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_4) ....

Ammonia (NH_3) ....

(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_3 reacts with an H^+ ion to form a PH_4^+ ion.
Name the type of bond formed when PH_3 reacts with H^+ 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 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 °C and the boiling point of NH_3 is –33.0 °C.
       Suggest why the boiling point of AsH_3 is lower than that of NH_3

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(1)

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

       ...... $AsCl_3$ + ... $NaBH_4$ →   ...... AsH_3 + ... $NaCl$ + ... BCl_3

(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_3F) and hydrogen fluoride.

	F–F		H–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.

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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

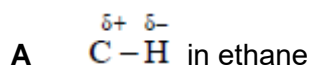(i)   Explain the trend in the boiling points of the hydrogen halides from HCl to HI.

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(ii)   Give **one** reason why the boiling point of HF is higher than that of all the other hydrogen halides.
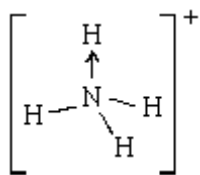
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(3)
(Total 11 marks)

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

A $\overset{\delta+\ \ \delta-}{C-H}$ in ethane

B $\overset{\delta+\ \ \delta-}{C-Br}$ in bromoethane

C $\overset{\delta+\ \ \delta-}{C-O}$ in ethanol

D $\overset{\delta+\ \ \delta-}{C=O}$ in ethanal
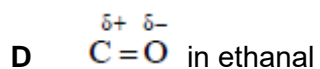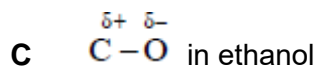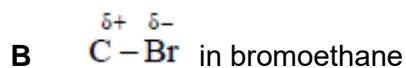
(Total 1 mark)

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.

$$\left[\begin{array}{c} H \\ \uparrow \\ H - N - H \\ \diagdown \\ H \end{array} \right]^{+}$$

(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 NH_4^+ ion are all 109° 28'

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(7)

(b) Define the term *electronegativity*.

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(2)

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

(i)   In this representation, what is the meaning of the symbol δ+ ?

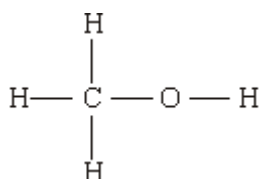..

(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

H—C—O—H structure with H above and below C

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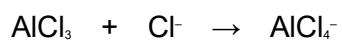
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(ii)   Explain, in terms of the intermolecular forces present in each compound, why
HF has a higher boiling point than HCl.

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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.

$$AlCl_3 \quad + \quad Cl^- \quad \rightarrow \quad AlCl_4^-$$

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.

PCl₅   PCl₄⁺

Bond angle(s) ....   Bond angle(s) ....

(4)
(Total 10 marks)