| Candidate Name | Form Class | Index Number |
|---|---|---|
| | | |

# ANG MO KIO SECONDARY SCHOOL
# PRELIMINARY EXAMINATION 2025
# SECONDARY FOUR EXPRESS

**CHEMISTRY**
Paper 1 Multiple Choice

**6092/01**
**2 September 2025**
**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 on the Answer Sheet in the spaces provided.

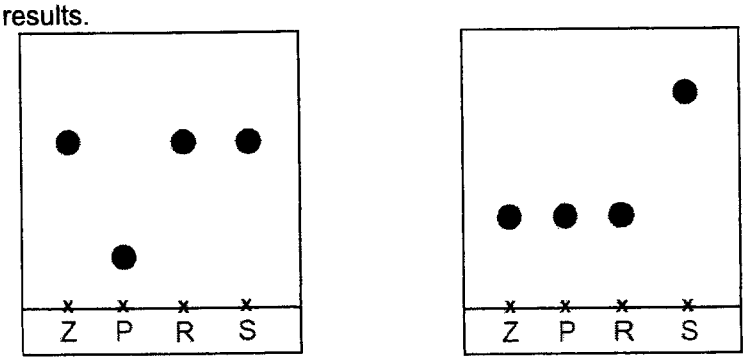
There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice **in soft pencil** on the separate Answer Sheet.

**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 on this question paper.
A copy of the Periodic Table is printed on page 17.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **17** printed pages and **1** blank page.

1 A student suspects that substance Z is one of three possible pure substances P, R or S. Two chromatograms of the four substances are obtained using different solvents. The diagrams show the results.




What could Z be?

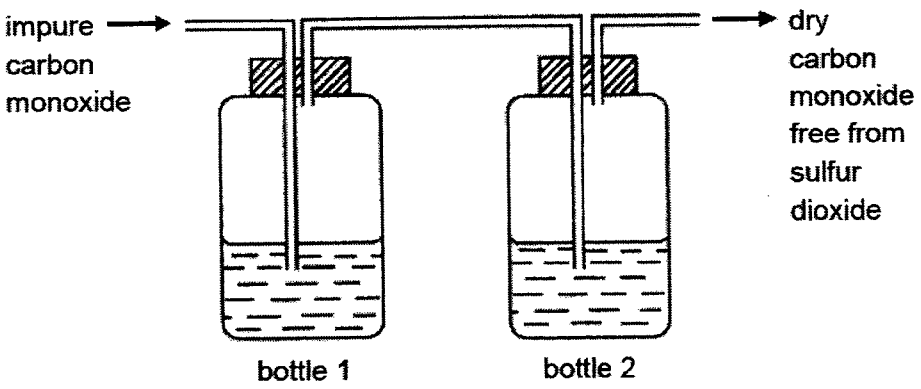
**A** R

**B** S

**C** Either P or S

**D** Neither P, R nor S

2 The apparatus shown is used to obtain a dry sample of carbon monoxide from a sample of the gas contaminated with sulfur dioxide gas.




Which shows the appropriate solutions in bottles 1 and 2 to collect a dry pure sample of carbon monoxide gas?

| | bottle 1 | bottle 2 |
|---|---|---|
| **A** | aqueous sodium hydroxide | concentrated sulfuric acid |
| **B** | aqueous sodium hydroxide | dilute sulfuric acid |
| **C** | dilute sulfuric acid | aqueous sodium hydroxide |
| **D** | dilute sulfuric acid | concentrated sulfuric acid |

3 The atmosphere of a newly discovered planet is composed of mainly argon, nitrogen and oxygen gas. The melting and boiling points of these gases are shown in the table.

| gas | melting point / °C | boiling point / °C |
|---|---|---|
| argon | −189 | −186 |
| nitrogen | −210 | −196 |
| oxygen | −219 | −183 |

What temperature should a sample of air from the newly discovered planet be cooled to if only liquid oxygen is to be obtained?

**A** −180 °C

**B** −185 °C

**C** −187 °C

**D** −198 °C

4 Naturally occurring bromine has a relative atomic mass of 80 and consists entirely of two isotopes of relative isotopic masses 79 and 81.

What can be deduced about naturally-occurring bromine from this information only?

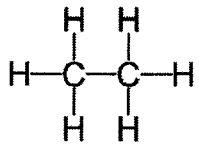
**A** Bromine isotopes have different numbers of protons.

**B** Naturally occurring bromine exist as atoms.

**C** The two isotopes of bromine exist in equal proportions in nature.

**D** There is a higher proportion of bromine-81 than bromine-79.

5 The diagram shows the structural formula of ethane.



How many electrons in a molecule of ethane are **not** involved in bonding?

**A** 2

**B** 4

**C** 7

**D** 14

6 The ion $X^{3-}$ has three complete shells of electrons. There are 17 neutrons in its nucleus.

What is the relative atomic mass of X element?

**A** 31

**B** 32

**C** 35

**D** 38

7 The chemical formula of sodium chlorate is $NaClO_3$ and the chemical formula of thallium sulfate is $Tl_2(SO_4)_3$.

What is the chemical formula of thallium chlorate?

**A** $TlClO_3$

**B** $Tl(ClO_3)_2$

**C** $Tl(ClO_3)_3$

**D** $Tl_2(ClO_3)_3$

8 Which solution contains the greatest number of ions?

**A** 1 $dm^3$ of 0.1 mol/$dm^3$ $Al_2(SO_4)_3$

**B** 1 $dm^3$ of 0.2 mol/$dm^3$ $NH_4NO_3$

**C** 2 $dm^3$ of 0.1 mol/$dm^3$ $CaCl_2$

**D** 2 $dm^3$ of 0.2 mol/$dm^3$ KI

9 Excess nitric acid is reacted with 9.00 g of pure calcium oxide to produce 16.20 g of pure anhydrous calcium nitrate crystals.

$$2\ HNO_3 + CaO \rightarrow Ca(NO_3)_2 + H_2O$$

What is the percentage yield of calcium nitrate? [Ar: H, 1; N, 14; O, 16; Ca, 40]

**A** 34.1 %

**B** 55.6 %

**C** 61.5 %

**D** 72.0 %

10 192 g of copper metal is formed when an electric current is passed through a solution of copper(II) nitrate.

What is the mass of silver formed if the same electrical current is passed through a solution silver nitrate?

**A** 108 g

**B** 216 g

**C** 324 g

**D** 648 g

11 Which substance will react with dilute nitric acid to give a colourless solution only?

**A** calcium oxide

**B** iron(II) hydroxide

**C** sodium carbonate

**D** zinc metal

12 Which salt can be prepared by titration?

**A** aluminium chloride

**B** silver chloride

**C** sodium nitrate

**D** zinc sulfate

13 Elements X, Y and Z have consecutive proton numbers. Element Y exists as gaseous atoms.

Which statement is correct?

**A** Element X forms an amphoteric oxide when it reacts with oxygen.

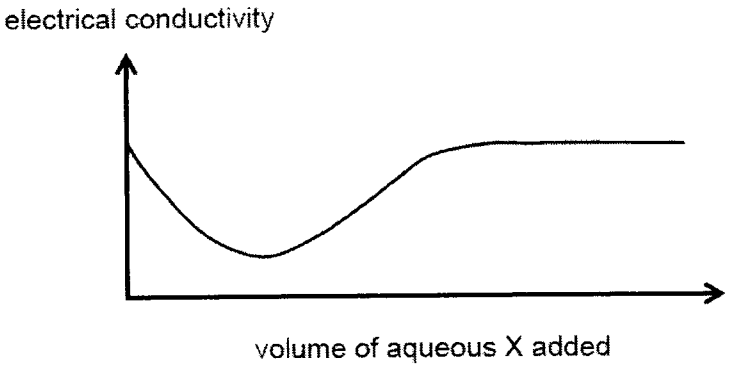
**B** Element Y forms a neutral oxide when it reacts with oxygen.

