

# 4.3 Intermolecular Forces & Metallic Bonding

## Question Paper

Course	DPIB Chemistry
Section	4. Chemical Bonding & Structure
Topic	4.3 Intermolecular Forces & Metallic Bonding
Difficulty	Medium

**Time allowed:** 70  
**Score:** /51  
**Percentage:** /100

**Question 1a**

- a) Magnesium is a lightweight metal used for the manufacturing of car seats.

Describe the structure and bonding present in solid magnesium.

[3 marks]

**Question 1b**

- b) Magnesium has a considerably higher boiling point than sodium. Explain this difference, despite the fact both elements are in period 3.

[3 marks]

**Question 1c**

- c) Explain, with reference to bonding, the principal property of a metal that makes it suited to manufacturing shaped objects such as railings.

[3 marks]

**Question 1d**

- d) Many alloys are harder than their constituent metal elements alone.

Outline the reason for this with reference to the structure of metal alloys.

[2 marks]

**Question 2a**

- a) Based on the type of intermolecular force present, explain why butan-1-ol has a higher boiling point than butanal.

[2 marks]

**Question 2b**

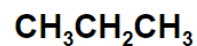
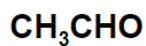
- b) Ethane,  $C_2H_6$ , and disilane,  $Si_2H_6$ , are both hydrides of Group 4 elements with similar structures but different chemical properties.

Explain why disilane has a higher boiling point than ethane.

[2 marks]

**Question 2c**

- c) Put the following molecules in order of increasing boiling point and explain your choice:



[3 marks]

**Question 2d**

- d) Based on the type of intermolecular force present, explain the difference in solubility in water between ethane and ethanol.

[4 marks]

**Question 3a**

- a) The elements sodium, aluminium, silicon, phosphorus and sulfur are in period 3 of the periodic table.

Describe and explain the general trend in melting points of the metals in period 3.

[4 marks]

**Question 3b**

- b) Identify, with reasoning, which of the period 3 metals has the highest melting point.

[3 marks]

**Question 3c**

- c) Explain, by reference to the intermolecular forces, why sulfur has a higher melting point than phosphorus.

[2 marks]

**Question 3d**

- d) Although the molar masses of  $ICl$  and  $Br_2$  are very similar, the boiling point of  $ICl$  is  $97.4\text{ }^{\circ}C$  and that of  $Br_2$  is  $58.8\text{ }^{\circ}C$ .

Explain the difference in these boiling points in terms of the intermolecular forces present in each liquid.

[2 marks]

**Question 4a**

- a) The melting points of some Group 1 elements are listed in **Table 1**.

**Table 1**

	Na	K	Rb
Melting point / $^{\circ}C$	98	63	

Predict, with a reason, the melting point of Rb.

[3 marks]

**Question 4b**

- b) Explain why ammonia,  $\text{NH}_3$ , is a gas at room temperature.

[2 marks]

**Question 4c**

- c) Phosphine (IUPAC name phosphane) is a hydride of phosphorus, with the formula  $\text{PH}_3$ . Phosphine has a much greater molar mass than ammonia.

Explain why phosphine has a significantly lower boiling point than ammonia.

[3 marks]

**Question 4d**

- d) Identify the type of interaction that must be overcome when liquid hydrazine,  $\text{N}_2\text{H}_4$ , vaporizes. Suggest, with a reason, whether hydrazine has a lower or higher boiling point than diimide,  $\text{N}_2\text{H}_2$ .

[2 marks]

**Question 5a**

- a) Copper is a transition metal. Describe the bonding in metals.

[2 marks]

**Question 5b**

- b) Aluminium and copper can be used to make the alloy duralumin.  
Explain why an aluminium-copper alloy is harder than pure aluminium.

[2 marks]

**Question 5c**

- c) This question is about the chlorides of copper and aluminium.
- i) State the type of bonding present in copper(II) chloride which melts at 771 K.
- ii) The chloride of aluminium,  $\text{AlCl}_3$ , melts 465 K. Suggest why the melting point is so much lower than that of  $\text{CuCl}_2$ .

[2 marks]



**Question 5d**

- d) Both copper and benzene have delocalised electrons. Explain why both structures have delocalised electrons, copper conducts electricity, but benzene does not.

[2 marks]