1 The table shows some data about the elements bromine and magnesium.

Element	**Melting point / K**	**Boiling point / K**
Bromine	266	332
Magnesium	923	1383

In terms of structure and bonding explain why the boiling point of bromine is different from that of magnesium. Suggest why magnesium is a liquid over a much greater temperature range compared to bromine.

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(Total 5 marks)

2 Which substance exists as a macromolecule?

A Cu ⬭

B SiO_2 ⬭

C P_4O_{10} ⬭

D MgO ⬭

(Total 1 mark)

3 Silicon dioxide (SiO_2) has a crystal structure similar to diamond.

(a) Give the name of the type of crystal structure shown by silicon dioxide.

....

(1)

(b) Suggest why silicon dioxide does **not** conduct electricity when molten.

....

....

....

(1)

(c) Silicon dioxide reacts with hydrofluoric acid (HF) to produce hexafluorosilicic acid (H_2SiF_6) and one other substance.

Write an equation for this reaction.

....

(1)
(Total 3 marks)

4 Some airbags in cars contain sodium azide (NaN_3).

(a) Sodium azide is made by reacting dinitrogen monoxide gas with sodium amide ($NaNH_2$) as shown by the equation.

$$2NaNH_2 + N_2O \longrightarrow NaN_3 + NaOH + NH_3$$

Calculate the mass of sodium amide needed to obtain 550 g of sodium azide, assuming there is a 95.0% yield of sodium azide.
Give your answer to 3 significant figures.

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(5)

(b) If a car is involved in a serious collision, the sodium azide decomposes to form sodium and nitrogen as shown in the equation.

$$2NaN_3(s) \longrightarrow 2Na(s) + 3N_2(g)$$

The nitrogen produced then inflates the airbag to a volume of 7.50×10^{-2} m^3 at a pressure of 150 kPa and temperature of 35 °C.

Calculate the minimum mass of sodium azide that must decompose.
(The gas constant R = 8.31 J K^{-1} mol^{-1})

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(6)

(c) Sodium azide is toxic. It can be destroyed by reaction with an acidified solution of nitrous acid (HNO_2) as shown in the equation.

$$2NaN_3 + 2HNO_2 + 2HCl \longrightarrow 3N_2 + 2NO + 2NaCl + 2H_2O$$

(i) A 500 cm^3 volume of the nitrous acid solution was used to destroy completely 150 g of the sodium azide.

Calculate the concentration, in mol dm^{-3}, of the nitrous acid used.

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(3)

(ii) Nitrous acid decomposes on heating.

Balance the following equation for this reaction.

........HNO_2 $\longrightarrow$ ....HNO_3 + ...NO + ...H_2O

(1)

(d) Sodium azide has a high melting point.

Predict the type of bonding in a crystal of sodium azide.
Suggest why its melting point is high.

Type of bonding ....

Reason for high melting point ....

....

....

....

....

(3)

(e) The azide ion has the formula N_3^-

(i) The azide ion can be represented as $N \equiv N - N^-$
One of these bonds is a co−ordinate bond.

On the following diagram, draw an arrowhead on one of the bonds to represent the direction of donation of the lone pair in the co−ordinate bond.

$$N \equiv N - N^-$$

(1)

(ii) Give the formula of a molecule that has the same number of electrons as the azide ion.

....

(1)

(iii) Which is the correct formula of magnesium azide?

Tick (✓) **one** box.

Mg_3N	☐
MgN	☐
MgN_6	☐
Mg_3N_2	☐

(1)
(Total 21 marks)

5 (a) Nickel is a metal with a high melting point.

(i) State the block in the Periodic Table that contains nickel.

....

(1)

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

....

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....

....

(2)

(iii) Draw a labelled diagram to show the arrangement of particles in a crystal of nickel.
In your answer, include at least six particles of each type.

(2)

(iv) Explain why nickel is ductile (can be stretched into wires).

....

....

....

(1)

(b) Nickel forms the compound nickel(II) chloride ($NiCl_2$).

(i) Give the full electron configuration of the Ni^{2+} ion.

....

(1)

(ii) Balance the following equation to show how anhydrous nickel(II) chloride can be obtained from the hydrated salt using $SOCl_2$
Identify **one** substance that could react with both gaseous products.

......$NiCl_2.6H_2O(s)$ + ... $SOCl_2(g)$ $\longrightarrow$ ......$NiCl_2(s)$ + ...$SO_2(g)$ + ...$HCl(g)$

Substance ....

(2)
(Total 9 marks)

6 Thallium is in Group 3 of the Periodic Table.
Thallium reacts with halogens to form many compounds and ions.

(a) Draw the shape of the $TlBr_3^{2-}$ ion and the shape of the $TlCl_4^{3-}$ ion.
Include any lone pairs of electrons that influence the shapes.

Name the shape made by the atoms in $TlBr_3^{2-}$ and suggest a value for the bond angle.

....

(4)

(b) Thallium(I) bromide (TlBr) is a crystalline solid with a melting point of 480 °C.

Suggest the type of bonding present in thallium(I) bromide and state why the melting point is high.

