Q1. The following table shows the electronegativity values of the elements from lithium to fluorine.

	Li	Be	B	C	N	O	F
Electronegativity	1.0	1.5	2.0	2.5	3.0	3.5	4.0

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

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(Extra space) .....

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(2)

(ii) Suggest why the electronegativity of the elements increases from lithium to fluorine.

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(Extra space) .....

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(2)

(b) State the type of bonding in lithium fluoride.
Explain why a lot of energy is needed to melt a sample of solid lithium fluoride.

Bonding .....

Explanation .....

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(Extra space) .....

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(3)

(c) Deduce why the bonding in nitrogen oxide is covalent rather than ionic.

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(Extra space) .....

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(1)

(d) Oxygen forms several different compounds with fluorine.

(i) Suggest the type of crystal shown by OF_2

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(1)

(ii) Write an equation to show how OF_2 reacts with steam to form oxygen and hydrogen fluoride.

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(1)

(iii) One of these compounds of oxygen and fluorine has a relative molecular mass of 70.0 and contains 54.3% by mass of fluorine.

Calculate the empirical formula and the molecular formula of this compound. Show your working.

Empirical formula .....

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Molecular formula .....

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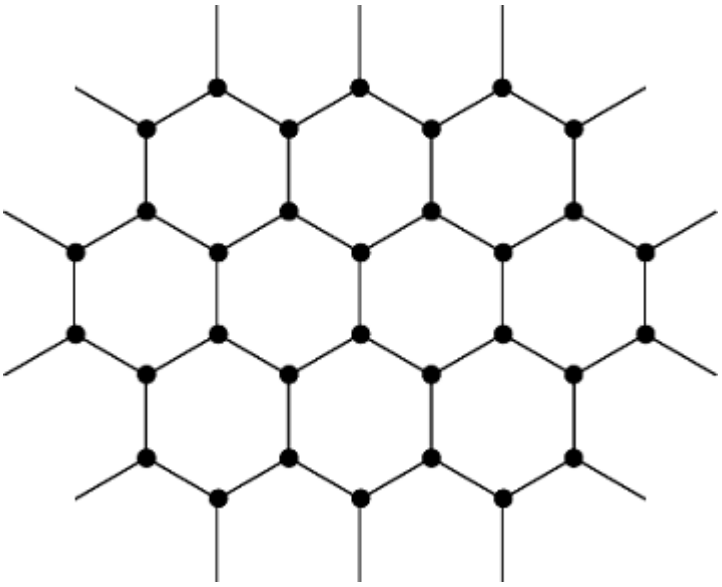
(4)
(Total 14 marks)

Q2. (a) Graphene is a new material made from carbon atoms. It is the thinnest and strongest material known. Graphene has a very high melting point and is an excellent conductor of electricity.
Part of the structure of graphene is illustrated in the diagram.



(i) Deduce the type of crystal structure shown by graphene.

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(1)

(ii) Suggest why graphene is an excellent conductor of electricity.

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(2)

(iii) Explain, in terms of its structure and bonding, why graphene has a high melting point.

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(2)

(b) Titanium is also a strong material that has a high melting point. It has a structure similar to that of magnesium.

(i) State the type of crystal structure shown by titanium.

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(1)

(ii) Explain, in terms of its structure and bonding, why titanium has a high melting point.

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(2)

(c) Titanium can be hammered into objects with different shapes that have similar strengths.

(i) Suggest why titanium can be hammered into different shapes.

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(1)

(ii) Suggest why these objects with different shapes have similar strengths.

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(1)

(d) Magnesium oxide (MgO) has a melting point of 3125 K.
Predict the type of crystal structure in magnesium oxide and suggest why its melting point is high.

Type of crystal structure .....

Explanation .....

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(3)
(Total 13 marks)

Q3. There are several types of crystal structure and bonding shown by elements and compounds.

(a) (i) Name the type of bonding in the element sodium.

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(1)

(ii) Use your knowledge of structure and bonding to draw a diagram that shows how the particles are arranged in a crystal of sodium.
You should identify the particles and show a minimum of six particles in a two-dimensional diagram.

(2)

(b) Sodium reacts with chlorine to form sodium chloride.

(i) Name the type of bonding in sodium chloride.

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(1)

(ii) Explain why the melting point of sodium chloride is high.

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(Extra space) .....

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(2)

(c) The table below shows the melting points of some sodium halides.

	NaCl	NaBr	NaI
Melting point /K	1074	1020	920

Suggest why the melting point of sodium iodide is lower than the melting point of sodium bromide.

