Q1. Which type of bond is formed between N and B when a molecule of NH_3 reacts with a molecule of BF_3?

A Ionic. ⬭

B Covalent. ⬭

C Co-ordinate. ⬭

D Van der Waals. ⬭

(Total 1 mark)

Q2.(a) Ammonia gas readily condenses to form a liquid when cooled.

(i) Name the strongest attractive force between two ammonia molecules.

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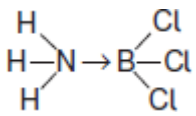
(1)

(ii) Draw a diagram to show how two ammonia molecules interact with each other in the liquid phase.
Include all partial charges and all lone pairs of electrons in your diagram.

(3)

(b) Ammonia reacts with boron trichloride to form a molecule with the following structure.



State how the bond between ammonia and boron trichloride is formed.

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(1)

(c) The following table shows the electronegativity values of some elements.

	H	**Li**	**B**	**C**	**O**	**F**
Electronegativity	2.1	1.0	2.0	2.5	3.5	4.0

(i) Give the meaning of the term **electronegativity.**

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(2)

(ii) Suggest the formula of an ionic compound that is formed by the chemical combination of two different elements from the table.

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(1)

(iii) Suggest the formula of the compound that has the least polar bond and is formed by chemical combination of two of the elements from the table.

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(1)
(Total 9 marks)

Q3. Fluorine and iodine are elements in Group 7 of the Periodic Table.

(a) Explain why iodine has a higher melting point than fluorine.

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(Extra space).....

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(2)

(b) (i) Draw the shape of the NHF_2 molecule and the shape of the BF_3 molecule.

Include any lone pairs of electrons that influence the shape. In each case name the shape.

Shape of NHF_2 Shape of BF_3

Name of shape of NHF_2 .....

Name of shape of BF_3 .....

(4)

(ii) Suggest a value for the F—N—F bond angle in NHF_2

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(1)

(c) State the strongest type of intermolecular force in a sample of NHF_2

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(1)

(d) A molecule of NHF_2 reacts with a molecule of BF_3 as shown in the following equation.

$$NHF_2 + BF_3 \longrightarrow F_2HNBF_3$$

State the type of bond formed between the N atom and the B atom in F_2HNBF_3.

Explain how this bond is formed.

Name of type of bond .....

How bond is formed .....

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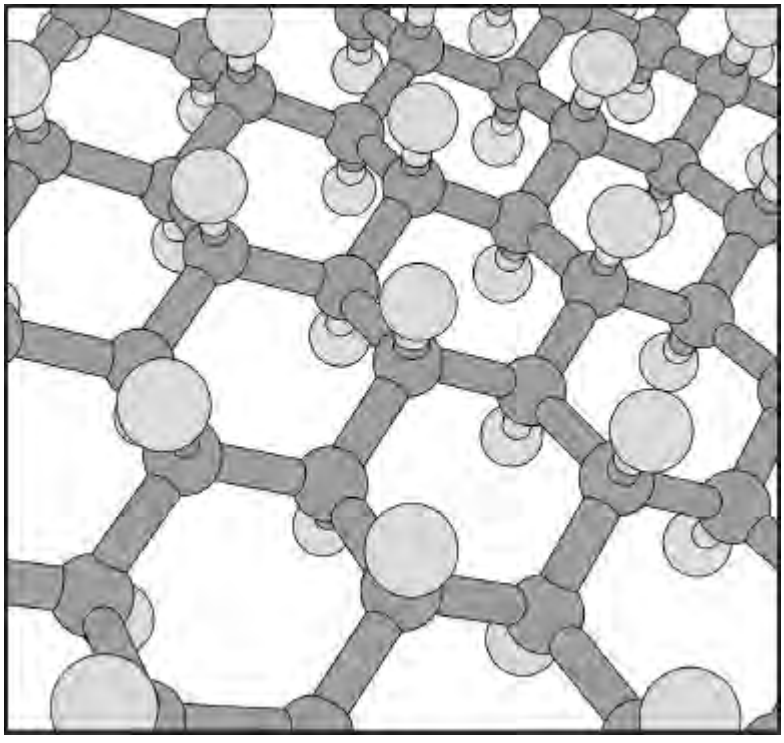
(2)
(Total 10 marks)

Q4. In 2009 a new material called graphane was discovered. The diagram shows part of a model of the structure of graphane. Each carbon atom is bonded to three other carbon atoms and to one hydrogen atom.



