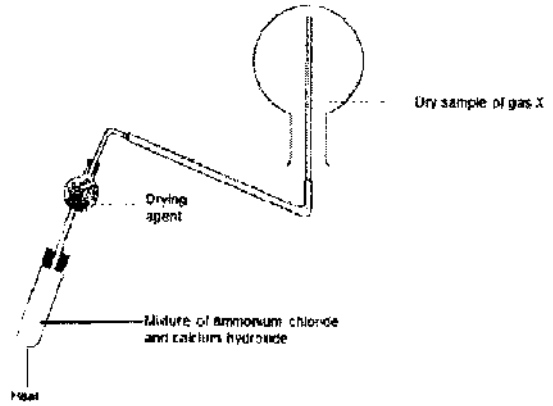
A a ruler
B a locating agent
C a ruler and a locating agent
D neither a ruler nor a locating agent

2 A mixture containing equal volumes of two miscible liquids is placed in the apparatus as shown. The miscible liquids are heated until the thermometer first shows a constant reading.

At which position will there be the highest proportion of liquid with the higher boiling point?



3 A student sets up the apparatus as shown to collect a sample of clean, dry gas X.



Predict the identity of gas X and identify a suitable drying agent to be used.

	gas X	drying agent
A	ammonia	calcium oxide
B	ammonia	concentrated sulfuric acid
C	hydrogen chloride	calcium oxide
D	hydrogen chloride	concentrated sulfuric acid

4 Which one of the following correctly describes the particles in a dilute sugar solution at room temperature?

	sugar molecules	water molecules
A	widely separated, moving at random	close together, moving at random
B	widely separated, not moving	close together, moving at random
C	widely separated, not moving	widely separated, moving at random
D	close together, moving at random	widely separated, vibrating slightly

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5 A filter tip of a cigarette acts as both a filter and a condenser.

Which of the following **cannot** be removed, assuming that the filter tip is 100% efficient?

	substance	boiling point/ °C
A	carbon monoxide	-191
B	nicotine	247
C	tar	350 to 400
D	water	100

6 A new substance was discovered and a series of experiments were conducted on it.

Which observation suggests that the substance cannot be an element?

A Electrolysis of the molten substance gave two products.
B It dissolved in water to give a colourless solution.
C It has a sharp melting point.
D When heated in air, it could form two oxides.

7 Deuterium, with chemical symbol D, is an isotope of hydrogen.

Which of the following chemical formula is incorrect?

A D_2O_2
B DCOOD
C ND_3
D CaOD

8 An ion X^{2-} has a mass number of m and n electrons.

What does the nucleus of an atom X contain?

	number of protons	number of neutrons
A	n - 2	m - n
B	n – 2	m – (n – 2)
C	n + 2	m – (n – 2)
D	n + 2	m – (n + 2)

9 Fibreglass is used as a reinforcing agent in many polymer products. It contains a mixture of ionic oxides and giant covalent oxides.

Which of the following is not a possible constituent of fibreglass?

A CaO
B SiO_2
C P_4O_9
D Cr_2O_3

10 In the lattice structure of ionic compounds, coordination number is the number of nearest neighbour ions of opposite charge. For instance, in sodium chloride, each sodium ion is surrounded by 6 chloride ions and each chloride ion is surrounded by six sodium ions. Hence, coordination number of sodium ions and chloride ions is 6.

The table below shows the ions present and the coordination number of the ions in some ionic compounds.

compound	ions present		coordination number of		formula
	cation	anion	cation	anion	
sodium chloride	Na^+	Cl^-	6	6	NaCl
titanium(V) oxide	Ti^{4+}	O^{2-}	6	3	TiO_2
P	Q	R	4	8	?

What is the formula of compound P?

A QR_2
B Q_2R
C QR_4
D Q_4R

11 Carbon dioxide is a gas at room conditions while silicon dioxide is a solid because

A carbon-oxygen bonds are not as strong as silicon-oxygen bonds.
B carbon dioxide contains double covalent bods while silicon dioxide contains single covalent bonds.
C intermolecular forces of attraction are much weaker than covalent bonds.
D relative molecular mass of carbon dioxide is less than that of silicon dioxide.

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12 Silicon carbide, SiC, has a structure similar to diamond. Boron nitride, BN has a structure similar to graphite. Bronze is an alloy of copper and tin.

Which statements about SiC, BN and bronze are correct?

1 All atoms are bonded covalently.
2 All have high melting and boiling point.
3 All except bronze are soluble in organic solvent.
4 All except silicon carbide conduct electricity when solid.

A 1 and 2
B 2 and 3
C 2 and 4
D 2, 3 and 4

13 When 200 g of compound X containing carbon, hydrogen, aluminium and oxygen is heated in excess oxygen, 42.2 g of aluminium oxide is obtained as residue.

What is the percentage by mass of aluminium in the sample?

A 11.2 %
B 13.5 %
C 21.1 %
D 27.0 %

14 5.0 dm^3 of sulfur dioxide is reacted with 3.0 dm^3 of oxygen at room temperature and pressure to form sulfur trioxide only.

$$2SO_2\,(g) + O_2\,(g) \rightarrow 2SO_3\,(g)$$

What is the total volume of gas(es) at the end of the reaction?

A 4.0 dm^3
B 5.0 dm^3
C 5.5 dm^3
D 6.0 dm^3

15 Tin is extracted from its ore cassiterite (containing SnO_2) by reducing it with coal in a furnace according to the equation shown below.

$$SnO_2 + 2C \rightarrow Sn + 2CO$$

What is the percentage purity of tin ore if 600 g of cassiterite on reduction produces 82 g of tin?

A $\frac{82}{119} \times \frac{600}{151} \times 100$
B $\frac{82}{119} \times \frac{151}{600} \times 100$
C $\frac{119}{82} \times \frac{600}{151} \times 100$
D $\frac{119}{82} \times \frac{151}{600} \times 100$

16 Zinc oxide is produced by heating zinc carbonate. What is the percentage yield of zinc oxide if 125 g of zinc carbonate produces 75 g of zinc oxide when heated?

A $\frac{75}{81} \times 100$
B $\frac{81}{75} \times 100$
C $125 \times \frac{81}{75} \times 100$
D $125 \times \frac{75}{81} \times 100$

17 If 2 g of nitrogen gas contains y atoms, what is the number of atoms in 12 g of silicon?

A 2y
B 3y
C 6y
D 11y

18 In an experiment, 10.0 cm^3 of 0.01 mol/dm^3 copper(II) sulfate solution was mixed with 5.0 cm^3 of 0.01 mol/dm^3 sodium carbonate solution according to the equation below.

$$CuSO_4 + Na_2CO_3 \rightarrow Na_2SO_4 + CuCO_3$$

What does the reaction vessel contain at the end of the experiment?

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

19 The equation below shows the reaction between a metal F and dilute sulfuric acid.

$$F\,(s) + H_2SO_4\,(aq) \rightarrow FSO_4\,(aq) + H_2\,(g)$$

Which particles are responsible for the electrical conducivity in metal F, dilute sulfuric acid and the salt produced?

	metal F	dilute sulfuric acid	salt
A	cations	cations	cations
B	cations and electrons	cations	cations and anions
C	cations and electrons	cations and anions	cations and anions
D	electrons	cations and anions	cations and anions

20 Powdered calcium carbonate is commonly placed near the chimneys in a coal-burning power stations. Which waste gas will not be removed by the powdered calcium carbonate?

A sulfur trioxide
B nitrogen dioxide
C carbon monoxide
D phosphorus(V) oxide

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21 The pH of an aqueous solution of hydrochloric acid is 2. What will be the pH of the acid after addition of 10 g of sodium chloride?

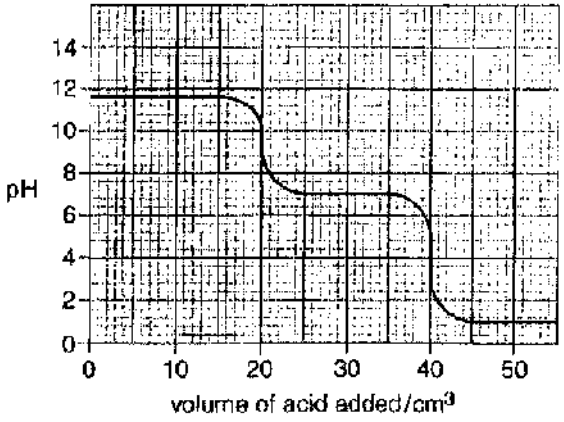
A	1	**B**	2
C	7	**D**	9

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

Which of the following is the best method which the student should adopt?

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

23 The reaction between sodium carbonate and dilute hydrochloric acid happens in two stages as shown below.



Stage 1: Sodium carbonate reacts with dilute hydrochloric acid to form sodium hydrogencarbonate ($NaHCO_3$) and a neutral salt.

