



**SECTION A**

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

- 1 (a) Define the terms *mass number* and *atomic number* of an atom.

*Mass number* .....

*Atomic number* .....

(2 marks)

- (b) Give the symbol, including the mass number and the atomic number, for the atom which has 3 fewer neutrons and 2 fewer protons than  ${}^{14}_7\text{N}$ .

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(2 marks)

- (c) In terms of sub-levels, give the complete electronic configuration of the nitrogen atom, N, and of the nitride ion,  $\text{N}^{3-}$ .

N .....

$\text{N}^{3-}$  .....

(2 marks)

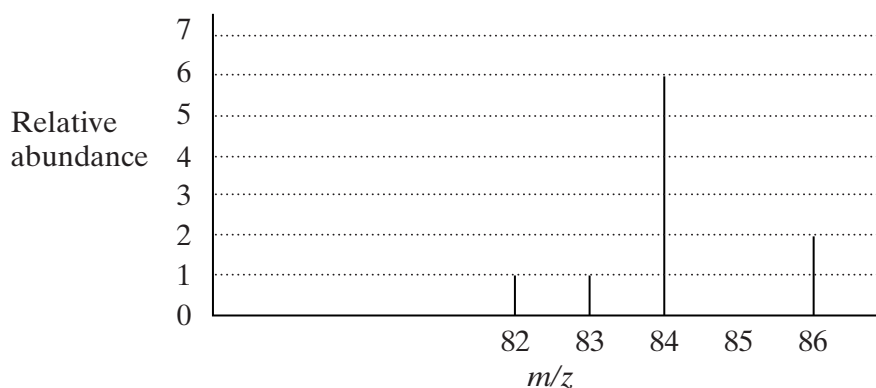
- (d) Define the term *relative atomic mass* of an element.

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(2 marks)

- (e) When a pure, gaseous sample of element **X** is introduced into a mass spectrometer, four mononuclear, singly-charged ions are detected, as shown in the spectrum below.



- (i) Describe the process by which the gaseous sample of **X** is converted into ions in a mass spectrometer.

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- (ii) What adjustment is made to the operating conditions in order to direct the different ions, in turn, onto the detector of a mass spectrometer?

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- (iii) Use data from the spectrum above to calculate the relative atomic mass of **X**.

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- (iv) Identify the element **X**.

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(7 marks)

- 2 (a) What is the name given to the number of molecules in one mole of carbon dioxide?

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(1 mark)

- (b) (i) State the ideal gas equation.

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- (ii) Calculate the volume of 1.00 mol of carbon dioxide gas at 298 K and 100 kPa.  
(The gas constant  $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$ )

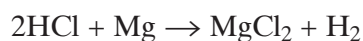
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- (iii) Calculate the mass of carbon dioxide gas at 273 K and 500 kPa contained in a cylinder of volume  $0.00500 \text{ m}^3$ .

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(7 marks)

- (c) Hydrogen can be made by the reaction of hydrochloric acid with magnesium according to the equation



What mass of hydrogen is formed when  $100\text{ cm}^3$  of hydrochloric acid of concentration  $5.0\text{ mol dm}^{-3}$  reacts with an excess of magnesium?

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(3 marks)

- (d) A compound of iron contains 38.9% by mass of iron and 16.7% by mass of carbon, the remainder being oxygen.

- (i) Determine the empirical formula of the iron compound.

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- (ii) When one mole of this iron compound is heated, it decomposes to give one mole of iron(II) oxide,  $\text{FeO}$ , one mole of carbon dioxide and one mole of another gas. Identify this other gas. (The molecular formula of the iron compound is the same as its empirical formula.)

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(4 marks)

15

Turn over 

- 3 (a) Name the type of force that holds the particles together in an ionic crystal.

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(1 mark)

- (b) What is a covalent bond?

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(1 mark)

- (c) State how a co-ordinate bond is formed.

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(2 marks)

- (d) Describe the bonding in a metal.

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(2 marks)

- (e) A molecule of hydrogen chloride has a dipole and molecules of hydrogen chloride attract each other by permanent dipole–dipole forces. Molecules of chlorine are non-polar.

- (i) What is a permanent dipole?

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- (ii) Explain why a molecule of hydrogen chloride is polar.

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- (iii) Name the type of force which exists between molecules of chlorine.

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(5 marks)

- (f) Show, by means of a diagram, how two molecules of hydrogen fluoride are attracted to each other by hydrogen bonding; include all lone-pair electrons and partial charges in your diagram.

(3 marks)

- (g) Why is there no hydrogen bonding between molecules of hydrogen bromide?

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(1 mark)

15

**TURN OVER FOR THE NEXT QUESTION**

**Turn over** 

- 4 (a) Describe the motion of the particles in solid iodine and in iodine vapour.

*Motion in solid iodine* .....

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*Motion in iodine vapour* .....

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(3 marks)

- (b) Explain why solid iodine vaporises when warmed gently.

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(2 marks)

- (c) Silver and sodium chloride melt at similar temperatures. Give two physical properties of silver which are different from those of sodium chloride and, in each case, give one reason why the property of silver is different from that of sodium chloride.

*First property of silver* .....

*Reason for difference* .....

.....

*Second property of silver* .....

*Reason for difference* .....

.....

(4 marks)

- (d) Draw the shapes of  $\text{BeCl}_2$ ,  $\text{NCl}_3$  and  $\text{BeCl}_4^{2-}$ . In each case, show any lone-pair electrons on the central atom and state the value of the bond angle.



(6 marks)

15

**TURN OVER FOR SECTION B**

**Turn over** 













