

**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 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*.

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(2)

(b) The table below shows the boiling points of fluorine, fluoromethane (CH<sub>3</sub>F) and hydrogen fluoride.

	F-F	<pre>       F               C      /   \     H  H  H           </pre>	H-F
Boiling point/K	85	194	293

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

Liquid F<sub>2</sub>.....  
 Liquid CH<sub>3</sub>F .....  
 Liquid HF .....

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

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(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.

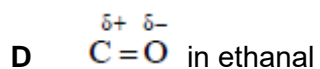
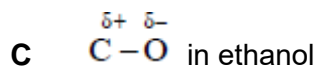
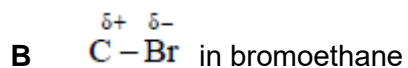
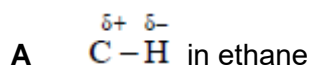
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(ii) Give **one** reason why the boiling point of HF is higher than that of all the other hydrogen halides.

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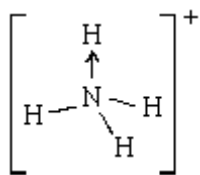
(3)  
(Total 11 marks)

**Q3.** Which one of the following bond polarities is **not** correct?



(Total 1 mark)

- Q4.** (a) An ammonium ion, made by the reaction between an ammonia molecule and a hydrogen ion, can be represented as shown in the diagram below.



- (i) Name the type of bond represented in the diagram by N—H

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- (ii) Name the type of bond represented in the diagram by N→H

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- (iii) In terms of electrons, explain why an arrow is used to represent this N→H bond.

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- (iv) In terms of electron pairs, explain why the bond angles in the  $\text{NH}_4^+$  ion are all  $109^\circ 28'$

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(7)

- (b) Define the term *electronegativity*.

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(2)

(c) A bond between nitrogen and hydrogen can be represented as  $\overset{\delta-}{\text{N}}-\overset{\delta+}{\text{H}}$

(i) In this representation, what is the meaning of the symbol  $\delta+$  ?

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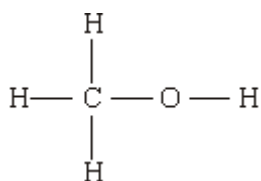
(ii) From this bond representation, what can be deduced about the electronegativity of hydrogen relative to that of nitrogen?

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(2)  
(Total 11 marks)

**Q5.** (a) Methanol has the structure



Explain why the O–H bond in a methanol molecule is polar.

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(2)

(b) The boiling point of methanol is +65 °C; the boiling point of oxygen is –183 °C. Methanol and oxygen each have an  $M_r$  value of 32. Explain, in terms of the intermolecular forces present in each case, why the boiling point of methanol is much higher than that of oxygen.

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(3)  
(Total 5 marks)

**Q6.** (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)