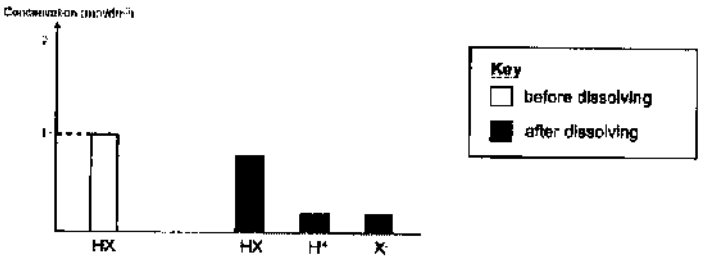
Stage 2: Sodium hydrogencarbonate undergoes a further reaction with hydrochloric acid.

What is the volume of acid added to form the neutral salt?

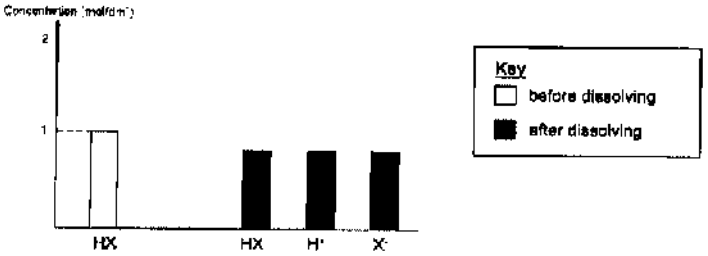
A	10 cm^3	**B**	20 cm^3
C	30 cm^3	**D**	40 cm^3

24 Which graph below shows the solution formed when one mole of weak acid, HX, is dissolved in 1 dm^3 of water?

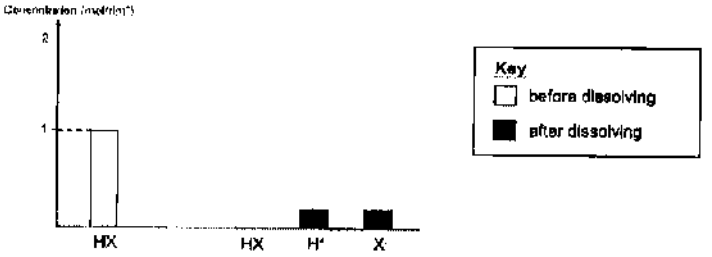
A



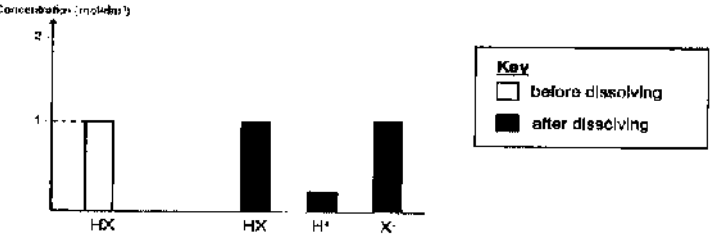
B



C



D



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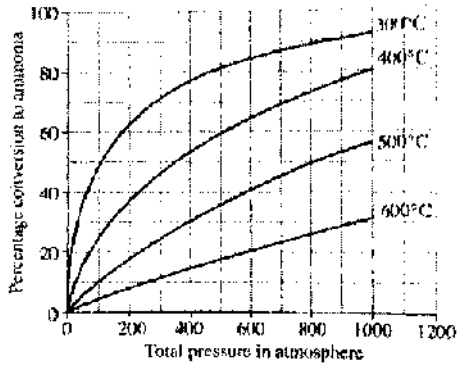
25 Ammonia is produced from Haber Process using a suitable catalyst.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The following graph shows the different yields of ammonia at different temperature and pressure.



Which of the following is not true?

A A higher percentage yield of ammonia can be obtained at higher pressure.
B A higher percentage yield of ammonia can be obtained at lower temperature.
C At the right conditions of temperature and pressure, all of the hydrogen and nitrogen can be converted into ammonia.
D Some of the ammonia formed will decompose to form hydrogen and nitrogen.

26 During the Haber Process, ammonia that is produced is separated from the reaction mixture by

A passing the gaseous mixture through fused calcium chloride.
B dissolving the other two gases.
C filtering out the other two gases by passing through cotton wool.
D cooling the mixture.

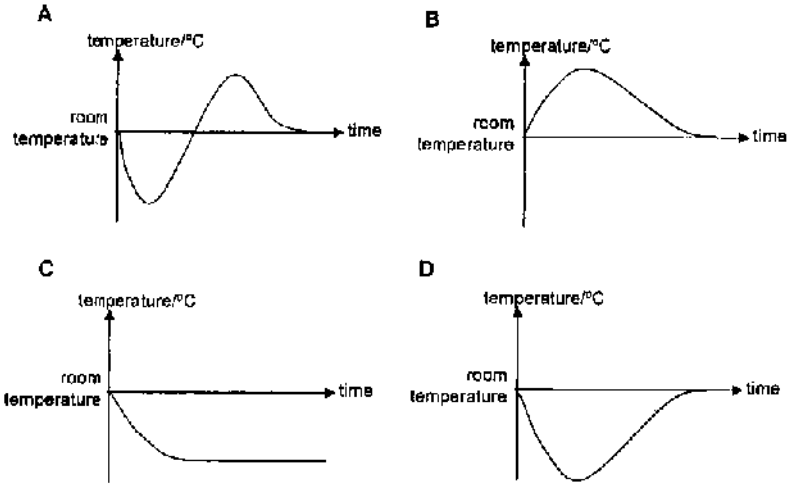
27 During the combustion of coal, a burning matchstick or an ignition source is usually used.

What is a possible reason for this?

A The reaction is endothermic, and heat energy must be supplied for burning to occur.
B Heat energy is used to overcome the energy barrier before the reaction can proceed.
C To ensure that there are enough oxygen molecules for a complete reaction.
D To reduce the enthalpy change so that the reaction can occur.

28 The dissolving of potassium iodide is an endothermic process.

Which of the following graphs shows the temperature change that occurs when potassium iodide is stirred with water until no further change in temperature is observed?



29 The same number of moles of a molten chloride of a Group I metal, XCl, and a molten chloride of a Group II metal, YCl_2, are separately electrolysed using the same current for the same period of time.

Which statements about this experiment are correct?

1 An equal number of moles of X and Y are deposited.
2 An equal number of moles of X and Cl_2 are formed.
3 An equal number of moles of Y and Cl_2 are formed.
4 XCl gives off the same volume of chlorine gas as YCl_2, measured under the same temperature and pressure.

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

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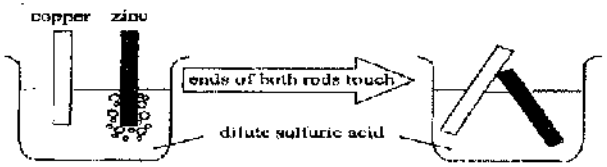
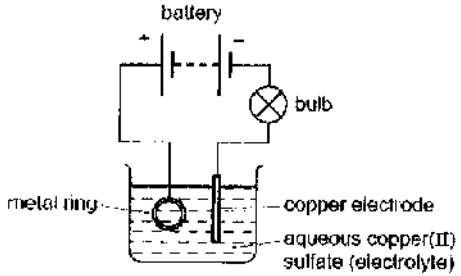
30 In an experiment, a copper rod and a zinc rod are placed in a beaker of dilute sulfuric acid as shown. Effervescence was observed around the zinc rod only.



What happens when the ends of both rods touch each other?

A Effervescence observed at both rods.
B Effervescence observed around the copper rod only.
C Effervescence observed around the zinc rod only.
D No effervescence observed around both rods.

31 The diagram shows apparatus used in an attempt to electroplate a metal ring with copper.



The experiment did not work.

Which change in the experiment is needed to make it work?

A Add solid copper(II) sulfate to the electrolyte.
B Increase the temperature of the electrolyte.
C Replace the copper electrode with a carbon electrode.
D Reverse the connections to the battery.

32 Which pairs of statements correctly describes the differences between the conduction of electricity during electrolysis and the conduction of electricity by metals?

	conduction during electrolysis	conduction by metals
1	The current is due to the movement of both positive and negative ions.	The current is due to the movement of electrons.
2	Charged particles move towards both electrodes.	Charged particles move in one direction only.
3	It results in a chemical change.	It does not result in a chemical change.

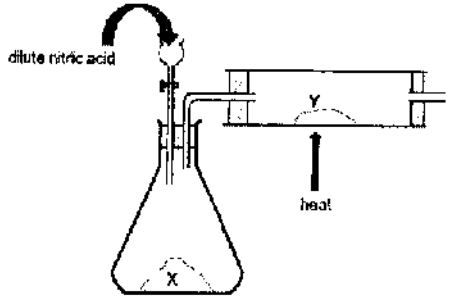
A 1 only
B 1 and 2 only
C 2 and 3 only
D 1, 2 and 3

33 Some magnesium blocks are attached to iron pipes to prevent them from rusting.

How does magnesium stop the iron from rusting?

