



Answer ALL questions. Write your answers in the spaces provided.

1. (a) A sample of an element can be analysed to show its isotopic composition using a mass spectrometer.

(i) Explain how the sample is ionised.

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(2)

(ii) State the TWO properties of the ion that determine the path of the ion through the magnetic field.

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(2)

(b) Define relative isotopic mass.

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(2)



- (c) The following data were obtained from the mass spectrum of a sample of chromium.

Relative isotopic mass	Percentage abundance
49.95	4.345
51.94	83.79
52.94	9.501
53.94	2.364

Calculate the relative atomic mass of this sample of chromium.

Give your answer to **four** significant figures.

(2)

- (d) Complete the electron configuration of an iron atom, atomic number 26.

1s	2s	2p			3s	3p			3d				4s
↑↓	↑↓	↑↓	↑↓	↑↓									

(2)

Q1

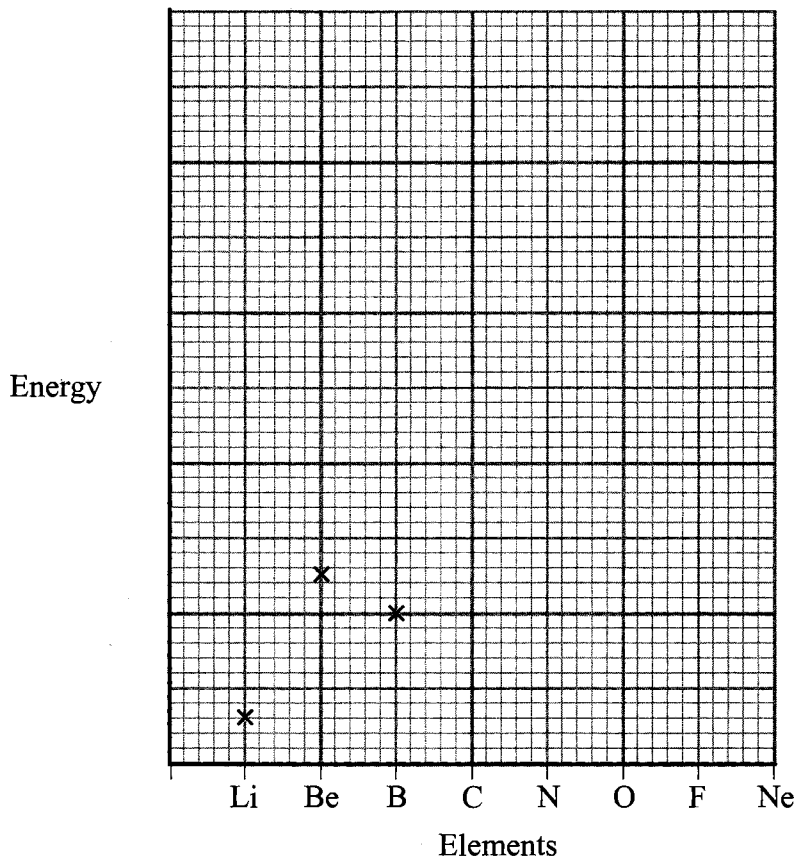
(Total 10 marks)



2. (a) The graph below shows the first ionisation energies of the elements Li, Be, and B.

Complete the graph by adding the **approximate** first ionisation energies of the elements C to Ne.

First ionisation energy of the elements Li to Ne



(2)



(b) Explain why the general trend is for the first ionisation energy to increase across the period.

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(3)

(c) Explain why the first ionisation energy of boron, B, is lower than that of beryllium, Be.

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(2)

(Total 7 marks)

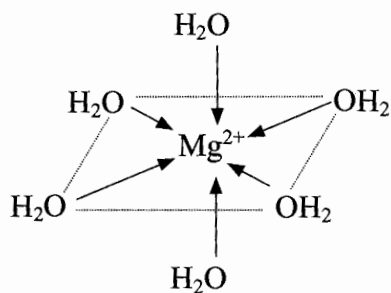
Q2



3. (a) Write an equation, with state symbols, to illustrate the process occurring when the **second ionisation energy** of magnesium is measured.

..... (2)

- (b) Hydrated magnesium chloride crystals,  $[\text{Mg}(\text{H}_2\text{O})_6]\text{Cl}_2$ , have six molecules of water attached to the central magnesium ion as shown below.



State the type of bond that exists in this ion between

- (i) the oxygen in the water molecules and the magnesium ion

..... (1)

- (ii) hydrogen and oxygen in the water molecules

..... (1)



(c) The data below shows the decomposition temperatures of the carbonates of two Group 2 elements.

