

Q1. The table below shows the electronegativity values of some elements.

	H	C	N	O
Electronegativity	2.1	2.5	3.0	3.5

(a) State the meaning of the term *electronegativity*.

.....
.....
.....

(2)

(b) State the strongest type of intermolecular force in the following compounds.

Methane (CH₄)

Ammonia (NH₃)

(2)

(c) Use the values in the table to explain how the strongest type of intermolecular force arises between two molecules of ammonia.

.....
.....
.....
.....
.....

(3)

(d) Phosphorus is in the same group of the Periodic Table as nitrogen.
A molecule of PH₃ reacts with an H⁺ ion to form a PH₄⁺ ion.
Name the type of bond formed when PH₃ reacts with H⁺ and explain how this bond is formed.

Type of bond

Explanation

.....
.....

(3)

- (e) Arsenic is in the same group as nitrogen. It forms the compound AsH_3 . Draw the shape of an AsH_3 molecule, including any lone pairs of electrons. Name the shape made by its atoms.

Shape

Name of shape

(2)

- (f) The boiling point of AsH_3 is $-62.5\text{ }^\circ\text{C}$ and the boiling point of NH_3 is $-33.0\text{ }^\circ\text{C}$. Suggest why the boiling point of AsH_3 is lower than that of NH_3 .

.....
.....
.....

(1)

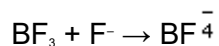
- (g) Balance the following equation which shows how AsH_3 can be made.



(1)

(Total 14 marks)

Q2. The equation below shows the reaction between boron trifluoride and a fluoride ion.



- (i) Draw diagrams to show the shape of the BF_3 molecule and the shape of the BF_4^- ion. In each case, name the shape. Account for the shape of the BF_4^- ion and state the bond angle present.
- (ii) In terms of the electrons involved, explain how the bond between the BF_3 molecule and the F^- ion is formed. Name the type of bond formed in this reaction.

(Total 9 marks)

Q3. (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.

.....
.....

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

.....
.....
.....
.....
.....

(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.

.....

.....

.....

(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)

Q4. 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

.....

.....

(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)

Q5. Lithium hydride, LiH , is an ionic compound containing the hydride ion, H^- .
The reaction between LiH and aluminium chloride, AlCl_3 , produces the ionic compound LiAlH_4 .

- (a) Balance the equation below which represents the reaction between LiH and AlCl_3 .



(1)

- (b) Give the electronic configuration of the hydride ion, H^- .

.....

(1)

(c) Predict the shape of the AlH_4^- ion. Explain why it has this shape.

Shape

Explanation

.....

.....

(3)

(d) A bond in AlH_4^- can be represented by $\text{H} \rightarrow \text{Al}$

Name this type of bond and explain how it is formed.

Type of bond

Explanation

.....

.....

(3)

(Total 8 marks)