A Magnesium reacts in preference to iron.
B Magnesium forms an alloy with the iron.
C Magnesium reacts to form a protective coating of magnesium oxide to the iron.
D Magnesium stops the oxygen in the water from getting to the iron.

34 The diagram below shows the apparatus used in an experiment to reduce substance Y with the gas produced in the conical flask.



Which of the following pairs could X and Y be?

	X	Y
A	lead	copper(II) oxide
B	copper	lead(II) oxide
C	zinc	magnesium oxide
D	magnesium	zinc oxide

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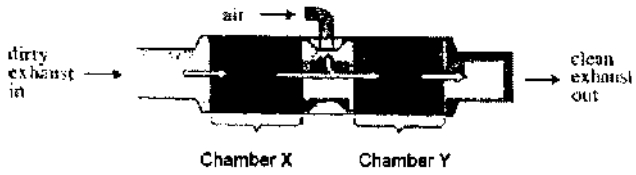
35 The diagram below shows a catalytic converter fitted into a car engine that runs on petrol. It consists of two chambers containing different type of catalysts at work, a reduction catalyst and an oxidation catalyst.



Dirty exhaust is first passed into chamber X before it is mixed with air and then passed into chamber Y.

Which of the following reactions are most likely to occur in the two chambers?

	Chamber X	Chamber Y
A	$C + O_2 \rightarrow CO_2$	$2NO \rightarrow O_2 + N_2$
B	$2NO_2 \rightarrow 2O_2 + N_2$	$2CO + O_2 \rightarrow 2CO_2$
C	$2NO \rightarrow O_2 + N_2$	$CO_2 \rightarrow C + O_2$
D	$2CO + O_2 \rightarrow 2CO_2$	$N_2 + 2O_2 \rightarrow 2NO_2$

36 Zirconium, Zr, is a transition metal used in flash bulbs.

When the filament inside the bulb gets hot, zirconium burns with a white light to form a mixture of zirconium(II) oxide and zirconium(IV) oxide. Zirconium has no reaction with water or steam.

Based on the above information, which statement shows that zirconium is a transition metal?

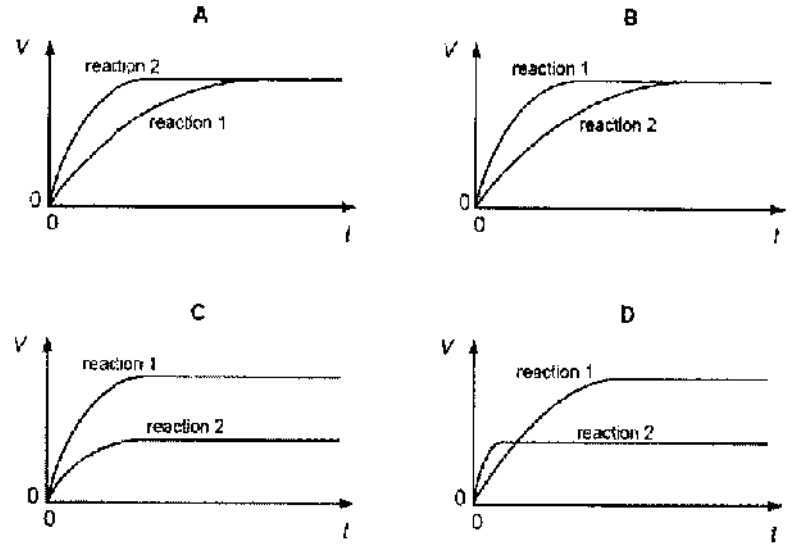
A Zirconium burns with a white light.
B The oxides of zirconium are amphoteric.
C Zirconium has the oxidation states of +2 and +4 in its oxides.
D Zirconium is unreactive.

37 A student performs two reactions.

Reaction 1 10 g of magnesium ribbon with 1dm^3 of 2. 0 mol/dm^3 dilute hydrochloric acid.
Reaction 2 5 g of magnesium powder with 1dm^3 of 3.0 mol/dm^3 dilute hydrochloric acid.

In both experiments, the volume of hydrogen produced, V is measured against time, t and the results are plotted graphically.

Which set of graphs is correct?



38 With the presence of UV light, 1 mole of C_3H_8 reacts with 3 moles of chlorine in a substitution reaction. What is the formula of the organic product in this reaction?

A $C_3H_2Cl_6$ **B** $C_3H_3Cl_5$
C $C_3H_4Cl_4$ **D** $C_3H_5Cl_3$

39 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 bonds are present in 1 molecule of arachidonic acid?

A 1 **B** 2
C 3 **D** 4

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40 In the polymerisation of propene to form poly(propene), there is no change in

A	boiling point	**B**	density
C	mass	**D**	molecular formula

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Preliminary Examinations (2016)
Secondary Four Express

Candidate			
	Name	Register No.	Class

CHEMISTRY

5073/02

Paper 2 Section A

Date: 24 August 2016
Duration: 1 hour 45 min

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number in the spaces at the top of this page.
Write in dark blue or black pen.
You are to use a soft pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue, correction fluid or correction tape.

Section A (50 marks)
Answer all questions in the spaces provided.

At the end of the paper, 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 2.

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

For Examiner's Use
Section A

Setter: Mr Lim Wee Keong

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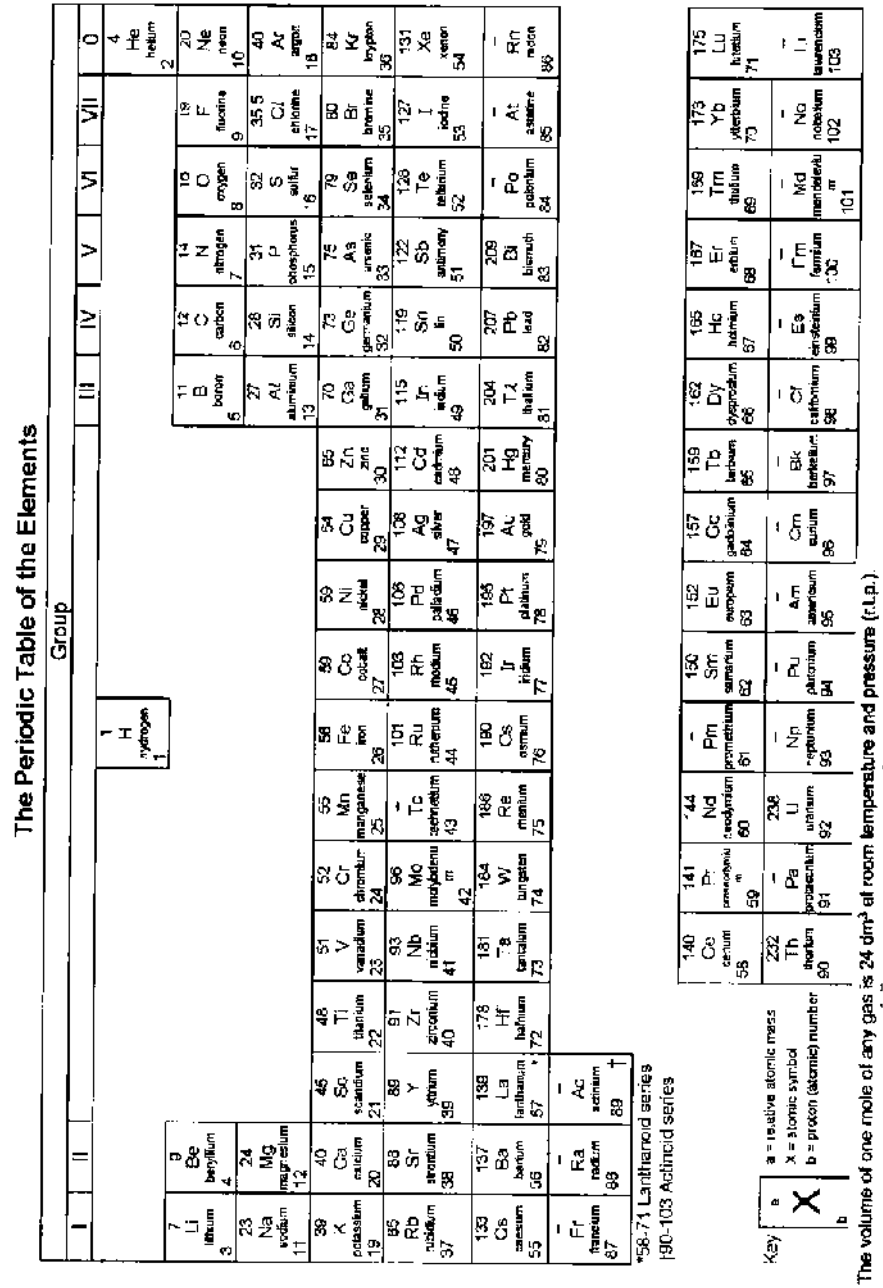

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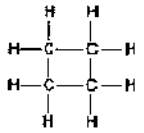
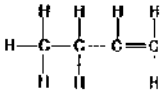
Section A (50 marks)

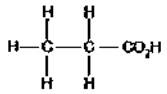
1 Structures of six organic compounds are shown below.



