

**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*.

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(2)

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

Methane (CH<sub>4</sub>) .....

Ammonia (NH<sub>3</sub>) .....

(2)

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

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(3)

(d) Phosphorus is in the same group of the Periodic Table as nitrogen.  
A molecule of PH<sub>3</sub> reacts with an H<sup>+</sup> ion to form a PH<sub>4</sub><sup>+</sup> ion.  
Name the type of bond formed when PH<sub>3</sub> reacts with H<sup>+</sup> and explain how this bond is formed.

Type of bond .....

Explanation .....

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(3)

- (e) Arsenic is in the same group as nitrogen. It forms the compound  $\text{AsH}_3$ . Draw the shape of an  $\text{AsH}_3$  molecule, including any lone pairs of electrons. Name the shape made by its atoms.

Shape

Name of shape .....

(2)

- (f) The boiling point of  $\text{AsH}_3$  is  $-62.5\text{ }^\circ\text{C}$  and the boiling point of  $\text{NH}_3$  is  $-33.0\text{ }^\circ\text{C}$ . Suggest why the boiling point of  $\text{AsH}_3$  is lower than that of  $\text{NH}_3$ .

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(1)

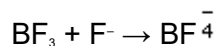
- (g) Balance the following equation which shows how  $\text{AsH}_3$  can be made.



(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  $\text{BF}_3$  molecule and the shape of the  $\text{BF}_4^-$  ion. In each case, name the shape. Account for the shape of the  $\text{BF}_4^-$  ion and state the bond angle present.
- (ii) In terms of the electrons involved, explain how the bond between the  $\text{BF}_3$  molecule and the  $\text{F}^-$  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.

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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)

**Q4.** Phosphorus and nitrogen are in Group V of the Periodic Table and both elements form hydrides. Phosphine,  $\text{PH}_3$ , reacts to form phosphonium ions,  $\text{PH}_4^+$ , in a similar way to that by which ammonia,  $\text{NH}_3$ , forms ammonium ions,  $\text{NH}_4^+$

- (a) Give the name of the type of bond formed when phosphine reacts with an  $\text{H}^+$  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  $\text{PH}_3$ .....

Bond angle in  $\text{PH}_4^+$  .....

(4)

(Total 7 marks)

**Q5.** Lithium hydride,  $\text{LiH}$ , is an ionic compound containing the hydride ion,  $\text{H}^-$ .  
The reaction between  $\text{LiH}$  and aluminium chloride,  $\text{AlCl}_3$ , produces the ionic compound  $\text{LiAlH}_4$ .

- (a) Balance the equation below which represents the reaction between  $\text{LiH}$  and  $\text{AlCl}_3$ .



(1)

- (b) Give the electronic configuration of the hydride ion,  $\text{H}^-$ .

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(1)

(c) Predict the shape of the  $\text{AlH}_4^-$  ion. Explain why it has this shape.

*Shape* .....

*Explanation* .....

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(3)

(d) A bond in  $\text{AlH}_4^-$  can be represented by  $\text{H} \rightarrow \text{Al}$

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

*Type of bond* .....

*Explanation* .....

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(3)

(Total 8 marks)