**C** Element Z forms a basic oxide when it reacts with oxygen.

**D** Neither the oxides of X, Y nor Z reacts with an acid to form a salt.

14 In an experiment, aqueous X is added slowly to aqueous barium hydroxide. The change in

the electrical conductivity of the reactant mixture is as shown.




What could X be?

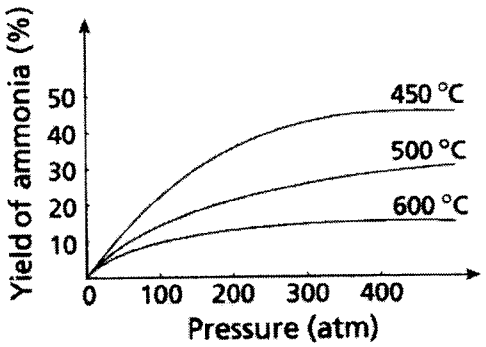
**A** aqueous ammonia

**B** hydrochloric acid

**C** iron(II) sulfate

**D** potassium chloride

**15** The graph shows the effects of pressure and temperature on the yield of ammonia in the Haber Process to manufacture ammonia.




What will be the effect of increasing the temperature but keeping pressure constant on the production of ammonia?

**A** Ammonia is produced at an increased rate and its yield increases.

**B** Ammonia is produced at an increased rate but its yield decreases.

**C** Ammonia is produced at a decreased rate but its yield increases.

**D** Ammonia is produced at a decreased rate and its yield decreases.

**16** Which statement about the manufacturing of ammonia by the Haber Process is not true?

**A** A high temperature of 450 °C is used.

**B** It is not possible to obtain 100 % yield of ammonia.

**C** Nickel catalyst is used to increase the speed of reaction.

**D** Nitrogen is reduced by hydrogen.

**17** Aqueous zinc sulfate is added to excess aqueous barium chloride during an experiment. The precipitate formed is then removed by filtration.

What are the ions present in the filtrate?

**A** $Ba^{2+}$ and $SO_4^{2-}$

**B** $Zn^{2+}$ and $Cl^-$

**C** $Zn^{2+}$, $SO_4^{2-}$ and $Cl^-$

**D** $Zn^{2+}$, $Ba^{2+}$ and $Cl^-$

**18** A series of tests was carried out on an aqueous solution of sodium carbonate and the results were recorded in a table.

Which test should be repeated because of an incorrect observation entered in the table?

| | test | observation |
|---|---|---|
| **A** | add barium chloride solution | white precipitate formed |
| **B** | add copper(II) chloride solution | green precipitate formed |
| **C** | add potassium hydroxide solution | white precipitate formed |
| **D** | add dilute sulfuric acid | effervescence occurred |

**19** A brown precipitate is formed when excess sodium hydroxide is added to solution S. The resulting mixture is heated, and no gas is formed. Aluminium foil is then added to the warmed mixture. A gas that turns damp red litmus paper blue is given off.

Which ions could be present in solution S?

**A** $Fe^{2+}$ and $NO_3^-$

**B** $Fe^{3+}$ and $NO_3^-$

**C** $Fe^{3+}$, $NH_4^+$ and $NO_3^-$

**D** $NH_4^+$ and $I^-$

**20** Which method will not slow down the rusting process of an iron nail?

**A** Electroplate the iron nail with silver metal.

**B** Coat the surface of the iron nail with paint.

**C** Submerge the iron nail in oil.

**D** Weld a piece of copper metal to the iron nail.

**21** The equations shown represent the reactions of a metal M and its oxide.

$$M + 2\,HCl \rightarrow MCl_2 + H_2$$
$$2\,M + O_2 \rightarrow 2\,MO$$
$$2\,MO + C \rightarrow \text{no reaction}$$

What could metal M be?

**A** copper

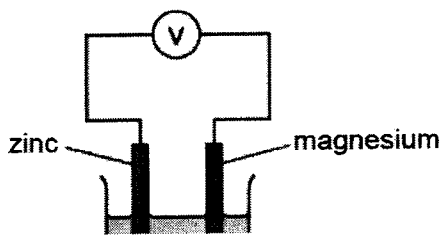
**B** magnesium

**C** silver

**D** zinc

**22** Which setup will generate the highest voltage?

**A**



B

C

D

23 Which electrolyte will require two moles of electrons to produce one mole of metal during electrolysis?

A aqueous sodium chloride

B aqueous zinc chloride

C molten magnesium chloride

D molten aluminium chloride

**24** Why are Group 1 metals generally more reactive than Group 2 metals?

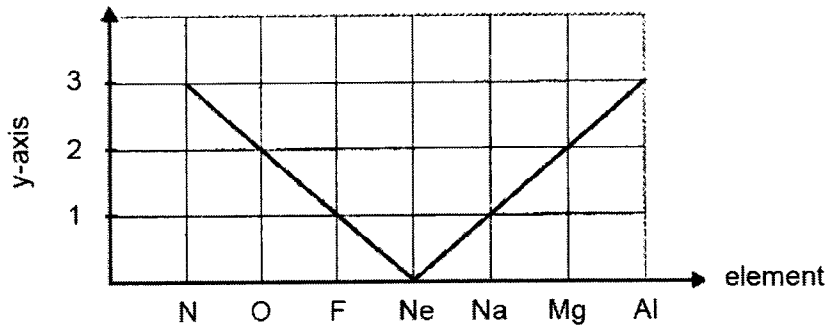
A Group 1 metals have lower melting and boiling points than Group 2 metals.

B Group 1 metals have a greater tendency to form ions than Group 2 metals.

C Group 1 metal ions are less stable than Group 2 metal ions.

D The layer of metal oxide is more soluble on Group 1 metals than Group 2 metals.

**25** The graph shows the information of seven elements in the Periodic Table.




Which property should the y-axis be?

A atomic number

B number of electron shells

C number of valence electrons

D valency of element

**26** Some properties of elements in the Periodic Table are listed.

1 metallic character

2 number of electron shells in an atom

3 number of protons in an atom

4 total number of electrons in an atom

Which two properties increase across a period of the Periodic Table?

**A** 1 and 2

**B** 1 and 3

**C** 2 and 4

**D** 3 and 4

**27** The following sequence shows the steps in the conversion of calcium phosphate, $Ca_3(PO_4)_2$, to phosphorus acid, $H_3PO_3$.

$$Ca_3(PO_4)_2 \rightarrow P_4 \rightarrow P_4O_6 \rightarrow H_3PO_3$$

What are the respective oxidation numbers of phosphorus in the above sequence?

**A** +5, 0, +3, +3

**B** +5, −3, +3, +3

**C** +6, −3, +3, +1

**D** +6, −4, +3, +4

**28** Which reaction shows a redox reaction?

**A** $2\ AgNO_3\ (aq) + FeCl_2\ (aq) \rightarrow 2\ AgCl\ (s) + Fe(NO_3)_2\ (aq)$

**B** $CaO\ (s) + CO_2\ (g) \rightarrow CaCO_3\ (s)$

**C** $Cu(NO_3)_2\ (aq) + Mg\ (s) \rightarrow Mg(NO_3)_2\ (aq) + Cu\ (s)$

**D** $2\ NaOH\ (aq) + H_2SO_4\ (aq) \rightarrow Na_2SO_4\ (aq) + 2\ H_2O\ (l)$

**29** The equation represents the reaction between copper(II) oxide and ammonia.

$$3CuO + 2NH_3 \rightarrow 3Cu + N_2 + 3H_2O$$

Which statement about the reaction is true?