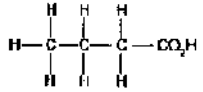
compound A



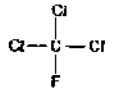
compound B



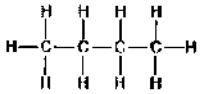
compound C



compound D



compound E



compound F

(a) Choose from the above compounds to answer the following questions. Each compound can be used once, more than once or none at all.

(i) Which compound(s) can react with metal carbonates to produce effervescence?

.....[1]

(ii) Which compound(s) decolourise(s) aqueous bromine?

.....[1]

(iii) Which compound(s) will undergo hydration and oxidation to form butanoic acid?

.....[1]

(b) Explain whether compound A and compound B are isomers.

.....

..... [1]

(c) Draw an isomer of compound D.

[1]
[Total: 5]

2 Seawater contains many dissolved ions. The table shows the concentration of some of these ions in a typical sample of seawater.

ion	concentration g/dm^3
chloride	19.00
sodium	10.56
sulfate	2.65
magnesium	1.26
calcium	0.40
potassium	0.38

(a) **(i)** State what you would see if three drops of acidified aqueous silver nitrate is added to 5 cm^3 of seawater.

.....[1]

(ii) Hence, construct an ionic equation for the reaction in (a)(i).

.....[1]

(b) Calculate the mass of sulfate ions which can be precipitated when excess acidified barium nitrate is added to 20 cm^3 of seawater.

[1]

[Total: 3]

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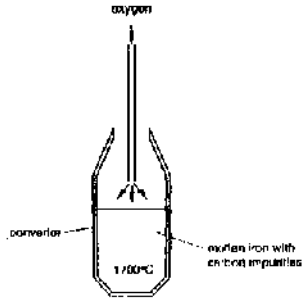
3 Iron from the Blast Furnace contains carbon as an impurity. To remove the carbon, oxygen is blown on the molten iron in a large vessel known as a converter.

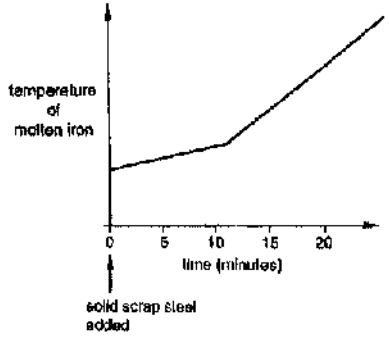


(a) The temperature of the molten iron increases as the oxygen is blown onto it. Explain why.

.....

..... [1]

(b) Scrap steel is recycled by being added, as a solid, to the molten iron, before the oxygen blow. The graph shows how the temperature of the molten iron changes during the oxygen below.



(i) Describe and explain how the solid scrap steel affects the temperature change during the oxygen blow.

.....

.....

.....[2]

(ii) State a reason why it is important to recycle steel.

.....[1]

(c) Using ideas about the arrangement of atoms, explain why high carbon steel is preferred over pure iron to be used as cutting tool.

.....

.....

.....[2]

[Total: 6]

4 Hydrogen peroxide is a colourless liquid.

An aqueous solution of hydrogen peroxide reacts with the iodide ions in acidified potassium iodide to form water and iodine according to the equation shown below.

$$H_2O_2(aq) + 2H^+(aq) + 2I^-(aq) \rightarrow 2H_2O(l) + I_2(aq)$$

(a) (i) Explain, in terms of electrons, whether the iodide ions are acting as the oxidising agent or reducing agent in this reaction.

.....

.....[1]

(ii) Describe the colour change for the above reaction.

.....[1]

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(b) The table shows how the speed of this reaction changes when different concentrations of aqueous potassium iodide and dilute sulfuric acid are used. The hydrogen peroxide is always added in excess and the temperature remains constant.

experiment	concentration of aqueous potassium iodide in mol/dm^3	concentration of dilute sulfuric acid in mol/dm^3	speed of reaction in mol/dm^3/s
1	0.1	0.1	0.00017
2	0.2	0.1	0.00034
3	0.1	0.2	0.00017
4	0.3	0.1	0.00051
5	0.1	0.3	0.00017

"The speed of this reaction is more dependent on the concentration of aqueous potassium iodide than aqueous sulfuric acid."

Using the information in the table, justify whether you agree with the above statement.

.....

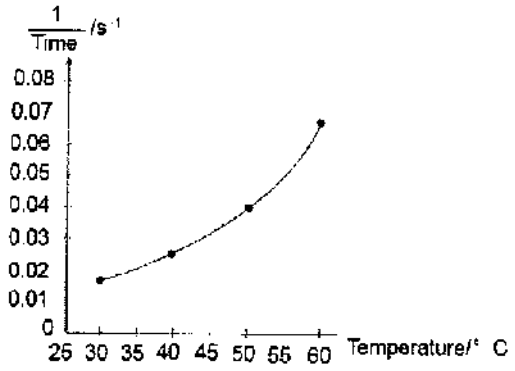
.....

.....

.....

.....[2]

(c) The experiment was repeated by varying the temperature of aqueous potassium iodide, with other variables being kept constant. The results of the experiment were represented by the graph shown below.



Use ideas about collision between particles to explain the trend in the results.

.....

.....

.....[2]

(d) A student thinks that iron(III) oxide acts as catalyst in this reaction.

Describe what the student should do and what information he should collect to test his hypothesis.

.....

.....

.....

.....[3]

[Total: 9]

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5 (a) Carbon dioxide is a greenhouse gas and is given a greenhouse factor of 1.

Other gases are given a greenhouse factor that compares their effects with carbon dioxide. The greenhouse effect increases as the factor value increases.

Table 1 below gives information about the greenhouse factor and the composition of four different gases in the Earth's atmosphere.

gas	greenhouse factor	percentage of gas in the atmosphere
CO_2	1	0.036
CH_4	30	0.0017
N_2O	160	3.0×10^{-4}
CCl_3F	21000	2.8×10^{-8}

Table 1

Using the information above, explain whether scientists should be more worried about the percentage increase of methane in the Earth's atmosphere as compared to the percentage increase of carbon dioxide.

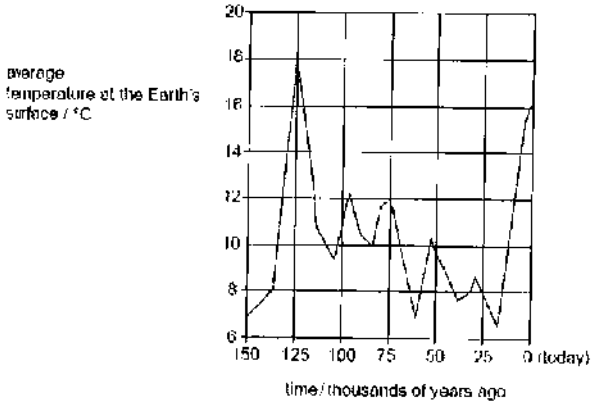
.....

.....

.....[2]

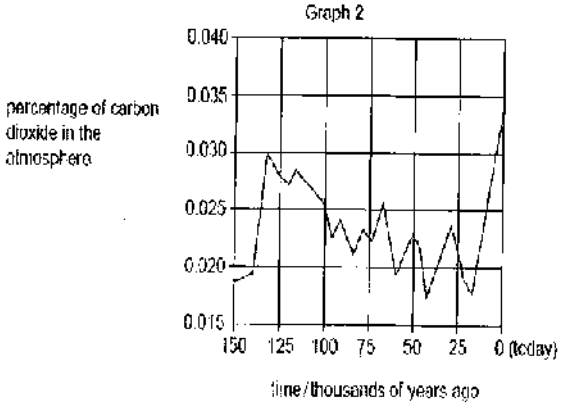
(b) Graph 1 below shows how the average temperature at the Earth's surface may have changed over the last 150 thousand years.

Graph 1



Graph 2 below shows how the percentage of carbon dioxide in the atmosphere may have changed over the last 150 thousand years.

Graph 2



(i) Scientists think that an increase in the amount of carbon dioxide will result in global warming.

Explain how Graph 1 and 2 support this statement.

.....

.....[1]

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(ii) "Increase in amount of carbon dioxide is not the only factor which contributes to global warming."

Using the information from **Table 1**, **Graph 1 and 2**, explain how these information can be used to support the above statement.

.....

.....

.....

.....[2]

(iii) Describe one possible consequence of global warming.

.....

.....[1]

(iv) Showing only the outer shell electrons, draw a "dot-and-cross" diagram to show the bonding present in CC*l*aF.

[2]

(v) Explain how the presence of CC*l*aF in the atmosphere contributes to health problems like skin cancer.

.....

.....

.....[2]

[Total: 10]

6 Small pieces of a silver coloured metal, **X**, were added to concentrated nitric acid. A brown acidic gas, **Z**, and a colourless solution containing salt **Y** were formed.

