

Answer ALL the questions in the spaces provided.

1. The element bromine has an atomic number of 35 and has two isotopes of relative isotopic mass 79 and 81.

(a) (i) Define the term **relative isotopic mass**.

.....

(2)

(ii) Complete the table below.

Atom	Number of protons	Number of neutrons
^{79}Br		
^{81}Br		

(3)

(b) Bromine gas has the formula Br_2 . When a sample of bromine gas was analysed in a mass spectrometer, three peaks were obtained of m/e values of 158, 160 and 162.

Give the formulae of the species responsible for the peaks with m/e values 158, 160 and 162.

.....

(3)

(Total 8 marks)

Q1

2. (a) Complete the electronic configuration of an

Al atom $1s^2$

Al³⁺ ion $1s^2$

(2)

(b) Describe the structure of aluminium metal and explain why it conducts electricity.

.....
.....
.....
.....
.....

(3)

(c) (i) Define the term **first ionisation energy**.

.....
.....
.....
.....

(3)

(ii) Explain why the first ionisation energy of aluminium is less than that of magnesium.

.....
.....
.....
.....
.....

(2)

(Total 10 marks)

Q2

3. (a) You may find the following table useful in answering the question below.

Element	Electronegativity
Hydrogen	2.1
Oxygen	3.5

Draw a diagram to show a hydrogen bond between two water molecules and explain why it forms.

Diagram

Explanation

.....

.....

.....

(4)

(b) Magnesium forms a hydrated ion $[Mg(H_2O)_6]^{2+}$.

(i) Name the type of bond between an oxygen atom and a hydrogen atom in this hydrated ion.

.....

(1)

(ii) Name the type of bond between an oxygen atom and the magnesium ion in this hydrated ion.

.....

(1)

(c) Write the equations for the reactions of the following with water:

(i) sodium

..... (1)

(ii) calcium oxide, CaO

..... (1)

(iii) chlorine

..... (1)

(Total 9 marks)

Q3

4. (a) Hydrogen iodide, HI, has a boiling temperature of $-35\text{ }^{\circ}\text{C}$, and hydrogen chloride, HCl, a boiling temperature of $-85\text{ }^{\circ}\text{C}$.

(i) Draw a dot and cross diagram of a hydrogen iodide molecule (showing outer shell electrons only).

(2)

(ii) Explain why hydrogen iodide has a higher boiling temperature than hydrogen chloride.

.....

.....

.....

.....

(3)

(b) Hydrogen iodide and hydrogen chloride react with water to form acidic solutions.

(i) Write the equation for the reaction of hydrogen iodide with water.

.....

(1)

(ii) State why the solution formed is acidic.

.....

(1)

(c) (i) Excess dilute hydrochloric acid reacts with a lump of calcium oxide, CaO, to form an aqueous solution of calcium chloride.

Write the equation for this reaction, including state symbols.

.....

(2)

(ii) In a similar reaction with dilute sulphuric acid and a lump of calcium oxide, the reaction stops after a short time even though some calcium oxide remains. State why the reaction stops so quickly.

.....

.....

(1)

(Total 10 marks)

Q4

5. (a) Draw diagrams to show how the following bonds are formed from atomic orbitals.

σ bond

π bond

(2)

(b) (i) State the shape of a methane, CH_4 , molecule, and explain why it has this shape.

Shape:

Explanation:

.....

.....

(3)

(ii) State the shape of a carbon dioxide, CO_2 , molecule, and explain why it has this shape.

Shape:

Explanation:

.....

(2)

(c) Explain why carbon dioxide is a gas at room temperature and pressure, whereas silicon dioxide is a solid with a very high melting temperature.

.....

.....

.....

.....

.....

.....

(4)

(Total 11 marks)

Q5

6. (a) Define the term reduction.

.....

 (1)

(b) Sodium iodide, NaI, contains iodide ions which reduce Fe³⁺ ions to Fe²⁺ ions in aqueous solution.

(i) Write the ionic half-equation for the reduction of Fe³⁺ ions to Fe²⁺ ions.

.....
 (1)

(ii) Write the ionic half-equation for the oxidation of iodide ions.

.....
 (1)

(iii) Hence write the overall ionic equation for the reduction of Fe³⁺ ions by iodide ions.

.....
 (1)

(c) Sodium chlorate, NaClO₃, is used as a weedkiller and is manufactured by the following disproportionation reaction



(i) State the oxidation numbers of chlorine in

NaClO

NaClO₃

NaCl

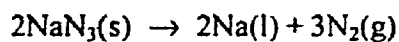
(3)

(ii) Explain why this reaction is classified as a disproportionation reaction.

.....

 (1)

- (d) The decomposition of sodium azide, NaN_3 , takes place when an airbag, which is used as a safety feature in cars, inflates. An airbag requires a large volume of a cool gas to be produced in a few milliseconds. The gas is produced by the rapid decomposition of the sodium azide.



When the airbag is fully inflated, 54 dm^3 of nitrogen gas are produced.

- (i) Calculate the amount (in moles) of nitrogen gas produced.

[The molar volume of nitrogen gas under the conditions in the airbag is $20 \text{ dm}^3 \text{ mol}^{-1}$].

(1)

- (ii) Calculate the amount (in moles) of sodium azide, NaN_3 , that would produce 54 dm^3 of nitrogen gas.

(1)

- (iii) Calculate the mass of sodium azide that would produce 54 dm^3 of nitrogen gas.

(2)

(Total 12 marks)

Q6

TOTAL FOR PAPER: 60 MARKS

END