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

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

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

Setter: Mr Vincent Voo

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.

**[Turn Over**

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## 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]



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

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

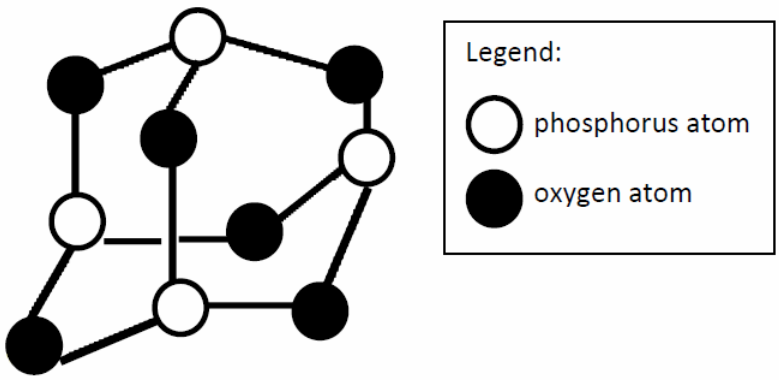



**Fig. 2.1**

**(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]



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**(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]

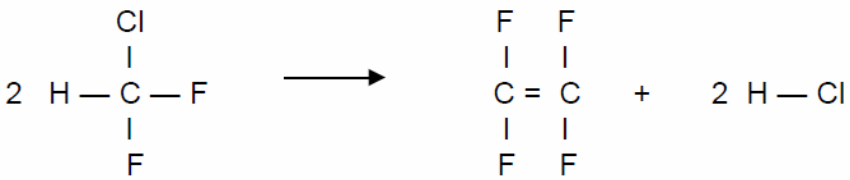
[Total: 7]

**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]



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**(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



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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.

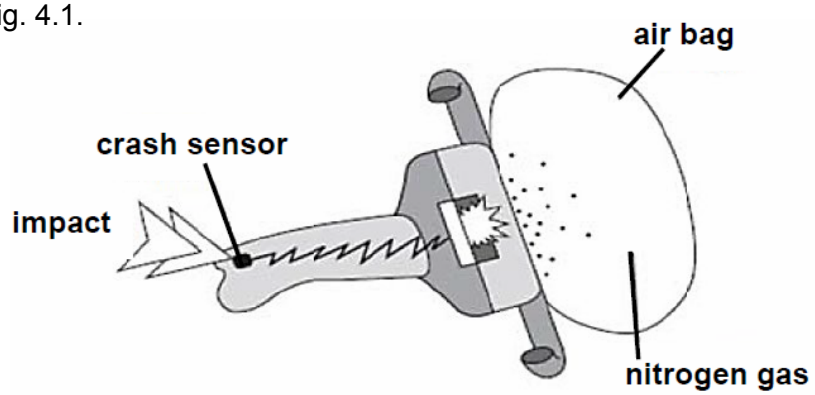



**Fig. 4.1**

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.



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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]



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**(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.

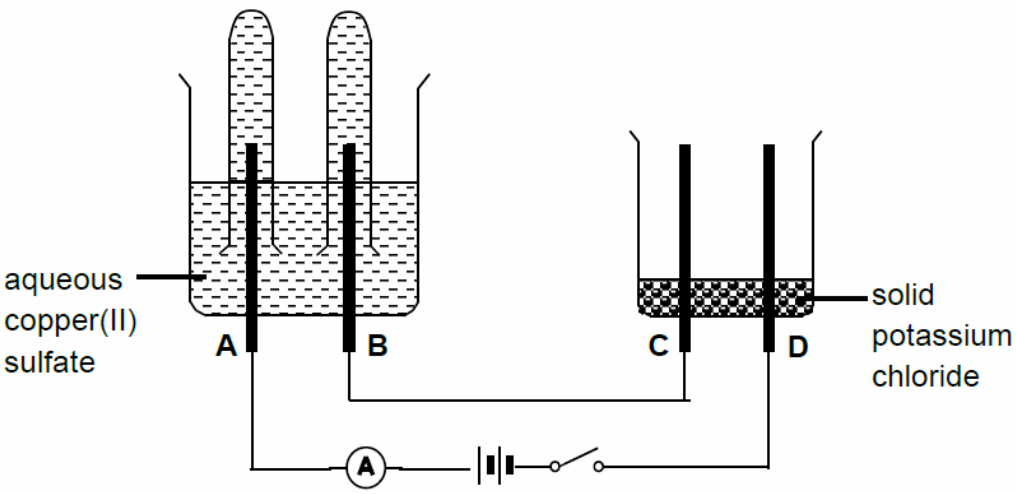



**Fig. 6.1**

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.

…….



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……. [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.



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**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.