Analysis of 0.0914 mole sample of **Z** showed it contained 1.28 g of nitrogen and 2.93 g of oxygen.

The small sample of the colourless solution was diluted with water and then divided into two portions.

To the first portion

Aqueous sodium hydroxide was added drop by drop until it was in excess. A white precipitate, **W**, was formed that redissolved in the excess aqueous sodium hydroxide.

To the second portion

Aqueous ammonia was added drop by drop until it was in excess. A white precipitate, **W** was formed and remained insoluble in the excess aqueous ammonia.

(a) With the means of chemical calculation, determine the empirical formula of **Z**.

[2]

(b) (i) Suggest the identities of precipitate **W**.

.....[1]

(ii) Construct one possible ionic equation, with state symbols, for the forming of **W** from the first portion.

.....[2]

(c) (i) Suggest the identities of **X**.

.....[1]

(ii) Describe a chemical test to determine the anion present in **Y**.

.....

.....[2]

[Total: 8]

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7 **(a)** Four isomers of butanol are shown in the table below.

Isomer	1	2	3	4
	$CH_3CH_2CH_2CH_2OH$	CH_3CH_2-CH(OH)-CH_3	CH_3-CH(CH_3)-CH_2OH	CH_3-C(CH_3)(OH)-CH_3
Name	Butan-1-ol	Butan-2-ol	2-methylpropanol	2-methyl propan-2-ol

(i) Name the organic product when butan-1-ol is added to acidified potassium managante (VII).

....[1]

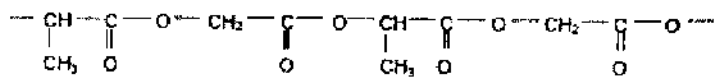
(ii) A student would like to prepare a sweet-smelling compound **X**. He added 2-methyl propanol to a beaker containing aqueous propanoic acid, with warming. Concentrated sulfuric acid was also added to the mixture

Show the full structural formula of compound **X** and name compound **X**.

[1]

Name of compound **X**: ....[1]

(b) Lactomer is a trade name of synthetic material that is used to make surgical stitches. Part of this polymer is shown below.

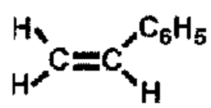


Draw the two possible monomers which are used to form the above polymer.

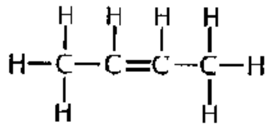
monomer 1	monomer 2

[2]

(c) Styrene-butylene rubber is a synthetic rubber. It is made by polymerising a mixture of the monomers styrene and butylene.

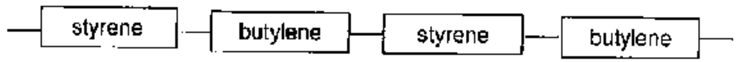


Styrene



butylene

One possible structure for the polymer is shown below.



(i) Styrene is processed by cracking of crude oil in an oil refinery.

Explain why cracking of styrene is an important process in the oil refinery industry.

....

....[1]

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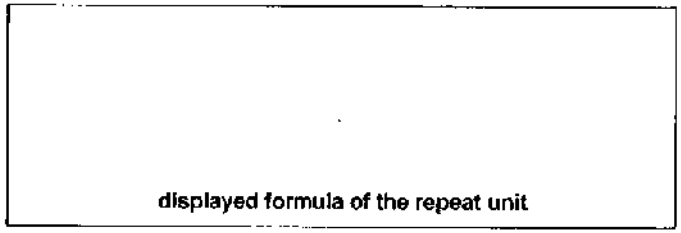
(ii) Draw the displayed formula of the repeat unit in this polymer structure.



[1]

(iii) When the mixture of styrene and butylene polymerises, the polymer is unlikely to contain only this regular, repeating pattern. Explain why.

.....

.....[1]

(iv) Describe one difference between the reactions to form styrene-butylene polymer and lactomer.

.....

.....

.....

.....[1]

[Total:9]

End of Section A

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中正中学 (义顺)
CHUNG CHENG HIGH SCHOOL (YISHUN)

Preliminary Examinations (2016)
Secondary Four Express

Candidate			
	Name	Register No.	Class

CHEMISTRY

5073/02

Paper 2 Section B

Date: 24 August 2016

Duration: 1 hour 45 min

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number in the spaces at the top of this page.
Write in dark blue or black pen.
You are to use a soft pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue, correction fluid or correction tape.

Section B (30 marks)
Answer all three questions in the spaces provided.
The last question is in the form either/or.

At the end of the paper, 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 2 of Section A.

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

For Examiner's Use	
Section B	

Setter: Mr Lim Wee Keong

This document consists of 12 printed pages, INCLUDING the cover page.

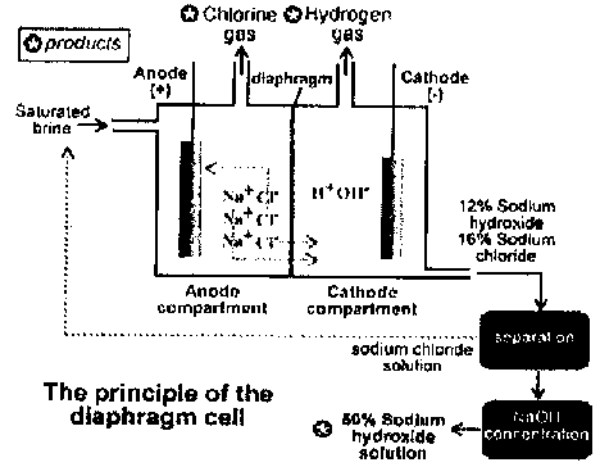
[Turn over

Section B (30 marks)

1 Electrolysis reactions are the basic foundations of today's modern industry. There are various elements, chemical compounds and organic compounds that can only be produced by electrolysis. For example, chlorine and sodium hydroxide.

Brine is a saturated solution of sodium chloride, containing about 25 % by mass of sodium chloride. Industrial electrolysis of brine can be carried out in a **diaphragm cell** and a **membrane** cell.

The diagram below shows how the **diaphragm** cell works.



The principle of the diaphragm cell

The brine is contained in the anode compartment and the electrode which is used can either be made up of graphite or titanium. However, graphite is commonly preferred over titanium.

On the cathode side, the hydroxide ions and hydrogen gas are formed due to the reduction of water. Due to the difference in the solution level between the anode and the cathode, there will be a gradual flow of sodium chloride from the anode into the cathode. However, there will not be any backflow of sodium ions into the anode. If chlorine and sodium hydroxide come into contact, chlorine turns into ClO^-, ClO_3^- and Cl^- ions.

To ensure that a pure sodium hydroxide can be collected, purification of sodium chloride out of the sodium hydroxide will have to be carried out. After purification, the industry is able to get a solution of 50% of aqueous sodium hydroxide and about 1% of sodium chloride.

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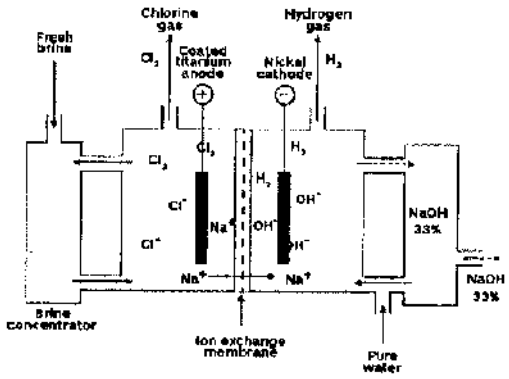
The diagram below shows how the membrane cell works.



In the membrane cell, the brine is fed to the brine concentrator and current passing through will result in the aqueous sodium chloride to split into sodium ions and chloride ions. The sodium ions will flow through the ion exchange membrane and react with the hydroxide ions that are produced through the reduction of water to form aqueous sodium hydroxide. Without the ion exchange membrane the sodium hydroxide would not be pure because it would contain chloride ions.

The table shows some information about the two types of cells.

cell type	construction	operation of cell	quality of NaOH produced
diaphragm cell	Relatively simple and inexpensive.	Frequent replacement of diaphragm. Operates at 3.8 V.	Must be evaporated to concentrate from 12% to 50% and to crystallise out the salt.
membrane cell	Cheap to construct and install.	Requires high purity brine. Operates at 3.3 V. Membrane changes every 2 to 3 years.	High purity. Must be evaporated to concentrate from 33% to 50%.

(a) (i) Construct a half ionic equation for the reaction that happens at the cathode of the diaphragm cell.

..... [1]

(ii) Suggest a reason why graphite is commonly preferred over titanium to be used as electrode in the diaphragm cell

..... [1]

(b) When chlorine and sodium hydroxide comes into contact, a disproportionation reaction happens. Disproportionation happens when the oxidation state of the same element both increases and decreases in the reaction.

Use ideas about oxidation state to explain why the reaction of chlorine and sodium hydroxide is a disproportionation reaction.

.....

