1999 U 01 Sp 02

1. The Table below gives the values of ionisation energies 3 to 10 of calcium.

Ionisation Number	3	4	5	6	7	8	9	10
Ionisation Energies	4912	6474	8145	10496	12320	14207	18192	20385

(a) Plot a graph of ionisation energy against the number of electrons removed. **[4 marks]**

(b) Comment on the shape of the graph. **[3 marks]**

(c) Deduce the orbital distribution of electrons 3 to 10 in calcium. **[1 mark]**

(d) Insert on the graph by sketching, the suggested values of the 1st and 2nd ionisation energies of calcium. **[2 marks]**

4. Each of the statements labelled (i) to (v) below lists some physical properties of a pair of substances.

(i) Water and argon both have relative molecular masses of 18. The boiling point of water is 100°C, but that of argon is -186°C.

(ii) CO_2 and SiO_2 are both covalent molecules. However, CO_2 is a gas, but SiO_2 is a solid with a high melting point.

(iii) Neon and argon are both noble gases. The boiling point of neon is -245°C and the boiling point of argon is -186°C.

(iv) Sodium and aluminium are both metallic elements. Sodium melts at 98°C and aluminium melts at 660°C.

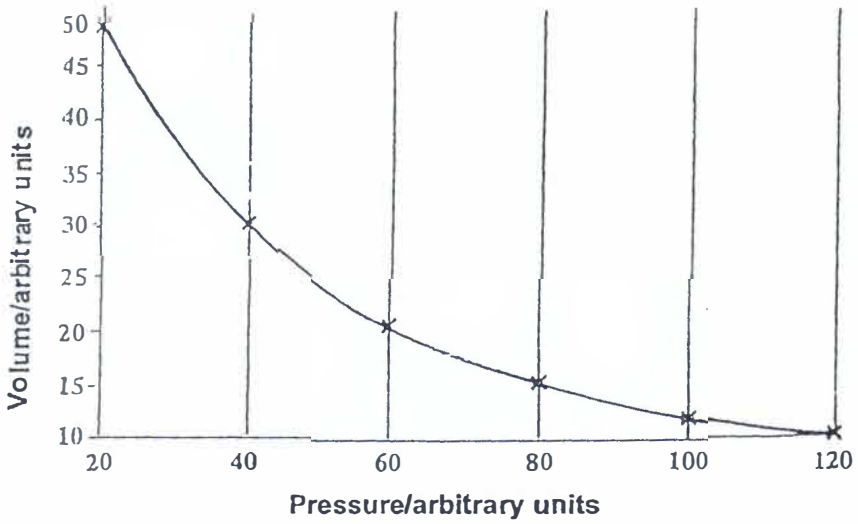
(v) Sodium chloride is a high melting point solid whereas hydrogen chloride is a gas.

For each of the statements labelled (i) to (v) above:

(a) Identify the types of forces operating.

(b) Account for any differences in the strengths of these forces and relate the nature and strength of the forces to the properties indicated in each pair. **[20 marks]**

5. **(a)** The graph below represents some volume and pressure relationships of a gas **X** at constant temperature.



(i) Using ANY TWO sets of data points from the graph, describe TWO relationships between the pressure and volume of the gas **X**.

(ii) Express the relationship derived in part (i) above mathematically and identify the law to which the relationship applies. **[5 marks]**

(b) **(i)** State the meaning of the term 'ideal gas'.

(ii) Give the conditions under which a real gas approximates ideal gas behaviour.

(iii) Identify the factors responsible for deviations from ideal behaviour.

(iv) Explain how these factors lead to the above deviations. **[9 marks]**

c) **(i)** Sketch a graph showing the relationship between the volume and temperature of a gas at constant pressure.

(ii) Indicate on your sketch the temperature at which the volume of an ideal gas becomes zero. **[3 marks]**

(d) 2.1 g of a diatomic gas was found to occupy a volume of 1.84 dm^3 at 30°C. The pressure of the gas was 93.22 kPa. Calculate the relative molecular mass of the gas and suggest the possible identity of the gas.

($R = 8.31\ J\ K^{-1}\ mol^{-1}$) **[3 marks]**