**A** $Cu^{2+}$ ions gain electrons.

**B** Cu is the reducing agent.

**C** $NH_3$ is reduced.

**D** Oxidation state of hydrogen decreases from +3 to +2.

**30** Dilute sulfuric acid is reacted with zinc oxide and copper(II) oxide separately during an experiment.

In what way are the two reactions similar?

**A** A coloured precipitate is formed in both reactions.

**B** A coloured solution is formed in both reactions.

**C** Both reactions are redox reactions.

**D** Temperature increases in both reactions.

**31** When a piece of calcium metal is added to dilute hydrochloric acid, the reaction is observed to be faster after 60 seconds from the start of the experiment than at the initial stage of the reaction.

What could be the possible explanation for this observation?

**A** The concentration of the acid increases as the reaction progresses.

**B** The particle size of the metal becomes smaller as the reaction progresses.

**C** The reaction becomes faster as hydrochloric acid acts as a catalyst.

**D** The reaction produces heat which increases the temperature of the acid.

**32** Methane reacts very slowly with air at room temperature. However, methane ignites readily when palladium, a transition metal, is added to the methane-air mixture.

What is the purpose of palladium in the reaction?

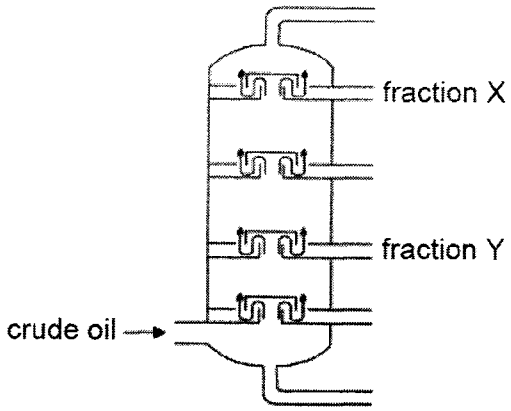
**A** It increases the enthalpy change of the reaction.

**B** It increases the flammability of methane.

C It lowers the activation energy of the reaction.

D It lowers the energy level of the reactants.

33 The diagram shows how crude oil is separated into fractions.




Which statement about fractions X and Y is correct?

A Fraction X burns more easily and has a lower boiling point than fraction Y.

B Fraction X burns more easily and has a higher boiling point than fraction Y.

C Fraction X burns less easily and has a lower boiling point than fraction Y.

D Fraction X burns less easily and has a higher boiling point than fraction Y.

34 Which statement best explains why bioethanol obtained from sugarcane plants is considered renewable?

A Bioethanol is formed by fermenting sugar from sugarcane plants.

B Bioethanol is considered to be a carbon neutral biofuel.

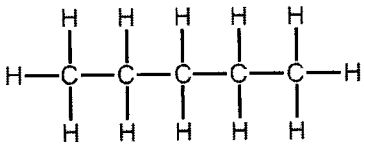
C Sugarcane plants can be regrown and replaced within a short period of time.

D Sugarcane plants take in carbon dioxide during photosynthesis.

35 The diagrams show the structures of five hydrocarbons.

14

1



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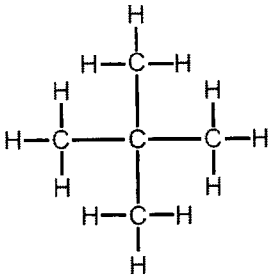

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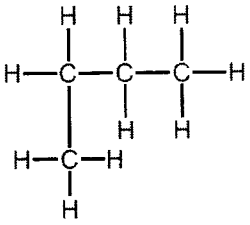

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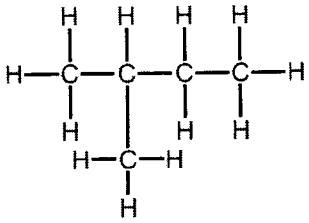

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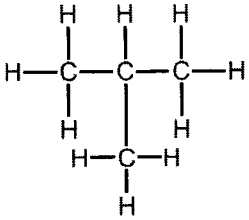


Which hydrocarbons are isomers of each other?

**A** 2 and 4

**B** 1, 2 and 4

**C** 2, 4 and 5

**D** 3, 4 and 5

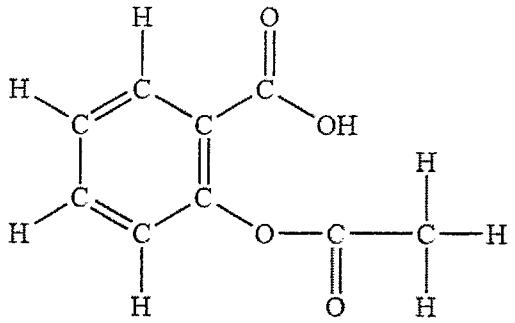
**36** Hydrogen gas is required in the production of margarine using vegetable oils.

Which of the following correctly lists the nature of the vegetable oils, the type of reaction occurring and the catalyst used?

| | nature of vegetable oil | type of reaction | catalyst used |
|---|---|---|---|
| **A** | saturated compound | addition reaction | nickel |
| **B** | unsaturated compound | substitution reaction | iron |
| **C** | saturated compound | substitution reaction | iron |
| **D** | unsaturated compound | addition reaction | nickel |

**37** Aspirin is a drug which is used as a general pain killer. The diagram shows the structural formula of aspirin.

15



Which statement about aspirin is not correct?

**A** It has a low melting point.

**B** It is formed from an alcohol and a carboxylic acid.

**C** It decolourises acidified aqueous potassium manganate(VII).

**D** It produces hydrogen gas when magnesium is added to its aqueous solution.

**38** Which natural resource is being depleted by the manufacture of plastics?

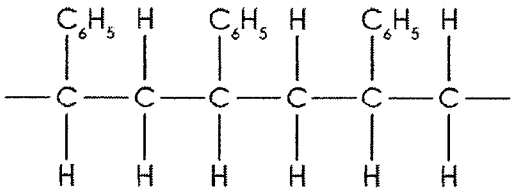
**A** air

**B** fossil fuels

**C** metal ores

**D** water

**39** The diagram shows the structure of a polymer.



What is the empirical formula of the monomers that are used to make this polymer?

**A** CH

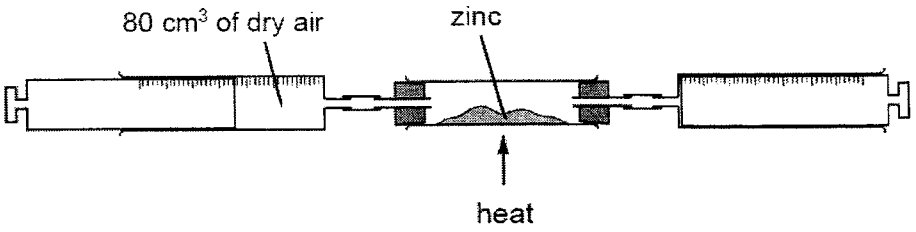
**B** $CH_2$

**C** $CH_3$

**D** $C_3H_4$

**40** A 80 $cm^3$ sample of dry air is trapped in a gas syringe. The air is slowly passed over heated excess zinc in a tube until there is no further change in the volume of air.

**16**




What is the final volume of air in the gas syringe?

**A** 16 $cm^3$

**B** 60 $cm^3$

**C** 64 $cm^3$

**D** 76 $cm^3$

**END OF PAPER**

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| Candidate Name | Form Class | Index Number |
|---|---|---|
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# ANG MO KIO SECONDARY SCHOOL
# PRELIMINARY EXAMINATION 2025
# SECONDARY FOUR EXPRESS

**CHEMISTRY** **6092/02**
**Paper 2** **29 August 2025**
**1 hour 45 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

**READ THESE INSTRUCTIONS FIRST**

Write your name, class and index number in the spaces provided at the top of this paper.
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.
Write your answers in the spaces provided.