.....[2]

(c) (i) Write an equation for the overall reaction that happens in the membrane cell.

..... [1]

(ii) Calculate the volume of hydrogen gas that can be produced from two tonnes of saturated brine in membrane cell at r.t.p.

[3]

(d) "Industries should adopt using membrane cell to produce sodium hydroxide instead of diaphragm cell."

Using the relevant information, explain one reason why such statement was made.

.....

.....[1]

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(e) A student made the following comment.

"In school laboratory, I can obtain aqueous sodium hydroxide by just using concentrated sodium bromide solution with graphite electrodes."

Explain whether you agree with the student.

.....

.....[1]

[Total:10]

2 Many carbonates thermally decompose to form a metal oxide and a gas.

Six 2.00 g of samples of carbonates are heated strongly until there is no further change in the mass. The table shows the mass of solid remaining at the end of the heating.

carbonate	mass before heating / g	mass after heating / g
calcium carbonate	2.00	1.12
copper(II) carbonate	2.00	1.29
iron(II) carbonate	2.00	1.24
magnesium carbonate	2.00	0.95
sodium carbonate	2.00	2.00
zinc carbonate	2.00	1.30

(a) Two students made the following conclusions based on the table above.

Student 1: The thermal stability of the metal carbonate is dependent on the charge of the metal ion.

Student 2: The more reactive the metal, the more thermal stable the metal carbonate is.

Which student's conclusion is correct? Use the information from the table to support your reasoning.

.....

.....

.....

.....

.....

.....

.....[3]

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(b) One of the metal oxides formed from the decomposition of the metal carbonate can be used to treat excess acidity of soils in agriculture.

(i) Using a 'dot-and-cross' diagram, show the bonding present in this metal oxide. Only outer-shell electrons need to be shown.

[2]

(ii) Plants thrive well on fertilisers such as ammonium chloride because of the nitrogen content.

Explain, with an equation, why it is not advisable for farmers to add this metal oxide together with ammonium chloride to the soil.

.....

..... [1]

(iii) The molten state of this metal oxide is suitable to be used as an electrolyte to extract the metal.

Explain in terms of structure and bonding, why this metal oxide has to be in molten state in order to be used as an electrolyte.

.....

.....

..... [2]

(iv) Write down the half ionic equations, including state symbols, for the reaction which takes place at the respective electrodes when this molten metal oxide is electrolysed using carbon electrodes.

positive electrode: .....[1]

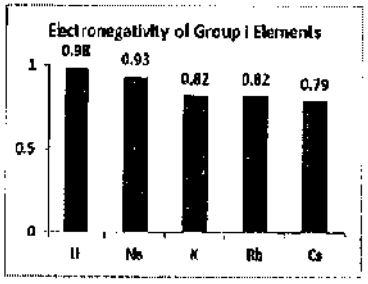
negative electrode: ..... [1]

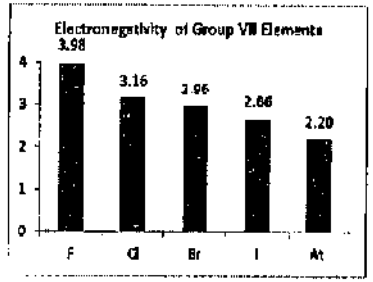
[Total: 10]

Either

3 (a) Electronegativity refers to the ability of an atom to attract electrons and is otherwise known as 'electron attracting' power. The greater the electronegativity value of an atom, the greater its ability to attract electrons and vice versa.

The diagrams below show the electronegativity of Group I and VII elements.





(i) Based on the data above, suggest a reason why the electronegativity for Group VII elements is generally higher than the electronegativity for Group I elements.

.....

..... [1]

(ii) Based on the electronegativity of Group VII elements, suggest and explain the trend of the oxidising power of Group VII elements when moving down the group.

.....

.....

..... [2]

(iii) Aqueous chlorine is bubbled into a solution of potassium bromide. Explain, with the use of an ionic equation, what will be observed.

.....

.....

..... [2]

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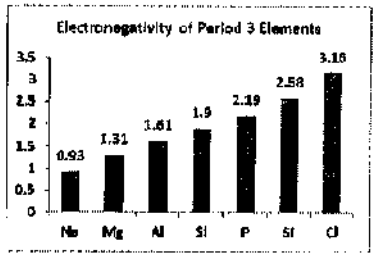
The following diagram shows the electronegativity across Period 3 elements with argon (Ar) being excluded.



(iv) Describe the general trend of electronegativity across Period 3 elements.

.....

..... [1]

(v) The electronegativity of the Period 3 elements is dependent on the number of electron shells the elements have.

Justify whether you agree or disagree with the statement.

.....

..... [1]

(b) Other than electronegativity, Group I and VII elements also show trends in their melting points.

	element	melting point / °C
Group I	lithium	180
	sodium	97.8
	potassium	64
Group VII	chlorine	-101
	bromine	-7
	iodine	114

Using the information provided, describe and explain the trend of melting points of Group I and Group VII elements.

.....

.....

.....[3]

[Total:10]

Or

3 (a) Researchers have been investigating the use of ethanol for replacing hydrogen as a liquid fuel for space craft intended for low Earth orbit. Its major advantage is that, unlike hydrogen, ethanol can be used as a liquid fuel without the need for storage at extremely low temperatures.

The table shows some information about ethanol and hydrogen.

compound	enthalpy change of combustion/ kJ per mol
hydrogen	-236
ethanol	-1367

(i) Given that the enthalpy change of combustion of hydrogen is -118 kJ/g, determine which fuel, hydrogen or ethanol, gives a greater energy output per gram of fuel used. Show your workings clearly, leaving your final answer to 3 significant figures.

[2]

(ii) Explain, in terms of bond breaking and bond making, why is combustion of hydrogen an exothermic reaction.

.....

..... [2]

(iii) In some countries, ethanol is produced from sugars in sugar cane.

An environmentalist claims that ethanol as a fuel is 'carbon neutral' because using it does not add to the amount of carbon dioxide in the atmosphere.

Explain why this is true.

.....

..... [1]

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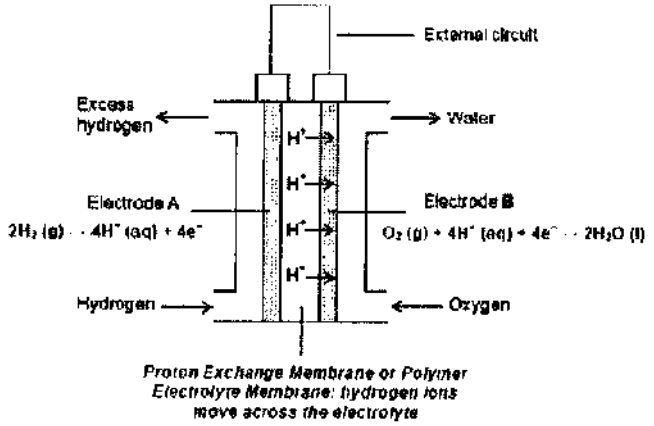
(b) One other use of hydrogen is using it as a fuel in the Proton Exchange membrane (PEM) fuel cell as shown in the diagram below.



Proton Exchange Membrane fuel cells use a polymer membrane (a thin plastic film which is semi permeable) as the electrolyte. Thus, they are also commonly known as Polymer Electrolyte Membrane (PEM) fuel cells.

(i) Hydrogen ions move across Proton Exchange Membrane.

With reference to a hydrogen ion, explain why it is considered as the "proton" in the Proton Exchange Membrane.

.....

..... [1]

(ii) With reference to the electrodes **A** and **B**, state the direction of the flow of electrons in the external circuit.

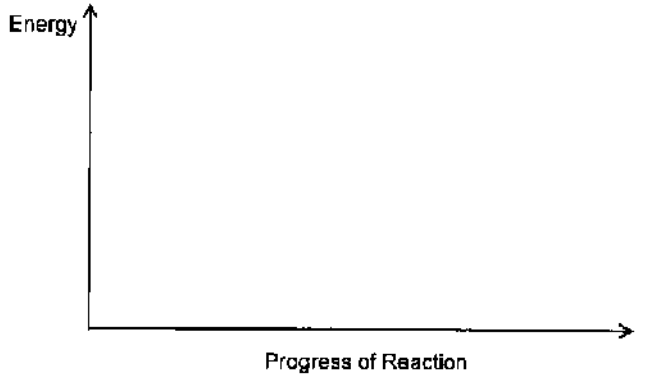
..... [1]

(iii) Construct an equation for the overall reaction that occurred in the Proton Exchange Membrane fuel cell.

..... [1]

(iv) Complete the energy profile diagram to illustrate the energy changes for the overall reaction. Your diagram should include

- The formula of the reactants and the products
- The label for the enthalpy change and the activation energy of the reaction.