Compound	Decomposition temperature / °C
MgCO <sub>3</sub>	400
BaCO <sub>3</sub>	1360

Use the idea of polarisation of ions to explain why MgCO<sub>3</sub> decomposes more readily than BaCO<sub>3</sub>.

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(3)

Q3

(Total 7 marks)



4. (a) Sodium chloride and sodium iodide both have the same crystal structure.

(i) Use your knowledge of the structure of solid sodium chloride to draw a labelled diagram of the three-dimensional structure of solid **sodium iodide**.

(2)

(ii) What are the TWO major factors that affect the strength of an ionic bond?

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(2)

(iii) Suggest why sodium iodide has a lower melting temperature than that of sodium chloride.

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(2)





(b) Explain why **molten** sodium iodide conducts electricity but **solid** sodium iodide does not.

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(2)

(c) Suggest why molten sodium iodide and molten sodium chloride have very high boiling temperatures.

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(1)

Q4

(Total 9 marks)

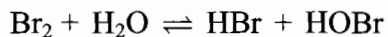


5. Bromine is extracted from seawater using chlorine.

- (a) (i) Write the equation for the reaction of chlorine with sodium bromide solution. Do **not** include state symbols.

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(1)

- (ii) The seawater is acidified before the reaction with chlorine to prevent the bromine produced reacting with the water.



Name the type of reaction taking place between bromine and water.

Explain your answer in terms of the changes in oxidation number of bromine.

**Type of reaction** .....

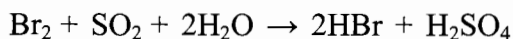
**Explanation**

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(2)



(iii) Bromine vapour reacts with sulphur dioxide and water as follows.



State the oxidation number of sulphur in

$\text{SO}_2$  .....

$\text{H}_2\text{SO}_4$  .....

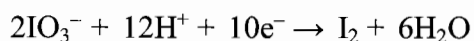
(2)

(iv) Use the data from (iii) to show that bromine is acting as an oxidising agent.

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(1)

(b) The ionic half-equation for the reduction of iodate(V) ions,  $\text{IO}_3^-$ , to iodine in acid solution is



(i) Write the ionic half-equation for the oxidation of  $\text{SO}_2$  in water to  $\text{SO}_4^{2-}$  and  $\text{H}^+$  ions. Do **not** include state symbols.

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(1)

(ii) Combine the reduction reaction of iodate(V) ions,  $\text{IO}_3^-$ , with the oxidation reaction of  $\text{SO}_2$  to give the full ionic equation for the reaction of  $\text{IO}_3^-$  with  $\text{SO}_2$ . Do **not** include state symbols.

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(2)

(Total 9 marks)

Q5



6. (a) State the flame colours of

(i) barium

..... (1)

(ii) strontium

..... (1)

(b) When barium is burnt in excess oxygen a compound containing 81.1% barium and 18.9% of oxygen is formed.

Calculate the empirical formula of this compound.

(2)

(c) (i) Write the equation for the reaction of barium with water. Do **not** include any state symbols.

..... (1)

(ii) When a small piece of barium is added to water, the barium gets smaller and eventually disappears.

State TWO other observations you could make.

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 .....  
 ..... (2)

(iii) What would be the effect of adding a piece of blue litmus paper and a piece of red litmus paper to the aqueous product of the reaction in (ii)?

Red litmus .....

Blue litmus .....

(1)

Q6

(Total 8 marks)



7. Phosphorus reacts with a limited amount of chlorine to produce phosphorus trichloride,  $\text{PCl}_3$ .

(a) (i) Draw a dot and cross diagram to show the arrangement of the electrons in phosphorus trichloride,  $\text{PCl}_3$ . You need only show the outer shell electrons.

(2)

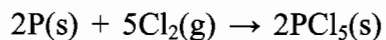
(ii) Draw the phosphorus trichloride molecule, making its three-dimensional shape clear.

(1)





(b) Phosphorus reacts with excess chlorine to produce phosphorus pentachloride,  $\text{PCl}_5$ .



(i) Calculate the mass of phosphorus needed to produce 7.19 g of phosphorus pentachloride.

(2)

(ii) Calculate the volume of chlorine needed to produce 7.19 g of phosphorus pentachloride.

[molar volume of chlorine under the conditions of this experiment =  $24.0 \text{ dm}^3 \text{ mol}^{-1}$ ]

(2)

Q7

(Total 10 marks)

**TOTAL FOR PAPER: 60 MARKS**

**END**



