

**Q1.** (a) Both HF and HCl are molecules having a polar covalent bond. Their boiling points are 293 K and 188 K respectively.

(i) State which property of the atoms involved causes a bond to be polar.

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(ii) Explain, in terms of the intermolecular forces present in each compound, why HF has a higher boiling point than HCl.

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**(4)**

(b) When aluminium chloride reacts with chloride ions, as shown by the equation below, a co-ordinate bond is formed.



Explain how this co-ordinate bond is formed.

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**(2)**

(c) Draw the shape of the  $\text{PCl}_5$  molecule and of the  $\text{PCl}_4^+$  ion. State the value(s) of the bond angles.



Bond angle(s) ..... Bond angle(s) .....

(4)  
(Total 10 marks)

**Q2.** The ester methyl ethanoate is hydrolysed as shown in the following equation.



Which one of the following compounds from the reaction mixture has no hydrogen bonding between its molecules when pure?

- A  $\text{CH}_3\text{COOCH}_3(\text{l})$
- B  $\text{H}_2\text{O}(\text{l})$
- C  $\text{CH}_3\text{COOH}(\text{l})$
- D  $\text{CH}_3\text{OH}(\text{l})$

(Total 1 mark)

**Q3.** Predict which one of the following has the highest boiling temperature.

- A  $\text{CH}_3\text{COOCH}_2\text{CH}_3$
- B  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$
- C  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
- D  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$

(Total 1 mark)

**Q4.** The table below shows some values of melting points and some heat energies needed for melting.

Substance	I <sub>2</sub>	NaCl	HF	HCl	HI
Melting point/K	387	1074	190	158	222
Heat energy for melting /kJ mol <sup>-1</sup>	7.9	28.9	3.9	2.0	2.9

(a) Name **three** types of intermolecular force.

Force 1 .....

Force 2 .....

Force 3 .....

(3)

(b) (i) Describe the bonding in a crystal of iodine.

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(ii) Name the crystal type which describes an iodine crystal.

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(iii) Explain why heat energy is required to melt an iodine crystal.

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(4)

(c) In terms of the intermolecular forces involved, suggest why

(i) hydrogen fluoride requires more heat energy for melting than does hydrogen chloride,

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(ii) hydrogen iodide requires more heat energy for melting than does hydrogen chloride.

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(5)

(d) (i) Explain why the heat energy required to melt sodium chloride is large.

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(ii) The heat energy needed to vaporise one mole of sodium chloride ( $171 \text{ kJ mol}^{-1}$ ) is much greater than the heat energy required to melt one mole of sodium chloride. Explain why this is so.

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(3)

(e) In terms of its structure and bonding, suggest why graphite has a very high melting point.

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(2)

(Total 17 marks)

- Q5.** (a) Predict the shapes of the SF<sub>6</sub> molecule and the  $\text{AlCl}_4^-$  ion. Draw diagrams of these species to show their three-dimensional shapes. Name the shapes and suggest values for the bond angles. Explain your reasoning.

(8)

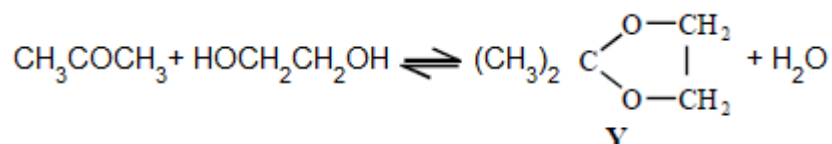
- (b) Perfume is a mixture of fragrant compounds dissolved in a volatile solvent.

When applied to the skin the solvent evaporates, causing the skin to cool for a short time. After a while, the fragrance may be detected some distance away. Explain these observations.

(4)

(Total 12 marks)

- Q6.** This question is about the reaction between propanone and an excess of ethane-1,2-diol, the equation for which is given below.



In a typical procedure, a mixture of 1.00 g of propanone, 5.00 g of ethane-1,2-diol and 0.100 g of benzenesulphonic acid, C<sub>6</sub>H<sub>5</sub>SO<sub>3</sub>H, is heated under reflux in an inert solvent. Benzenesulphonic acid is a strong acid.

Which one of the following statements is **not** true?

- A** Ethane-1,2-diol and water can form hydrogen bonds.
- B** Ethane-1,2-diol is soluble in water.
- C** Propane has a higher boiling point than ethane-1,2-diol.
- D** Y and water are polar molecules.

(Total 1 mark)