**Section B**
Answer **one** question.
Write your answers in the spaces provided.

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

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

This document consists of **21** printed pages and **1** blank page.

## Section A

Answer **all** questions.

1 Table 1.1 shows the atomic structure of six particles, represented by the letters **P** to **U**. These particles are either atoms or ions, and the letters are **not** the symbols of the elements.

**Table 1.1**

| particles | number of electrons | number of protons | number of neutrons |
|---|---|---|---|
| **P** | 12 | 12 | 12 |
| **Q** | 2 | 2 | 2 |
| **R** | 6 | 6 | 6 |
| **S** | 10 | 12 | 12 |
| **T** | 6 | 6 | 8 |
| **U** | 7 | 7 | 14 |

Use the letters, **P** to **U** to answer the following questions.

**(a)** Which two particles are an atom and an ion of the same element?

..... [1]

**(b)** Which particle is chemically unreactive?

..... [1]

**(c)** Write the formula of the compound formed between particles **P** and **U**.

..... [1]

**(d)** Draw the electronic structure of particle **S** by showing all electrons.

[1]

[Total: 4]

2 Substance **X** is formed by burning phosphorus in a limited supply of oxygen gas.

Fig. 2.1 shows the structure of substance **X**.

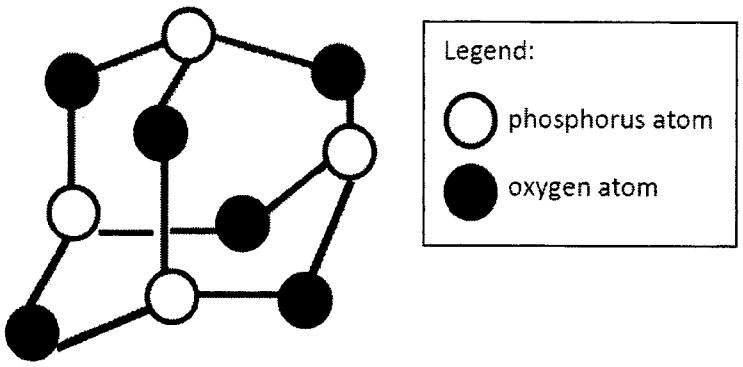



**Fig. 2.1**

**(a)** What type of bonding is present in substance **X**? Explain your answer.

.....

.....

..... [2]

**(b)** Write the chemical formula of substance **X**.

..... [1]

**(c)** Substance **X** forms a liquid when heated to 23.8 °C.

In terms of its structure, predict and explain the electrical conductivity of pure liquid **X**.

.....

.....

.....

..... [2]

**(d)** Substance **X** reacts with water to form a colourless solution **Y**.

With reference to the pH of water, predict and explain the pH of solution **Y**.

.....

.....

.....

..... [2]

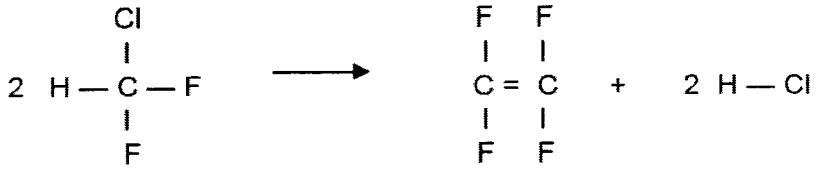
[Total: 7]

**3** Table 3.1 shows the bond energies of some bonds.

**Table 3.1**

| bond | bond energy (kJ/mol) |
|---|---|
| C – Cl | 339 |
| C – H | 413 |
| H – Cl | 431 |
| C – F | 495 |
| C = C | 610 |

Chlorodifluoromethane is used to make tetrafluoroethene as shown by the equation.



**(a)** Calculate the energy change involved in bond breaking.

energy change in bond breaking = ..... kJ [2]

**(b)** Calculate the energy change involved in bond making.

energy change in bond making = ..... kJ [2]

**(c)** Hence, calculate the enthalpy change for the reaction.

enthalpy change = ..... kJ [1]

**(d)** Explain why the bond energy of the C – F bond is more than the bond energy of the C – Cl bond.

.....

.....

..... [1]

[Total: 6]

**4** Air bags are used to protect passengers in a car during an accident. When the crash

sensor detects an impact, it causes a mixture of chemicals to be heated to a high temperature to react to produce nitrogen gas. The nitrogen gas fills the air bag as shown in Fig. 4.1.

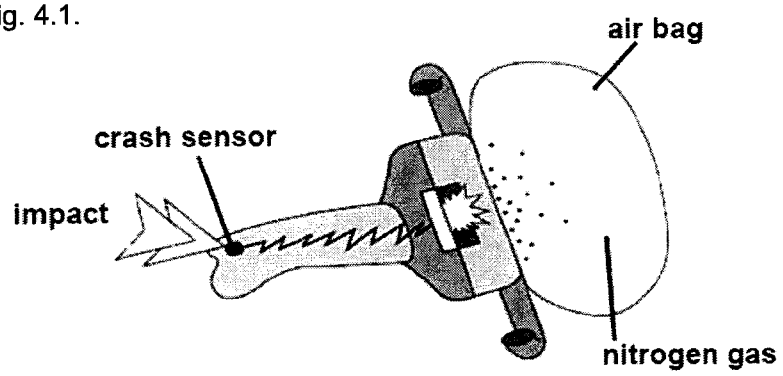



**Fig. 4.1**

The mixture of chemicals in the air bag contains sodium azide, potassium nitrate and silicon dioxide.

Sodium azide, $NaN_3$ decomposes on heating to form sodium and nitrogen. The mass of sodium azide in an air bag typically ranges from 50 g to 150 g, depending on the air bag's size and design.

**(a)** Write the equation, without state symbols, for the decomposition of sodium azide.

..... [1]

**(b)** Calculate the volume of nitrogen produced at room temperature and pressure if an air bag contains 120 g of sodium azide.

[3]

**(c)** Potassium nitrate and silicon dioxide are found in the mixture of chemicals in the air bag to help make the sodium produced from the decomposition of sodium azide safe.

Sodium reacts with potassium nitrate to form sodium oxide, potassium oxide and nitrogen.

**(i)** Write the equation, without state symbols, for the reaction between sodium and potassium nitrate.

..... [1]

**(ii)** Suggest why there is a need to make the sodium produced safe.

.....

..... [1]

**(d)** The salt potassium nitrate can be prepared in the laboratory. Suggest the method and the formulae of the reagents used.

method: .....

formulae of the reagents: ..... [2]

[Total: 8]

**5** Table 5.1 shows the formulae of some chemical reagents commonly found in the laboratory.

**Table 5.1**

| | |
|---|---|
| Zn (s) | Ag (s) |
| $Na_2CO_3$ (aq) | $Cu(NO_3)_2$ (aq) |
| $(NH_4)_2SO_4$ (aq) | NaOH (aq) |
| $HNO_3$ (aq) | $BaCO_3$ (s) |
| KI (aq) | $Ag(NO_3)_2$ (aq) |

Use the formulae to answer the following questions. You may use each formula once, more than once or not at all.

