



A-Level Chemistry

Intermolecular Forces

Question Paper

Time available: 68 minutes

Marks available: 65 marks

www.accesstuition.com

1.

This question is about structure and bonding.

- (a) Draw a diagram to show the strongest type of interaction between two molecules of ethanol ($\text{C}_2\text{H}_5\text{OH}$) in the liquid phase.

Include all lone pairs and partial charges in your diagram.

(3)

- (c) Methoxymethane (CH_3OCH_3) is an isomer of ethanol.

The table shows the boiling points of ethanol and methoxymethane.

Compound	Boiling point / $^{\circ}\text{C}$
ethanol	78
methoxymethane	-24

In terms of the intermolecular forces involved, explain the difference in boiling points.

(3)

- (c) Draw the shape of the POCl_3 molecule and the shape of the ClF_4^- ion. Include any lone pairs of electrons that influence the shapes.

In a POCl_3 molecule the oxygen atom is attached to the phosphorus atom by a double bond that uses two electrons from phosphorus.

Name each shape.

Suggest a value for the bond angle in ClF_4^-

Shape of POCl_3

Shape of ClF_4^-

Name of shape of POCl_3 _____

Name of shape of ClF_4^- _____

Bond angle in ClF_4^- _____

(5)

(Total 11 marks)

2.

This question is about intermolecular forces.

- (a) Give the meaning of the term electronegativity.

(1)

- (b) Explain how permanent dipole-dipole forces arise between hydrogen chloride molecules.

(2)

- (c) Complete the table by naming the shape of each molecule.

Place a tick (✓) in the final column if the molecule has a permanent dipole.

Molecule	Name of shape	Tick (✓) if molecule has a permanent dipole
SiH ₄		
PH ₃		
BeCl ₂		
CH ₃ Cl		

(4)

(Total 7 marks)

3.

This question is about elements in Group 7 of the Periodic Table and their compounds.

- (a) Bromine (Br_2), strontium chloride (SrCl_2) and iodine monochloride (ICl) all have similar M_r values.

Suggest, with reasons, the order of melting points for these three substances.

(6)

- (b) Write an equation for the reaction of chlorine with cold water.

State a reason why chlorine is added to drinking water, and suggest a disadvantage of treating water in this way.

Equation

Reason _____

Disadvantage _____

(3)

- (c) Bromine reacts with phosphorus to form phosphorus tribromide.

Write an equation for this reaction and draw the shape of the phosphorus tribromide molecule formed.

Suggest the bond angle in phosphorus tribromide.

Equation

Shape

Bond angle _____

(3)

- (d) Phosphorus pentabromide in the solid state consists of PBr_4^+ and Br^- ions.

Draw the shape of the PBr_4^+ ion and suggest its bond angle.

Shape

Bond angle _____

(2)

(Total 14 marks)

4.

- (a) Van der Waals' forces exist between all molecules.

Explain how these forces arise.

(3)

- (b) The table shows the boiling points of methanol (CH_3OH) and methanethiol (CH_3SH).

Compound	Boiling point / $^{\circ}\text{C}$
Methanol	65
Methanethiol	6

- (i) Explain, in terms of their intermolecular forces, why the boiling points of these compounds are different.

(3)

- (ii) Suggest how a mixture of methanol and methanethiol could be separated.

(1)

- (c) Suggest why methaneselenol (CH_3SeH) has a higher boiling point than methanethiol (CH_3SH).

(2)

- (d) Sulfur forms many molecular compounds with the halogens.

- (i) Draw the shape of an SF_6 and of an SF_4 molecule.
 Include any lone pairs that influence the shape.
 State the bond angle(s) in SF_6 and in SF_4 .
 Name the shape of SF_6 .

	SF_6	SF_4
Shape		
Bond angle(s)		
Name of shape		

(6)

- (ii) SCl_2 reacts with NaF to form SF_4 and S_2Cl_2 and one other product.

Write an equation for the reaction.

(2)

(Total 17 marks)

5.

Fritz Haber, a German chemist, first manufactured ammonia in 1909.
Ammonia is very soluble in water.

- (a) State the strongest type of intermolecular force between one molecule of ammonia and one molecule of water.

(1)

- (b) Draw a diagram to show how one molecule of ammonia is attracted to one molecule of water. Include all partial charges and all lone pairs of electrons in your diagram.

(3)

- (c) Phosphine (PH_3) has a structure similar to ammonia.

In terms of intermolecular forces, suggest the main reason why phosphine is almost insoluble in water.

(1)

(Total 5 marks)

6.

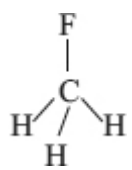
The table below shows the electronegativity values of some elements.

	Fluorine	Chlorine	Bromine	Iodine	Carbon	Hydrogen
Electronegativity	4.0	3.0	2.8	2.5	2.5	2.1

- (a) Define the term *electronegativity*.

(2)

- (b) The table below shows the boiling points of fluorine, fluoromethane (CH_3F) and hydrogen fluoride.

	$\text{F}-\text{F}$		$\text{H}-\text{F}$
Boiling point/K	85	194	293

- (i) Name the strongest type of intermolecular force present in:

Liquid F_2 _____

Liquid CH_3F _____

Liquid HF _____

- (ii) Explain how the strongest type of intermolecular force in liquid HF arises.

(6)

- (c) The table below shows the boiling points of some other hydrogen halides.

	HCl	HBr	HI
Boiling point / K	188	206	238

- (i) Explain the trend in the boiling points of the hydrogen halides from HCl to HI.

- (ii) Give **one** reason why the boiling point of HF is higher than that of all the other hydrogen halides.

(3)

(Total 11 marks)