(a) Deduce the type of crystal structure shown by graphane.

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(1)

(b) State how two carbon atoms form a carbon–carbon bond in graphane.

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(1)

(c) Suggest why graphane does **not** conduct electricity.

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(1)

(d) Deduce the empirical formula of graphane.

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(1)
(Total 4 marks)

Q5. Fluorine forms compounds with many other elements.

(a) Fluorine reacts with bromine to form liquid bromine trifluoride (BrF_3).
State the type of bond between Br and F in BrF_3 and state how this bond is formed.

Type of bond .....

How bond is formed .....

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(2)

(b) Two molecules of BrF_3 react to form ions as shown by the following equation.

$$2BrF_3 \longrightarrow BrF_2^+ + BrF_4^-$$

(i) Draw the shape of BrF_3 and predict its bond angle.
Include any lone pairs of electrons that influence the shape.

Shape of BrF_3

Bond angle .....

(2)

(ii) Draw the shape of BrF_4^- and predict its bond angle.
Include any lone pairs of electrons that influence the shape.

Shape of BrF_4^-

Bond angle .....

(2)

(c) BrF_4^- ions are also formed when potassium fluoride dissolves in liquid BrF_3 to form $KBrF_4$
Explain, in terms of bonding, why $KBrF_4$ has a high melting point.

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(Extra space) .....

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(3)

(d) Fluorine reacts with hydrogen to form hydrogen fluoride (HF).

(i) State the strongest type of intermolecular force between hydrogen fluoride molecules.

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(1)

(ii) Draw a diagram to show how two molecules of hydrogen fluoride are attracted to each other by the type of intermolecular force that you stated in part (d)(i).
Include all partial charges and all lone pairs of electrons in your diagram.

(3)

(e) The boiling points of fluorine and hydrogen fluoride are –188 °C and 19.5 °C respectively.
Explain, in terms of bonding, why the boiling point of fluorine is very low.

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(Extra space) .....

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(2)
(Total 15 marks)

Q6. The following equation shows the reaction of a phosphine molecule (PH_3) with an H^+ ion.

$$PH_3 + H^+ \longrightarrow PH_4^+$$

(a) Draw the shape of the PH_3 molecule. Include any lone pairs of electrons that influence the shape.

(1)

(b) State the type of bond that is formed between the PH_3 molecule and the H^+ ion.
Explain how this bond is formed.

Name of bond .....

How bond is formed .....

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(2)

(c) Predict the bond angle in the PH_4^+ ion.

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(1)

(d) Although phosphine molecules contain hydrogen atoms, there is no hydrogen bonding between phosphine molecules.
Suggest an explanation for this.

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(1)
(Total 5 marks)

Q7. Aluminium and thallium are elements in Group 3 of the Periodic Table.
Both elements form compounds and ions containing chlorine and bromine.

(a) Write an equation for the formation of aluminium chloride from its elements.

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(1)

(b) An aluminium chloride molecule reacts with a chloride ion to form the $AlCl_4^-$ ion.

Name the type of bond formed in this reaction. Explain how this type of bond is formed in the $AlCl_4^-$ ion.

Type of bond .....

Explanation .....

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(2)

(c) Aluminium chloride has a relative molecular mass of 267 in the gas phase.

Deduce the formula of the aluminium compound that has a relative molecular mass of 267

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(1)

(d) Deduce the name or formula of a compound that has the same number of atoms, the same number of electrons and the same shape as the $AlCl_4^-$ ion.

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(1)

(e) Draw and name the shape of the $TlBr_5^{2-}$ ion.

Shape of the $TlBr_5^{2-}$ ion.

Name of shape .....

(2)

(f) (i) Draw the shape of the $TlCl_2^+$ ion.

(1)

(ii) Explain why the $TlCl_2^+$ ion has the shape that you have drawn in part (f)(i).

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(1)

(g) Which **one** of the first, second or third ionisations of thallium produces an ion with the electron configuration [Xe] $5d^{10}6s^{1}$?

Tick (✓) one box.

First ☐

Second ☐

Third ☐

(1)

(Total 10 marks)