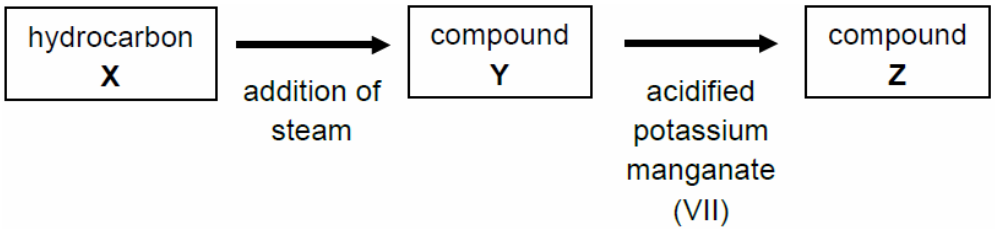
**(i)** Write the equation for the cracking of hexadecane.

…… [1]

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



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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**.



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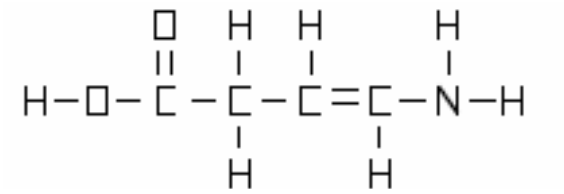


**Fig. 8.1**

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**.



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**(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



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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

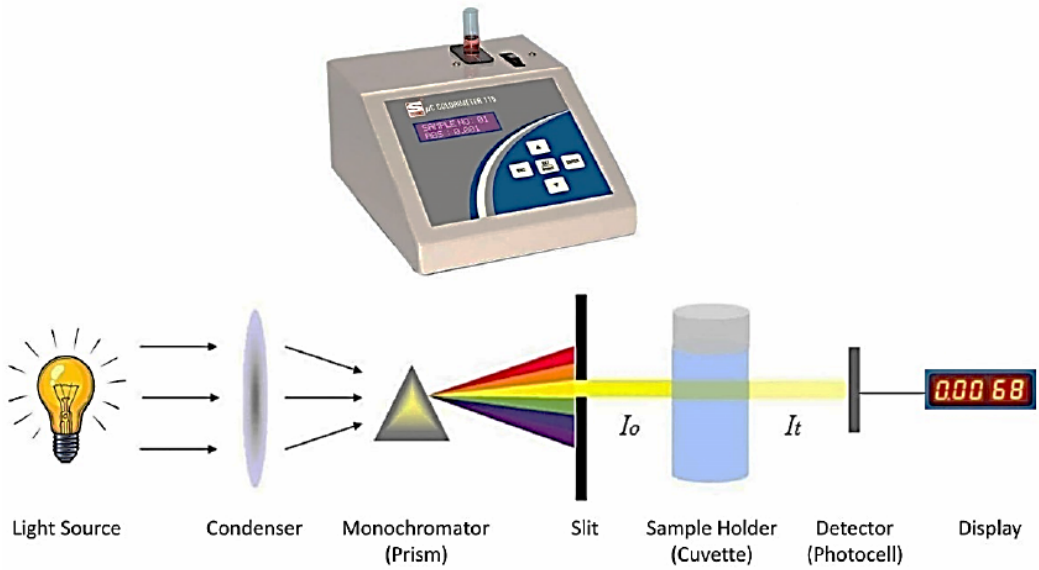



**Fig. 9.1**

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.



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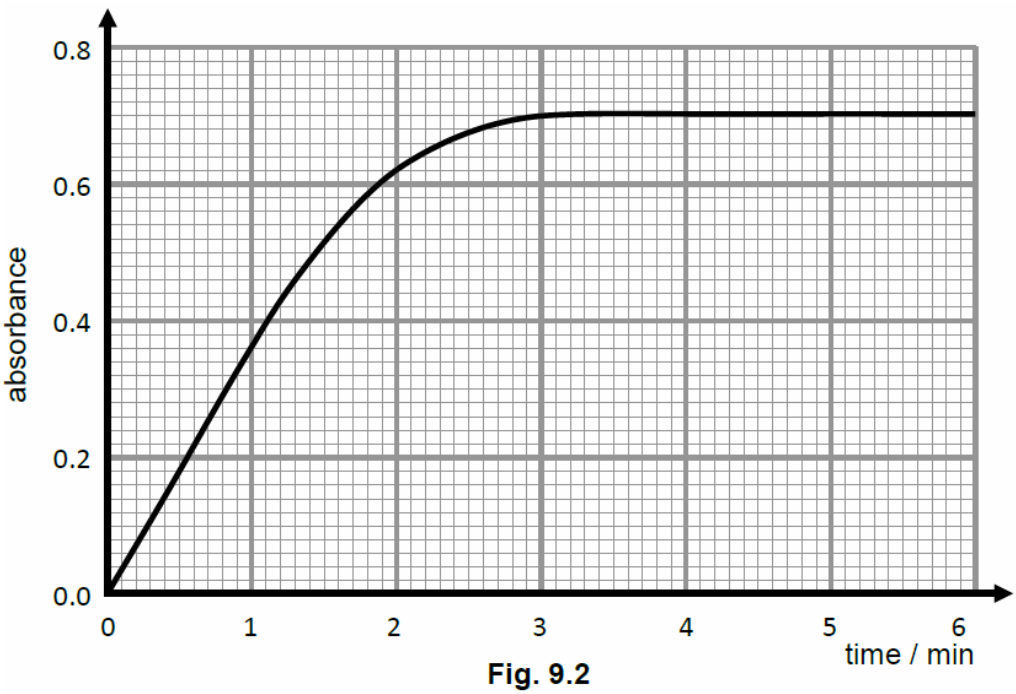