Write down the formulae of any two reagents, which when mixed together

**(a)** would produce a gas with a pH value of 12.

..... [1]

**(b)** would produce a gas that extinguishes a lighted splint with a 'pop' sound.

..... [1]

**(c)** would produce a green insoluble salt.

..... [1]

**(d)** would produce a red brown solid.

..... [1]

**(e)** would produce a yellow precipitate.

..... [1]

[Total: 5]

**6** Fig. 6.1 shows the set-up of two electrolytic cells.

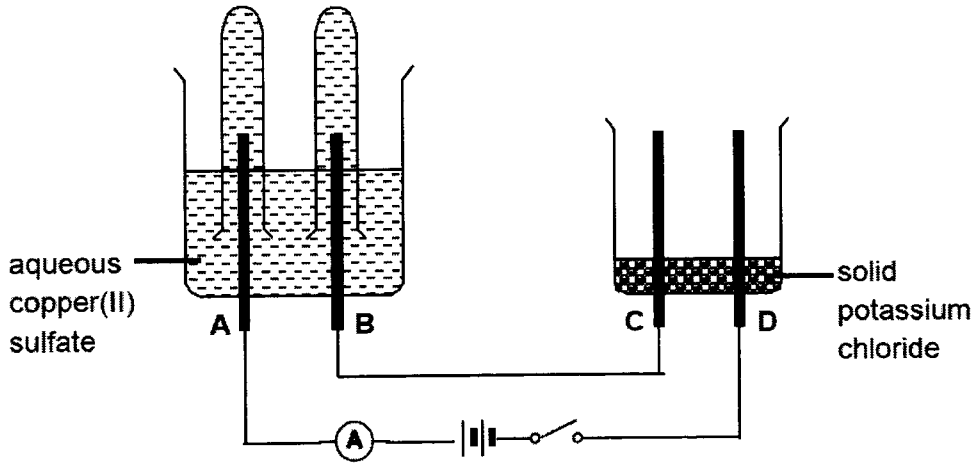



**Fig. 6.1**

The four electrodes, **A**, **B**, **C** and **D** are made of graphite. The switch is turned on once the electrolysis experiment begins.

**(a)** With reference to Fig. 6.1, explain why there is no current flow when the switch is turned on.

.....

.....

.....

..... [2]

**(b)** Suggest what can be done to the set-up in Fig. 6.1 for the electrolysis experiment to begin.

.....

..... [1]

For questions **(c)** to **(e)**, it is assumed that the experimental error in the set-up has been rectified.

**(c)** Describe and explain, with the aid of an equation, the observation made at electrode **A**.

.....

.....

.....

..... [3]

**(d)** Describe and explain, with the aid of an equation, the observation made at electrode **B**.

.....

.....

.....

..... [3]

**(e)** What observation would be made of the copper(II) sulfate electrolyte after electrolysis has been carried out for some time?

.....

..... [1]

[Total: 10]

**7** Crude oil is a mixture of mostly alkanes.

Table 7.1 shows the names and formulae of some alkanes.

**Table 7.1**

| alkane | formula |
|---|---|
| propane | $C_3H_8$ |
| butane | $C_4H_{10}$ |
| octane | |
| hexadecane | $C_{16}H_{34}$ |

**(a)** State the separation technique used to separate crude oil into useful products.

..... [1]

**(b)** One molecule of octane contains 8 carbon atoms.

Write the molecular formula of octane.

..... [1]

**(c)** Describe and explain the change in melting and boiling points of the alkanes as the number of carbon atoms in a molecule increases.

.....

.....

.....

.....

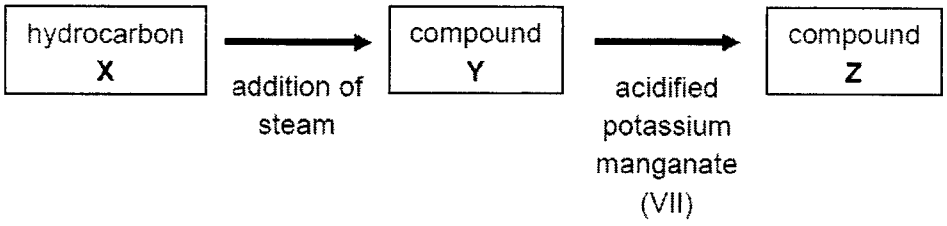
..... [2]

**(d)** Cracking of hexadecane produces 1 mole of octane, 2 moles of unsaturated hydrocarbon **X** and 1 mole of ethene.

**(i)** Write the equation for the cracking of hexadecane.

..... [1]

**(ii)** Hydrocarbon **X** undergoes the following reactions.




Name compound **Z** and draw its full structural formula.

name: ..... [1]

full structural formula:

[1]

**(e)** Compare and explain the flammability of octane with hexadecane by calculating the percentage of carbon by mass of each hydrocarbon.

.....

..... [3]

[Total: 10]

**8** Fig. 8.1 shows the structure of an organic compound **X**.

12

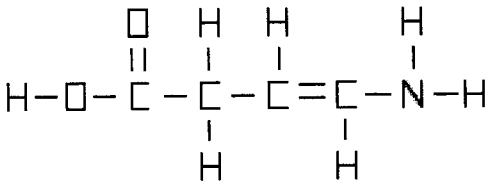


**Fig. 8.1**

A student warms compound **X** with propanol and concentrated sulfuric acid to form compound **Y**.

**(a)** Beside compound **Y**, name another substance that is formed during the reaction.

..... [1]

**(b)** What is compound **Y**?

State one physical property that is characteristic of compound **Y**.

.....

..... [2]

**(c)** Draw the structural formula of compound **Y**.

[1]

**(d)** Describe and explain what would be observed when a few drops of aqueous bromine are added to aqueous **X**.

.....

.....

.....

..... [2]

**(e)** Compound **X** can undergo polymerisation to form polymer **Z**.

**(i)** Draw two repeating units of polymer **Z**.

[2]

**(ii)** What type of linkage joins the repeating units in polymer **Z**?

..... [1]

[Total: 9]

**9** A colorimeter is a device that measures the colour of a sample, often by measuring the absorbance or transmittance of light through a solution. It is commonly used in various fields like chemistry and environmental analysis to determine colour intensity and the

concentration of a coloured substance in a solution.

The darker the colour of the solution, the more is light absorbed and the higher the absorbance reading on the colorimeter.

Fig. 9.1 shows how a colorimeter works.

A

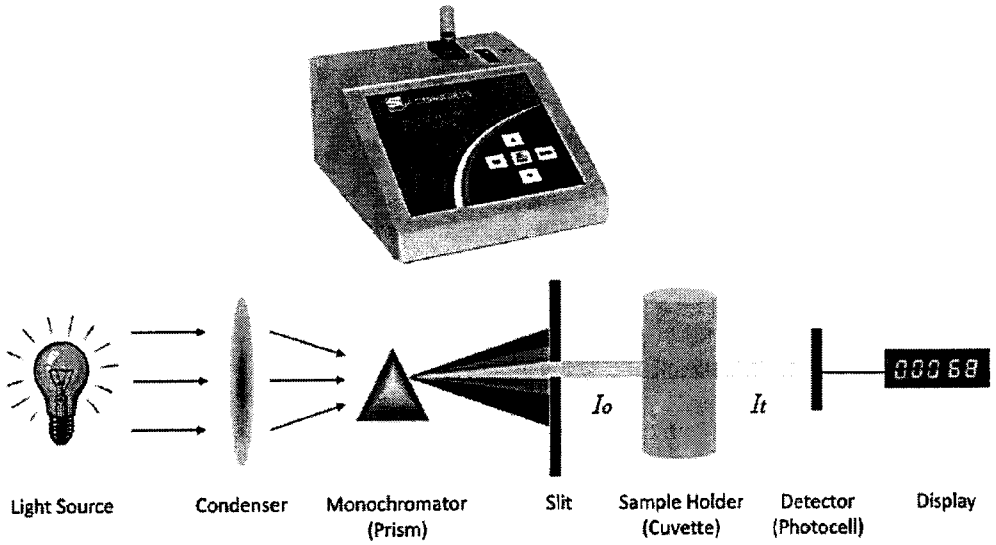



**Fig. 9.1**

student was investigating the reaction between chlorine gas and bromide ions. Chlorine gas was bubbled through aqueous sodium bromide for 6 minutes. Samples of the reaction mixture were taken every 30 seconds, and the colour intensity of each sample was measured using a colorimeter.

