



AS LEVEL CHEMISTRY

TOPIC 3 – STRUCTURE, BONDING AND THE PERIODIC TABLE

ASSESSED HOMEWORK

Answer all questions

Max 80 marks

Name		
Mark/80%	Grade



SECTION A

1. The table below shows the boiling points of some hydrogen compounds formed by Group 6 elements.

	H ₂ O	H ₂ S	H ₂ Se	H ₂ Te
Boiling point / K	373	212	232	271

- (a) State the strongest type of intermolecular force in water and in hydrogen sulfide (H₂S).

Water

Hydrogen sulfide

.....

(2)

- (b) Draw a diagram to show how two molecules of water are attracted to each other by the type of intermolecular force you stated in part (a). Include partial charges and all lone pairs of electrons in your diagram.

(3)

- (c) Explain why the boiling point of water is much higher than the boiling point of hydrogen sulfide.

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(1)

- (d) Explain why the boiling points increase from H₂S to H₂Te

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(2)

- (e) When H⁺ ions react with H₂O molecules, H₃O⁺ ions are formed.

Name the type of bond formed when H⁺ ions react with H₂O molecules.

Explain how this type of bond is formed in the H₃O⁺ ion.



Type of bond

Explanation

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(2)

- (f) Sodium sulfide (Na_2S) has a melting point of 1223 K. Predict the type of bonding in sodium sulfide and explain why its melting point is high.

Type of bonding

Explanation

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(3)

(Total 13 marks)

2. (a) (i) Describe the bonding in a metal.

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- (ii) Explain why magnesium has a higher melting point than sodium.

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(4)

- (b) Why do diamond and graphite both have high melting points?

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(3)



(c) Why is graphite a good conductor of electricity?

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(1)

(d) Why is graphite soft?

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(2)

(Total 10 marks)

3. (a) The shape of the molecule BCl_3 and that of the unstable molecule CCl_2 are shown below.



(i) Why is each bond angle exactly 120° in BCl_3 ?

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(ii) Predict the bond angle in CCl_2 and explain why this angle is different from that in BCl_3 .

Predicted bond angle

Explanation

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(5)

(b) Give the name which describes the shape of molecules having bond angles of $109^\circ 28'$.
Give an example of one such molecule.

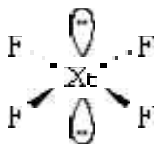
Name of shape

Example

(2)

MEGA LECTURE

(c) The shape of the XeF_4 molecule is shown below.



(i) State the bond angle in XeF_4 .

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(ii) Suggest why the lone pairs of electrons are opposite each other in this molecule.

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.....

(iii) Name the shape of this molecule, given that the shape describes the positions of the Xe and F atoms only.

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(4)

(d) Draw a sketch of the NF_3 molecule. Indicate in your sketch any lone pairs of electrons on nitrogen.

(2)

(Total 13 marks)



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

Substance	I ₂	NaCl	HF	HCl	HI
Melting point/K	387	1074	190	158	222
Heat energy for melting /kJ mol ⁻¹	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 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)



5. Sodium sulphide, Na_2S , is a high melting point solid which conducts electricity when molten. Carbon disulphide, CS_2 , is a liquid which does not conduct electricity.

(i) Deduce the type of bonding present in Na_2S and that present in CS_2

Bonding in Na_2S

Bonding in CS_2

(ii) By reference to all the atoms involved explain, in terms of electrons, how Na_2S is formed from its atoms.

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(iii) Draw a diagram, including all the outer electrons, to represent the bonding present in CS_2

(iv) When heated with steam, CS_2 reacts to form hydrogen sulphide, H_2S , and carbon dioxide.
Write an equation for this reaction.

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(7)
(Total 7 marks)

MEGA LECTURE

6. (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 PCl_5 molecule and of the PCl_4^+ ion. State the value(s) of the bond angles.



Bond angle(s) Bond angle(s)

(4)

(Total 10 marks)



7. Phosphorus and nitrogen are in Group V of the Periodic Table and both elements form hydrides. Phosphine, PH_3 , reacts to form phosphonium ions, PH_4^+ , in a similar way to that by which ammonia, NH_3 , forms ammonium ions, NH_4^+

(a) Give the name of the type of bond formed when phosphine reacts with an H^+ ion. Explain how this bond is formed.

Type of bond

Explanation

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(3)

(b) Draw the shapes, including any lone pairs of electrons, of a phosphine molecule and of a phosphonium ion. Give the name of the shape of the phosphine molecule and state the bond angle found in the phosphonium ion.



Shape of PH_3

Bond angle in PH_4^+

(4)

(Total 7 marks)

**MEGA LECTURE**

SECTION B

8. Which one of the following ions has three lone pairs of electrons around the central atom?

- A BF_2^-
- B NH_2^-
- C ClF_2^-
- D PF_6^-

(Total 1 mark)

9. Which one of the following bond polarities is **not** correct?

- A $\overset{\delta+}{\text{C}}-\overset{\delta-}{\text{H}}$ in ethane
- B $\overset{\delta+}{\text{C}}-\overset{\delta-}{\text{Br}}$ in bromoethane
- C $\overset{\delta+}{\text{C}}-\overset{\delta-}{\text{O}}$ in ethanol
- D $\overset{\delta+}{\text{C}}=\overset{\delta-}{\text{O}}$ in ethanal

(Total 1 mark)

10. Which one of the following has the most covalent character?

- A MgF_2
- B MgBr_2
- C AlF_3
- D AlBr_3

(Total 1 mark)