[2]

[Total:10]

End of Section B

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Marking Scheme
Secondary 4 Express Pure Chemistry Prelim 2016

Section A (40 marks)

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

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Marking Scheme
Secondary 4 Pure Chemistry Prelims 2016

Section A Answers

Q/No.	Answer	Marks	Remarks/ Markers Comments
1(a)(i)	C,D	[1]	
(ii)	B	[1]	A few candidates missundertood that unsaturation includes C=O and included C and D as their answers.
(iii)	B	[1]	
(b)	Yes. Both compounds have the same molecular formula but different structural formula.	[1]	general formula is not credited. link back to the definition for isomers: same molecular formula but different structural formula.
(c)		[1]	
2(a)(i)	White precipitate.	[1]	
(ii)	$Ag^+ + Cl^- \rightarrow AgCl$	[1]	
(b)	(2.65/1000) x 20 = 0.053g	[1]	check table header, concentration is given in g/dm3
3(a)	The reaction between carbon/iron and oxygen is exothermic / heat energy is being released.	[1]	not enough to simply state that O2 reacted with iron/carbon as the reaction can be endothermic if not stated. Keyword to be mentioned is exothermic.

(b)(i)	Between 0 to 10min, the solid scrap steel results in the temperature to **increase gently**. After 10 min, the solid scrap steel results in the temperature to **increase sharply**. When the solid scrap steel is added to the molten Fe, it begins to **melt for 10 minutes** and the **sudden rise** of temperature is due to **combustion of carbon**. *Examiners Report 2004:* *Vague answers such as 'temperature increases' did not score.* ***The simplest statement to score two marks was: 'temperature increases slowly at first then faster'.***	[1] [1]	process the data and put down your understanding of the data. understanding of temperature rise has to be mentioned. rej: temperature change Many students were not able to highlight the different in the rate of temperature rise for the two portions. Explanation was also pretty weak.
(ii)	Iron Ore is finite / recycling steel is cheaper than extracting iron / reduce environmental problem arising from extraction of iron. *Examiners Report 2004:* In giving an advantage of recycling steel, many candidates gave answers that were too vague for credit, for example 'less pollution', 'less waste' or 'saves resources'. Better answers were more specific, for example discussing landfill area, saving finite metal resources or finite energy sources.	[1]	Any logical answer. Rej: steel has finite resource, because the keywords: **finite metal** resources
(c)	As carbon atom is of different size compared to iron atoms, the introduction of carbon atom/ different sized atoms disrupt the orderly layer of iron atoms. The layer of atoms in high carbon steel is	[2]	The link to property such as hardness has to be mentioned. 3 pt: 2m 1-2pt:1m

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	unable to slide over one another <u>easily</u>. Hence, high carbon steel is **harder** and more suitable to be used as a cutting tool compared to pure iron.		Some students mentioned about steel being strong, however failed to mentioned it being hard.
4(a)(i)	Reducing agent. Iodide ions donate electrons.	[1]	Students incorrectly mentioned H was reduced. However, it was ignored. Lose electrons to ..... was accepted VS lose electrons (because the understanding is vague whether losing electrons means iodide ions is oxidised and thus is the reducing agent.)
(ii)	Colourless to brown.	[1]	original and final colour must be mentioned.
(b)	Do not agree. Expt 1,2: When concentration of KI increases by two times from 0.1 to 0.2 mol/dm³, the speed of reaction increases by two times from 0.00017 to 0.00034 mol/dm³/s. Expt 1,3: When concentration of H_2SO_4 increases by two times from 0.1 to 0.2 mol/dm³, the speed of reaction remains unchanged at 0.00017 mol/dm³/s. Hence rate of reaction more dependent on concentration of KI.	[1] [1]	Data has to be quoted and be interpreted for the marks to be awarded. Many students lacked clarity in linking data because it is important to link back to the experiment that is referred to as point of reference compared to just stating all the experiment data.

(c)	Higher the temperature, faster the rate of reaction. Higher the temperature, more particles have **higher kinetic energy equal to or greater than (sufficient) activation** energy. **Higher frequency of effective collisions** and hence, faster rate of reaction.	[1] [1]	Many students failed to highlight the full expianation.
(d)	1. Carry out two experiments – one with iron (III) oxide and the other without iron(III) oxide. 2. All other key variables such as temperature to be kept constant. 3. Record the time taken for the reaction to be completed.	[1] [1] [1]	Repeat the experiment was accepted as long as understanding was shown
5(a)	More worried about the increase in percentage of methane. With 0.00017 % of methane present in the atmosphere, the **greenhouse factor is 30**, which is 30 times than that of carbon dioxide. With more increase in methane, the **impact** on the environment will be at least **30 times bigger** than that of carbon dioxide.	[1] [1]	

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(bi)	Graphs are roughly similar / high percentage of carbon dioxide shows there's high percentage of average temperature. *(quoted from Jun 2006)*	[1]	
(ii)	**Other gases** such as methane, N_2O and CCl_3F are present in the atmosphere. Gas such as methane has a **greenhouse factor** of 30 which implied that their effects on the Earth's average temperature is at least 30 times. Between **125 to 100 / 100 to 75 thousand years** ago, there was a **period** of time when there's a **decline in percentage of carbon dioxide** in the atmosphere but the **average temperature** of the Earth's surface actually **rise**.	[1] [1]	
(iii)	melting of polar ice/ rise in sea level/ desertification/extreme climate changes/ effect on animal/plant habitats *(quoted from Jun 2006)*	[1]	
(iv)	Valence electrons of the halogens must be shown correctly	[2]	No key: minus [1] overall Any mistake minus [1]
(v)	Results in **depletion of ozone layer** which	[2]	

	results in **more harmful UV radiation entering** the Earth's surface.		
6(a)	<table><tr><td></td><td>N</td><td>O</td></tr><tr><td>Number of moles</td><td>(1.28/14) = 0.091429</td><td>(2.93/16) 0.183125</td></tr><tr><td>Ratio</td><td>(0.091429/0.91429) = 1</td><td>(0.18312 = 2</td></tr></table> Hence empirical formula is NO_2	[1] [1]	Working has to be shown.
b(i)	**Lead(II) hydroxide** and aluminium hydroxide	[1]	Both correct [1]
(ii)	$Pb^{2+}(aq) + 2OH^-(aq)\ Pb(OH)_2(s)$ $Al^{3+}(aq) + 3OH^-(aq)\ Al(OH)_3(s)$	[2]	[1] eqn [1] state symbols
(b)(i)	**Lead** / Pb or Alumnium / Al	[1]	Both correct [1]
(ii)	Add a piece of Al foil to the solution and add 2 to 3 drops of aqueous sodium hydroxide. Warm. Test the gas evolved with moist red litmus paper. Moist red litmus paper turns blue.	[1] [1]	Always to mention results of the experiment and to provide evidence to support the identity of the gas
7(a)(i)	butan-1-oic acid	[1]	butanoic acid accepted
(ii)	2-methyl propyl propanoate	[1] [1]	
(b)		[2]	[1] for each

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(c)(i)	To match the demand for fractions containing smaller and more useful molecules from refinery process.	[1]	
(ii)		[1]	
(iii)	Both contain C=C which can polymerise at **random.**	[1]	
(iv)	**Addition Polymerisation reaction** Double bond/ alkene/ unsaturated / only one type of monomer Only 1 product obtained high temperature and pressure same empirical formula as monomer / same composition by mass of monomer **Condensation Polymerisation** 2 type monomers / 2 type functional group / functional group on each end of member small molecule , H2O, given out Does not require high temperature and pressure Does not have the same empirical formula as	[1]	Any 1

	the monomers/ different composition by mass of monomer		

Section B Answers

Q/No.	Answer	Marks	Remarks/ Markers Comments
1(a)(i)	$2H_2O + 2e \quad 2OH^- + H_2$	[1]	Many candidates failed to extract the relevant information from the text which states that reduction of water happens in the cathode.
(ii)	Graphite is cheaper than titanium. OR Graphite is easier to obtain than titanium	[1]	Common mistake is "Graphite is inert". This answer is not acceptable as Ti is relatively inert too. *To consider 1. cost, 2 safety, 3 environment*
(b)	Oxidation state of Cl increases from 0 in Cl_2 to +1 in ClO^- / +5 in ClO_3^- Cl_2 is oxidised.	[1]	Candidates need to be mindful that they have to know how to calculate the oxidation states. Some candidates are still unable to calculate to determine the correct oxidation states.