**Fig. 9.2**

**(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?



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……. [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**



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## 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]



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**(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]



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

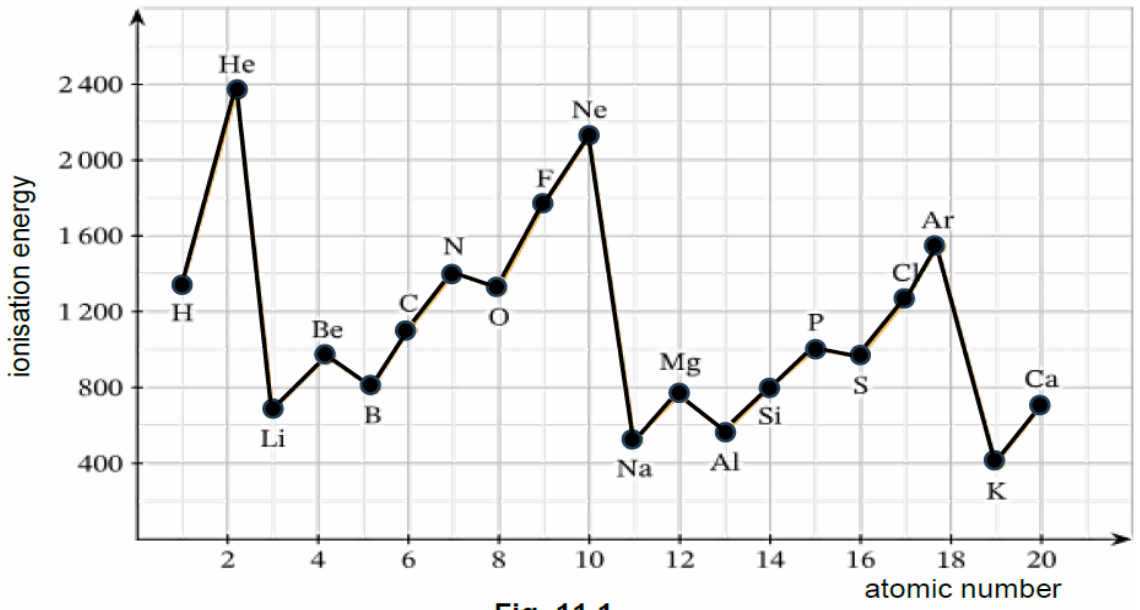



**Fig. 11.1**

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.



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

……

……

……

……

…… [2]

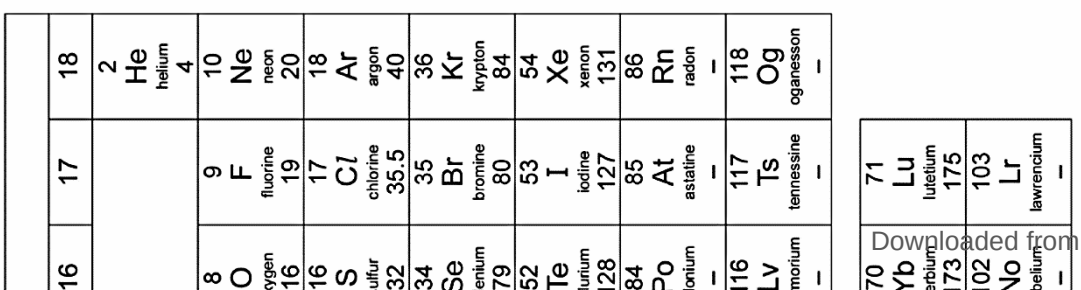
**(d)** Sodium sulfide can be synthesized in the laboratory by reacting sodium metal with sulfur.

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

[2]

[Total: 10]

**END OF PAPER**




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