The student conducted a total of four experiments, each time using the same volume of aqueous sodium bromide.

Table 9.1 shows the results of the four experiments.

**Table 9.1**

| experiment | time taken for end of reaction / min | absorbance reading at end of reaction |
|---|---|---|
| 1 | 5 | 0.4 |
| 2 | 3 | 0.7 |
| 3 | 3 | 0.4 |
| 4 | 7 | 0.8 |

Fig. 9.2 shows the graph plotted for the results of one of the experiments.

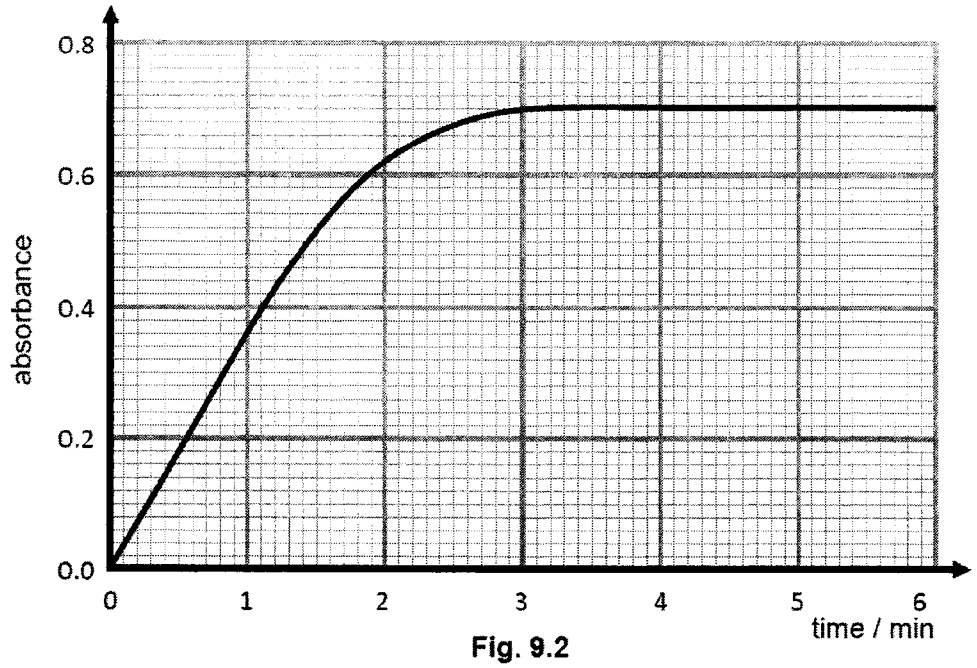



**Fig. 9.2**

**(a)** Write an equation, with state symbols, for the reaction between chlorine gas and aqueous sodium bromide.

..... [2]

**(b)** With reference to Table 9.1 and Fig. 9.2, state which experiment is the graph drawn for.

..... [1]

**(c)** With reference to Fig. 9.2, describe and explain the change in absorbance readings over time.

.....

.....

.....

.....

.....

.....

.....

..... [3]

**(d)** With reference to Table 9.1, which experiments use aqueous sodium bromide of the same concentration but at different temperature?

..... [1]

**(e)** The student conducted another two experiments, 5 and 6, using different halide solutions. The experiments were conducted using the same variables as experiment 1.

With reference to Table 9.1, compare and explain the absorbance readings obtained at the end of the reactions from using the different halide solutions with the absorbance reading of experiment 1.

**(i)** Experiment 5: chlorine gas bubbled into aqueous sodium fluoride

.....

.....

.....

.....

..... [2]

**(ii)** Experiment 6: chlorine gas bubbled into aqueous sodium iodide

.....

.....

.....

.....

..... [2]

[Total: 11]

**END OF SECTION A**

## Section B

Answer **one** question from this section.

**10** Potassium chlorate(V), $KClO_3$ is a white crystalline solid at room conditions. It decomposes to form potassium chloride and oxygen when heated to 400 °C in the presence of a catalyst, copper(II) oxide.

The reaction is represented by the equation as shown.

$$2KClO_3 \xrightarrow{CuO} 2\,KCl + 3\,O_2$$

Table 10.1 shows some properties of potassium chlorate(V), potassium chloride and copper(II) oxide.

**Table 10.1**

| | $KClO_3$ | KCl | CuO |
|---|---|---|---|
| melting point / °C | 368 | 770 | 1326 |
| boiling point / °C | – | 1420 | 2000 |
| solubility in water | soluble | soluble | insoluble |

**(a)** Suggest why the boiling point of potassium chlorate(V) is not given in Table 10.1.

.....  [1]

**(b)** What is the physical state of potassium chlorate(V) when it starts to decompose?

.....  [1]

**(c)** Describe briefly how you would obtain pure potassium chloride from a mixture of potassium chlorate(V), potassium chloride and copper(II) oxide.

.....

.....

.....

.....

.....

.....  [3]

**(d)** State the oxidation state of chlorine in $KClO_3$.

..... [1]

**(e)** Explain, in terms of oxidation number, why the decomposition of potassium chlorate(V) is a redox reaction.

.....

.....

.....

.....

.....

..... [2]

**(f)** With the aid of an equation, name a reaction that is not a redox reaction.

.....

..... [2]

[Total: 10]

11 Fig. 11.1 shows the ionisation energies of the first 20 elements in the Periodic Tabl

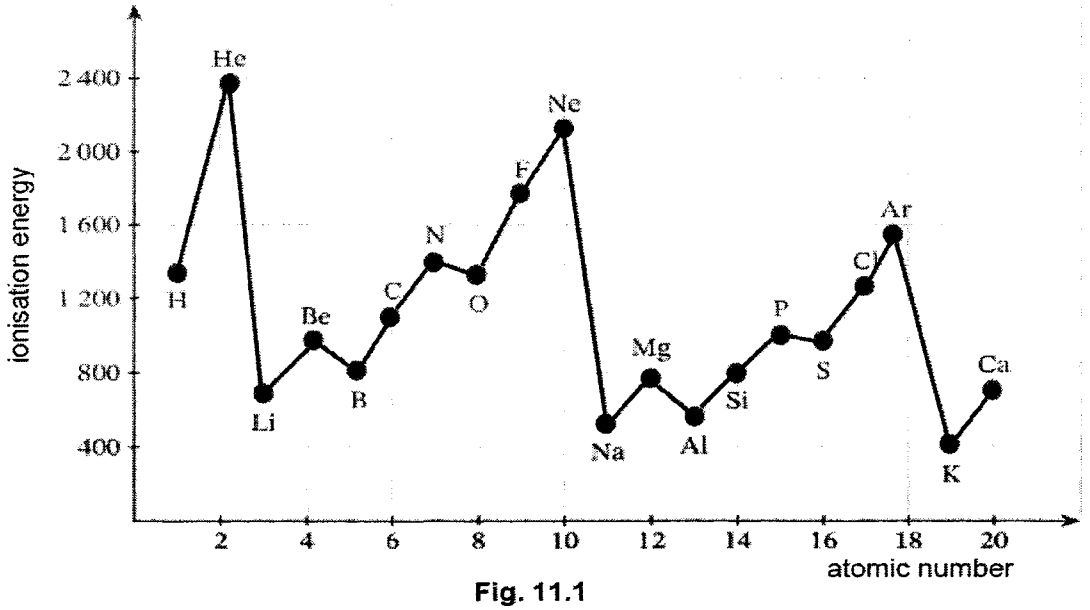



**Fig. 11.1**

The ionisation energy is the minimum energy required to remove an electron from a gaseous atom or ion, forming a positive ion.