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(1)
(Total 7 marks)

Q4. 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)

Q5. Trends in physical properties occur across all Periods in the Periodic Table.
This question is about trends in the Period 2 elements from lithium to nitrogen.

(a) Identify, from the Period 2 elements lithium to nitrogen, the element that has the largest atomic radius.

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(1)

(b) (i) State the general trend in first ionisation energies for the Period 2 elements lithium to nitrogen.

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(1)

(ii) Identify the element that deviates from this general trend, from lithium to nitrogen, and explain your answer.

Element .....

Explanation .....

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(Extra space) .....

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(3)

(c) Identify the Period 2 element that has the following successive ionisation energies.

	First	Second	Third	Fourth	Fifth	Sixth
Ionisation energy / kJ mol^{-1}	1090	2350	4610	6220	37 800	47 000

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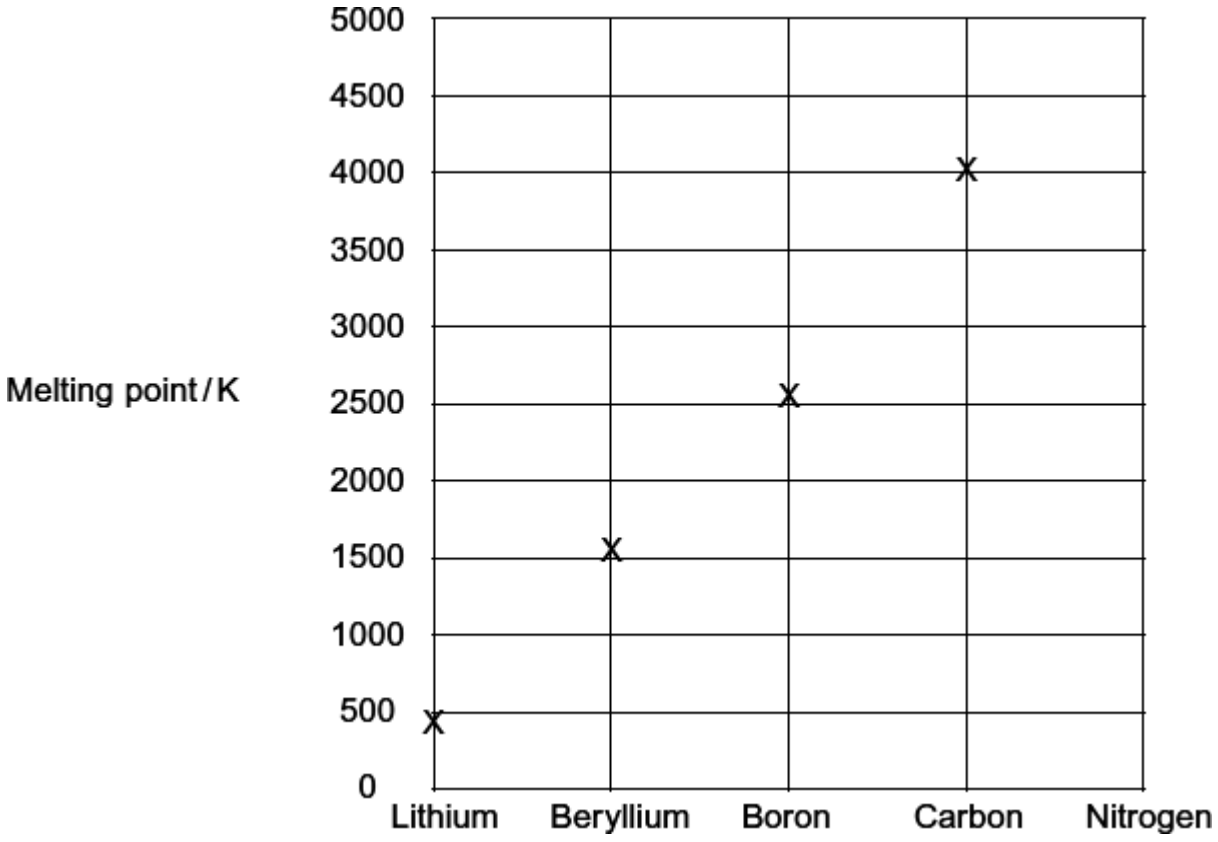
(1)

(d) Draw a cross on the diagram to show the melting point of nitrogen.



(1)

(e) Explain, in terms of structure and bonding, why the melting point of carbon is high.

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(Extra space) .....

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(3)

(Total 10 marks)