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	Oxidation state of Cl decreases from 0 in Cl_2 to -1 in Cl^-. Cl_2 is reduced.	[1]	
(c)(i)	$2NaCl + 2H_2O \rightarrow Cl_2 + 2NaOH + H_2$	[1]	Only few candidates manage to get this correct. Candidates need to be mindful of extracting relevant data.
(ii)	Number of moles of NaCl = 2 000 000 x 0.25 / (23 + 35.5) = 8547.00855 moles	[1]	Candidates need to be mindful of extracting relevant data as most candidates failed to read that only 25% of brine consists NaCl.
	Number of moles of H_2 = 4273.5 moles	[1]	
	Volume of H_2 = 4273.5 x 24 = 102 564 = 103 000 dm^3	[1]	Allow ECF from here.
(d)	Membrane cell operates at a **lower voltage** as compared to diaphragm cell, hence **cheaper to operate.**	[1]	Accepted answers include: 1. lesser electricity 2. higher purity higher concentration 3. 2 to 3 years of replacement of membrane vs frequent replacement Reject answers: 1. Cheap to construct (unless candidates mention that it is due to lower voltage) 2. Inexpensive = cheap and hence, elaboration has to be made

			otherwise, no marks will be awarded.
(e)	Agree. **Bromide ions are discharged** in preference to hydroxide ions due to concentration effect and **hydrogen ions are discharged** in preference to sodium ions. Sodium ions and hydroxide ions remain behind. OR The NaOH collected will be contaminated by the Br- ions.	[1]	Some candidates only mention that hydrogen and bromine gas are formed without any details on discharging of the ions.
2(a)	Student 2 is correct and student 1 is incorrect. When the metal ion has a charge of 2+ in carbonate such as calcium carbonate, the mass loss is 0.70g. When the metal ion has a charge of 1+ in carbonate such as sodium carbonate, there is no mass loss. However, it was also shown that when the metal ion has a charge of 2+ in carbonate such as copper (II) carbonate, the mass loss was 1.05g. Thus, it cannot be concluded that the thermal stability is dependent on the charge of the metal ion. Sodium being more reactive than calcium which is more reactive than copper, shows that there is a greater	[1] [1] [1]	Marks are awarded when candidates talk about both student 1 and student 2. [2m] The last 1m is given when candidates quote data. Many candidates had a poor explanation. Example, " calcium more reactive than zinc and hence, it / calcium is more thermal stable.." / "Calcium carbonate is more reactive than zinc carbonate". Candidates need to take note that thermal stability is referring to the metal carbonate and not the metal. Vague explanation or ambiguous explanation will not score.

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	mass loss in metal carbonate which contains a less reactive metal. Example: No mass loss for sodium carbonate but a mass loss of 0.70g for calcium carbonate and 1.05g for copper(II) carbonate. Hence, student 2's conclusion is correct. **Alternative 1** Student 1 is correct but student 2 is incorrect. Na ion has a charge of +1 and its carbonate did not decompose. Other carbonates in the table consists metal ions of charge +2 and its carbonate decompose, as shown by the decrease in mass loss. Eg: Zinc carbonate has a decrease in 0.70 g as zinc carbonate decompose to form zinc oxide and carbon dioxide. This shows that thermal stability of metal carbonate is dependent on the charge of the metal ion. Calcium more reactive than zinc but calcium carbonate has a higher mass loss of 0.88 g when being heated as compared to zinc carbonate with mass loss of 0.70 g. This shows that more reactive the metal, the metal carbonate is not more thermal stable. **Alternative 2** Both students are incorrect.		

	When the metal ion has a charge of 2+ in carbonate such as calcium carbonate, the mass loss is 0.70g. When the metal ion has a charge of 1+ in carbonate such as sodium carbonate, there is no mass loss. However, it was also shown that when the metal ion has a charge of 2+ in carbonate such as copper (II) carbonate, the mass loss was 1.05g. Thus, it cannot be concluded that the thermal stability is dependent on the charge of the metal ion. **(Student 1 is incorrect)** Calcium more reactive than zinc but calcium carbonate has a higher mass loss of 0.88 g when being heated as compared to zinc carbonate with mass loss of 0.70 g. This shows that more reactive the metal, the metal carbonate is not more thermal stable. **(Student 2 is incorrect)**		
(b)(i)		[2]	No key: minus [1] overall
(ii)	$2NH_4Cl + CaO \rightarrow CaCl_2 + 2NH_3 + H_2O$ **Ammonia** is formed and is released to	[1]	Eqn link to statement Candidates failed to include balanced equation. Some candidates faced

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	the surrounding. Hence, **nitrogen** content in the soil is **decreased.**		difficulty in writing the correct products.
(iii)	In molten state, the **giant ionic lattice** of calcium oxide **breaks down.** The **oppositely charged** / Ca^{2+} and O^{2-} are **no longer held in fixed positions and move relatively freely** to carry the electric current. Hence, suitable to be used as electrolyte.	[1] [1]	
(iv)	Positive electrode: $2O^{2-}(l) \rightarrow O_2(g) + 4e$ Negative electrode: $Ca^{2+}(l) + 2e \rightarrow Ca(l)$ Note: for overall equation, the number of electrons must be first balanced: $2CaO \rightarrow 2Ca + O_2$	[1] [1]	With correct state symbols. Candidates have problem with writing the correct state symbols and balancing the equation for the positive electrode. Some candidates mention hydroxide ions are discharged.
Either **3(a)(i)**	Group VII elements are **non metals** which **gain electrons** to achieve noble gas configuration while Group I elements are **metals** which **lose valence electrons** to achieve octet configuration.	[1]	No marks are awarded if candidates just mention about gaining or losing of electrons. Marks will be awarded if candidates link gaining/losing due to the metallic or non metallic character or the idea of achieving noble gas configuraton. Some candidates did not talk about Group I.
(ii)	Down the group, the **oxidising power decreases** because the elements	[1]	

	down the group has **lower tendency to gain** electrons. *Recall, reactive of the halogens decreases down the group because the attraction power for electron of the atom decreases down the group as the atomic size increases.	[1]	
(iii)	Colourless solution turns reddish-brown. $Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$ Chlorine **more reactive than bromine displace bromine** from aqueous potassium bromide to form a reddish brown bromine solution.	[1] [1]	the original colour and the final colour must be mentioned. Ionic equation to be supported by explanation. Candidates are still facing difficulty in constructing the correct ionic equation. Some candidates are unable to write the correct observation.
(iv)	Across the period, the electronegativity increases (from 0.93 to 3.16).	[1]	Candidates need to pay attention to the command word of the question - "describe the trend", hence data should be quoted. However, since the trend is obvious and it was only a 1 mark question, credit is given to all candidate.
(v)	Disagree. Across the period, the number of electron shell **remains as 3** but **electronegativity increases.**	[1]	change is rejected: direction of change e.g. increase/decrease/lower/larger etc. must be specified.
(b)	Down Group I, melting point of elements **decreases from 180°C to 64°C** while down Group VII, melting	[1]	Candidates need to pay attention to the command word of the question - "Using information provided", hence data should be quoted.

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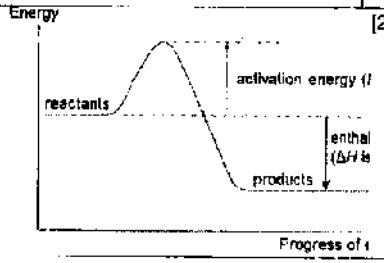
	point increase from -101°C to 114°C. Down Group I, the **metallic bond** becomes **weaker**. Thus, **lesser energy** needed to overcome the bond. Down Group VII, the **intermolecular** forces of attraction becomes **stronger** *(because the molecular size becomes bigger)*. Thus, **more energy** needed to overcome the intermolecular forces of attraction.	[1] [1]	As the atomic size increases, the valence electrons are further away from the positive metal nucleus, hence the attraction force becomes weaker and thus the metallic bond becomes weaker. *bond is different from force. eg. no BOND is present between molecules. ONLY forces of attraction are present before molecules.
Or 3(a)(i)	Number of moles of ethanol = (1/46) = 0.021739 mol Enthalpy change of combustion of ethanol = 0.021739 x -1367 = - 29.7kJ/g Thus, hydrogen gives greater output.	[1] [1] [1]	Allow ecf Surprisingly, some candidates do not know how to solve such question despite such question has appeared in O level many times. Some candidates failed to cite the units or forgot the negative sign. Marks are awarded if students did include negative sign but clear statement such as "Energy output", "Energy released" is used.
(ii)	More energy is released during the formation of bonds in water than the total energy absorbed during bond		[1]: idea of more energy released than absorbed

	breaking in hydrogen and oxygen.		[1]: reactants & products mentioned / specific bonds mentioned. Many candidates forgot that oxygen is one of the reactants. Some candidates talked about formation of carbon dioxide.
(iii)	During **photosynthesis, sugar cane takes in the carbon dioxide.** Hence, carbon dioxide produced from burning of fuel will not result in increase in amount of carbon dioxide being added.	[1]	This question was generally well attempted.
(b)(i)	Hydrogen ion has **one single proton** in its **nucleus** but **no electrons at all.**	[1]	No marks are awarded if candidates just mention because hydrogen ion has +1 charge, like a proton. Clear explaination is expected from candidates to mention idea about protons and electrons.
(ii)	A to B	[1]	This question was generally well attempted.
(iii)	$2H_2 + O_2 \rightarrow 2H_2O$	[1]	This question was generally well attempted.
(iv)		[2]	[1] Formula of reactants and products, label for enthalpy change [1] showing an exothermic energy profile diagram with correct axis.

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