**(a)** Describe and explain the trend in ionisation energy down group 1 of the Periodic Table.

.....

.....

.....

.....

..... [3]

**(b)** Describe and explain the trend in ionisation energy across period 2 of the Periodic Table.

.....

.....

.....

.....

..... [3]

**(c)** Lithium has two stable isotopes, Li−6 and Li−7.

Compare the ionisation energies of the two lithium isotopes. Explain your answer.

.....

.....

.....

.....

..... [2]

**(d)** Sodium sulfide can be synthesized in the laboratory by reacting sodium metal with sulfur.

Draw a 'dot and cross' diagram to show the bonding of sodium sulfide. Show only the outer electrons.

[2]

[Total: 10]

**END OF PAPER**

22

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**ANG MO KIO SECONDARY SCHOOL**
**PRELIM EXAMINATION 2025**
**SECONDARY FOUR EXPRESS**
**CHEMISTRY [6092]**

**ANSWER SCHEME**

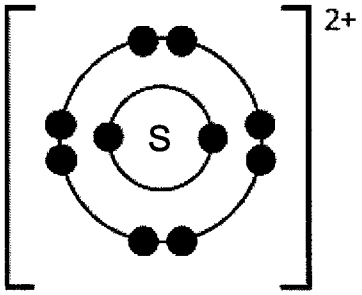
**Paper 1: Multiple-Choice Questions [40 Marks]**

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

**ANG MO KIO SECONDARY SCHOOL**
**PRELIMINARY EXAMINATION 2025**
**SECONDARY FOUR EXPRESS**
**CHEMISTRY [6092]**

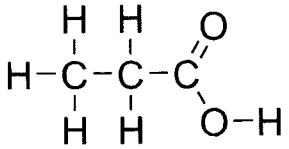
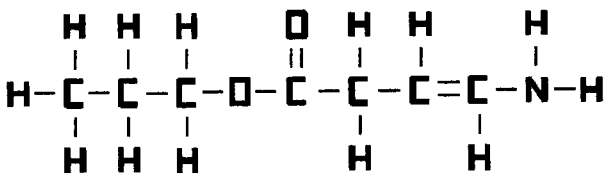
**ANSWER SCHEME**

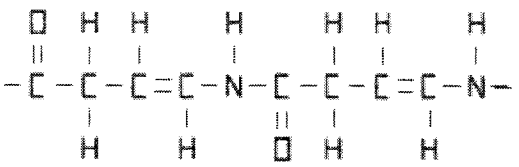
**Paper 2**
**Section A: Compulsory Structured Questions [70 Marks]**

| | | | |
|---|---|---|---|
| 1a | P and S | 1 | |
| | | | |
| 1b | Q | 1 | |
| | | | |
| 1c | $P_3U_2$ | 1 | |
| | | | |
| 1d |  | 1 | |
| | **Total** | **4** | |
| | | | |
| 2a | Covalent bonding.<br><br>Bonding between non-metal elements phosphorus and oxygen is covalent in nature. | 1<br><br>1 | |
| | | | |
| 2b | $P_4O_6$ | 1 | (R): $P_2O_3$ / $O_6P_4$ |
| | | | |
| 2c | Liquid X is not able to conduct electricity.<br><br>X has a simple molecular structure / is a simple molecule and does not have mobile ions or electrons to act as charge carriers to conduct electricity. | 1<br><br>1 | |
| | | | |
| 2d | pH of solution Y is less than pH 7.<br><br>Substance X is acidic oxide as it is a non-metal oxide and will dissolve in / react with water to form an acidic solution. | 1<br><br>1 | |
| | **Total** | **7** | |
| | | | |
| 3a | Bond breaking energy for 4 moles of C-F = 4 x 495 kJ/mol | 2 | |

| | | | |
|---|---|---|---|
| | = 1980 kJ<br><br>Bond breaking energy for 2 moles of C-Cl = 2 x 339 kJ/mol<br>= 678 kJ<br><br>Bond breaking energy for 2 moles of C-H = 2 x 413 kJ/mol<br>= 826 kJ<br><br>Total bond breaking energy = 1980 + 678 + 826 = 3484 kJ<br><br>(correct working = 1; correct ans = 1) | | |
| | | | |
| 3b | Bond forming energy for 4 moles of C-F = 4 x 495 kJ/mol<br>= 1980 kJ<br><br>Bond forming energy for 1 mole of C=C is 610 kJ<br><br>Bond forming energy for 2 moles of H-Cl = 2 x 431 kJ/mol<br>= 862 kJ<br><br>Total bond forming energy = 1980 + 610 + 862 = 3452 kJ<br><br>(correct working = 1; correct ans = 1) | 2 | |
| | | | |
| 3c | $\Delta$ H of the reaction = 3484 kJ – 3452 kJ<br>= + 32 kJ | 1 | Allow for ecf |
| | | | |
| 3d | Fluorine is more reactive than chlorine. Therefore, the covalent bond formed between C – F is stronger than between C – Cl. Hence, it needs more energy to break the C – F bond compared to C – Cl bond. | 1 | |
| | **Total** | **6** | |
| | | | |
| 4a | $2\ NaN_3 \rightarrow 2\ Na + 3\ N_2$ | 1 | |
| | | | |
| 4b | $M_r$ of $NaN_3$ = 23 + 3(14)<br>= 65<br>Number of moles of $NaN_3$ used = 120 ÷ 65<br>= 1.84615 mol [1m]<br>Mole ratio of $NaN_3$ : $N_2$ = 2 : 3<br>= 1.84615 : 2.76923<br>Number of moles of $N_2$ produced = 2.76923 mol [1m]<br>Volume of $N_2$ produced = 2.76923 × 24 $dm^3$<br>= 66.46154<br>= 66.5 $dm^3$ [1m] | 3 | |
| | | | |
| 4ci | $10\ Na + 2\ KNO_3 \rightarrow 5\ Na_2O + K_2O + N_2$ | 1 | |
| | | | |
| 4cii | Sodium is a very reactive metal which reacts violently with water and oxygen in air. | 1 | |
| | | | |
| 4d | Method: titration | 1 | |

| | | | |
|---|---|---|---|
| | Reagents formulae: KOH / $K_2CO_3$ and $HNO_3$ | 1 | |
| | **Total** | **8** | |
| | | | |
| 5a | NaOH and $(NH_4)_2SO_4$ | 1 | |
| | | | |
| 5b | $HNO_3$ and Zn | 1 | |
| | | | |
| 5c | $Cu(NO_3)_2$ and $Na_2CO_3$ | 1 | |
| | | | |
| 5d | $Cu(NO_3)_2$ and Zn | 1 | |
| | | | |
| 5e | KI and $Ag(NO_3)_2$ | 1 | |
| | **Total** | **5** | |
| | | | |
| 6a | Potassium chloride is an ionic compound.<br><br>In the solid state, the oppositely charged ions in potassium iodide are fixed in position and cannot move freely to act as charge carries to conduct electricity. | 1<br><br>1 | |
| | | | |
| 6b | Add distilled water to solid potassium chloride to form an aqueous solution / heat potassium chloride until it melts to form a molten liquid. | 1 | |
| | | | |
| 6c | $4\ OH^-\ (aq) \rightarrow 2\ H_2O\ (l) + O_2\ (g) + 4\ e^-$<br><br>Effervescence observed. A colourless and odourless gas is given off.<br><br>$OH^-$ ions are preferentially discharged in place of $SO_4^{2-}$ ions. Each $OH^-$ ion loses an electron to form water and oxygen gas. $OH^-$ ions are oxidised. | 1<br><br>1<br><br>1 | |
| | | | |
| 6d | $Cu^{2+}\ (aq) + 2\ e^- \rightarrow Cu\ (s)$<br><br>A brown solid is deposited on the electrode.<br><br>$Cu^{2+}$ ions are preferentially discharged in place of $H^+$ ions. $Cu^{2+}$ ion gains two electrons to form Cu metal. $Cu^{2+}$ ions are reduced. | 1<br><br>1<br><br>1 | |
| | | | |
| 6e | Blue copper(II) sulfate solution turns colourless / pale blue. | 1 | |
| | **Total** | **10** | |
| | | | |
| 7a | fractional distillation | 1 | |
| | | | |
| 7b | $C_8H_{18}$ | 1 | |
| | | | |
| 7c | The greater the number of carbon atoms per molecule, the | 1 | |

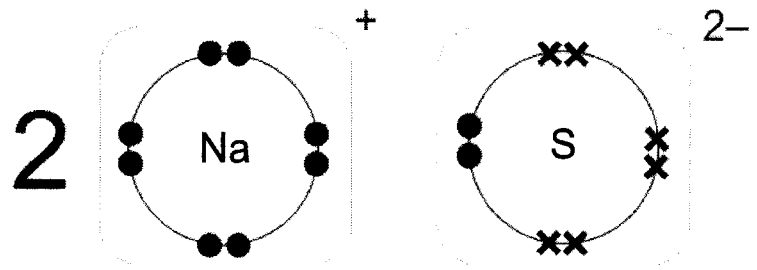
| | | | |
|---|---|---|---|
| | higher the melting and boiling points of the alkanes.<br><br>As the molecular mass / size increases with more carbon atoms per molecule, the intermolecular forces of attraction between the molecules increases. More energy is needed to overcome the stronger attractive forces. | 1 | |
| | | | |
| 7di | Equation: $C_{16}H_{34} \rightarrow C_8H_{18} + 2\,C_3H_6 + C_2H_4$ | 1 | |
| | | | |
| 7dii | Name: propanoic acid<br><br>Full structural formula:  | 1<br><br>1 | |
| | | | |
| 7e | Percentage by mass of carbon in octane<br>= {8(12) ÷ [8(12) + 18(1)]} × 100%<br>= 84.2%<br><br>Percentage by mass of carbon in hexadecane<br>= {16(12) ÷ [16(12) + 34(1)]} × 100%<br>= 84.95%<br>= 85.0%<br><br>Octane has a lower percentage by mass of carbon than hexadecane.<br><br>Octane is more flammable than hexadecane as flammability of alkanes decreases with higher percentage of carbon by mass. | 1<br><br>1<br><br>1 | |
| | **Total** | **10** | |
| | | | |
| 8a | water | 1 | |
| | | | |
| 8b | Ester<br><br>Sweet smelling | 1<br><br>1 | |
| | | | |
| 8c |  | 1 | |
| | | | |
| 8d | Red-brown aqueous bromine becomes decolourised / turns colourless. | 1 | |

| | | | |
|---|---|---|---|
| | Compound X is an unsaturated organic compound and will undergo addition reaction with bromine. | 1 | |
| | | | |
| 8ei |  <br>(correct amide linkage = 1; two repeating units = 1) | 2 | |
| | | | |
| 8eii | Amide bond / linkage | 1 | |
| | **Total** | **9** | |
| | | | |
| 9a | $Cl_2$ (g) + 2 NaBr (aq) → 2 NaCl (aq) + $Br_2$ (aq)<br>(balanced equation = 1; state symbols = 1) | 2 | |
| | | | |
| 9b | Experiment 2 | 1 | |
| | | | |
| 9c | In the first two minutes, the rate of change of absorbance is very fast as there is a high concentration of bromide ions being displaced.<br><br>The rate of change of absorbance then slows down as the concentration of bromide ions being displaced decreases over time.<br><br>After 3 minutes, the reaction has come to a stop as all the bromide ions are displaced from the solution. | 1<br><br>1<br><br>1 | |
| | | | |
| 9d | Experiments 1 and 3 | 1 | |
| | | | |
| 9ei | The absorbance reading of experiment 5 is lower than 0.4.<br><br>Chlorine is less reactive than fluorine and will not displace fluorine from sodium fluoride. The colour of aqueous chlorine and sodium fluoride is lighter than aqueous bromine. | 1<br><br>1 | |
| | | | |
| 9eii | The absorbance reading of experiment 6 is higher than 0.4.<br><br>Chlorine is more reactive than iodine and will displace iodine from sodium iodide to form aqueous iodine. Aqueous iodine is darker in colour than aqueous bromine. | 1<br><br>1 | |
| | **Total** | **11** | |

**Section B: Free Response Questions [10 Marks]**

| | | | |
|---|---|---|---|
| 10a | The decomposition point of potassium chlorate(V) is below its | 1 | (R): Sublimation |

| | | | |
|---|---|---|---|
| | boiling point / potassium chlorate(V) decomposes at a temperature below its boiling point. | | |
| | | | |
| 10b | Liquid state | 1 | |
| | | | |
| 10c | • Heat the mixture to 400 °C to decompose $KClO_3$ to form KCl.<br>• Weigh and reheat the mixture until the mass remains constant.<br>• Add excess distilled water to the cooled mixture to dissolve KCl.<br>• Filter the mixture to remove CuO as the residue.<br>• Heat the filtrate of KCl to saturation.<br>• Cool the filtrate to allow crystallisation of KCl.<br>• Filter the filtrate to obtain KCl crystals as residue.<br>• Wash with distilled water and dry between dry filter papers.<br>(8 points = 3; 6-7 points = 2; 4-5 points= 1) | 3 | |
| | | | |
| 10d | + 5 | 1 | |
| | | | |
| 10e | The oxidation state of chlorine decreases from +5 in $KClO_3$ to −1 in KCl. Therefore, chlorine in $KClO_3$ is reduced.<br><br>The oxidation state of oxygen increases from −2 in $KClO_3$ to 0 in $O_2$. Therefore, oxygen in $KClO_3$ is oxidised.<br><br>Since there is oxidation and reduction occurring during the decomposition reaction, it is a redox reaction. | 1<br><br>1 | |
| | | | |
| 10f | acid-base neutralisation / precipitation reaction<br><br>(an appropriate equation based on the stated reaction; state symbols not required) | 1<br><br>1 | |
| | **Total** | **10** | |
| | | | |
| 11a | Ionisation energy decreases down group 1.<br><br>Down group 1, the number of electron shells increases.<br><br>The increase in distance between the outer electron and the nucleus / protons resulted in weaker electrostatic attraction between them and less energy needed to remove an electron. | 1<br><br>1<br><br>1 | |
| | | | |
| 11b | Ionisation energy increases across period 2.<br><br>Across period 2, the number of protons increases but the number of electron shells is the same.<br><br>The increase in proton number but with similar distance between protons and outer electrons resulted in stronger electrostatic attraction between them and more energy needed to remove an electron. | 1<br><br>1<br><br>1 | |
| | | | |
| 11c | The ionisation energies of Li−6 and Li−7 are the same / similar. | 1 | |

| | | | |
|---|---|---|---|
| | Ionisation energy is dependent on the electrostatic attraction between protons and electrons, not the number of neutrons. Both isotopes have the same number of protons and electrons. | 1 | |
| | | | |
| 11d |  <br>(correct ratio of atoms and no. of electrons = 1; correct charges = 1) | 2 | |
| | **Total** | **10** | |