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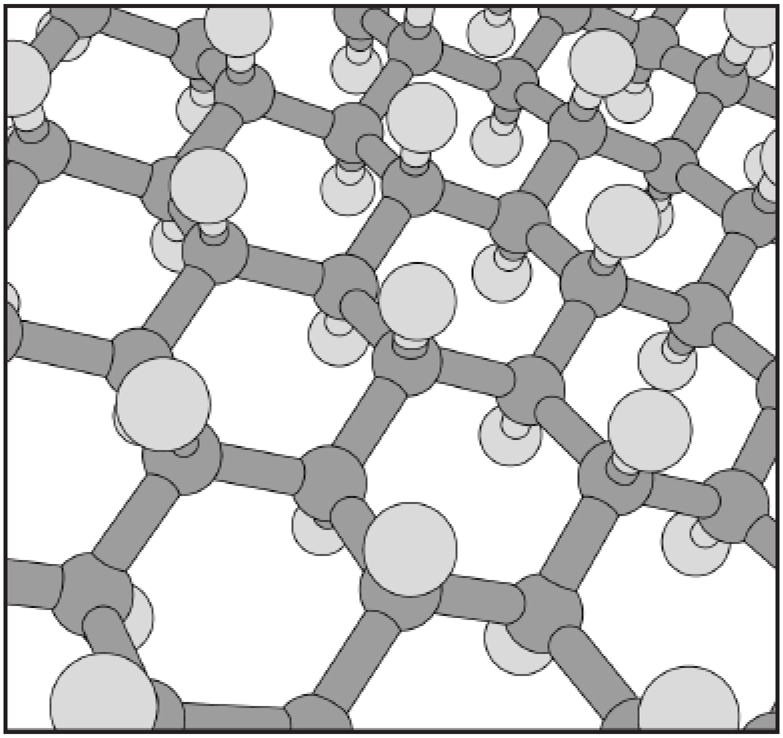
(3)

(c) Write an equation to show the formation of thallium(I) bromide from its elements.

....

(1)
(Total 8 marks)

7 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.

....

(1)

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

....

....

(1)

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

....

....

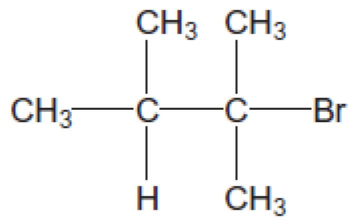
(1)

(d) Deduce the empirical formula of graphane.

....

(1)
(Total 4 marks)

8 (a) The structure of the bromoalkane **Z** is



Give the IUPAC name for **Z**.

Give the general formula of the homologous series of straight-chain bromoalkanes that contains one bromine atom per molecule.

Suggest **one** reason why 1-bromohexane has a higher boiling point than **Z**.

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(Extra space) ....

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(3)

(b) Draw the displayed formula of 1,2-dichloro-2-methylpropane.

State its empirical formula.

....

....

(2)
(Total 5 marks)

9 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*.

....

....

....

(Extra space) ....

....

(2)

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

....

....

....

(Extra space) ....

....

(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 ....

....

....

(Extra space) ....

....

(3)

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

....

....

(Extra space) ....

....

(1)

(d) Oxygen forms several different compounds with fluorine.

(i) Suggest the type of crystal shown by OF_2

....

(1)

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

....

(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 ....

....

....

....

....

....

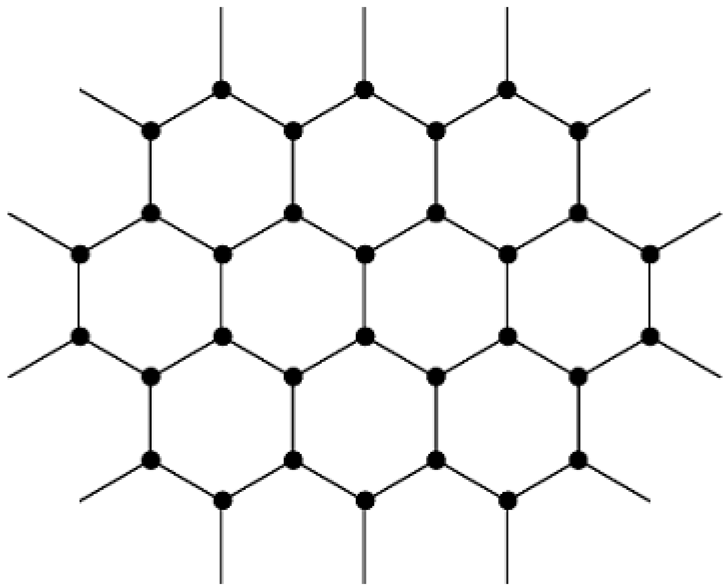
Molecular formula ....

....

(4)
(Total 14 marks)

10 (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.

....

(1)

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

....

....

....

....

(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.

....

(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.

....

....

(1)

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

....

....

(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 ....

....

....

....

(3)
(Total 13 marks)

11 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 ....

....

(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) ....

....

(3)

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

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

....

(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) ....

....

(2)
(Total 15 marks)

12 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.

....

(1)

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

....

(1)

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

Element ....

Explanation ....

....

....

(Extra space) ....

....

(3)

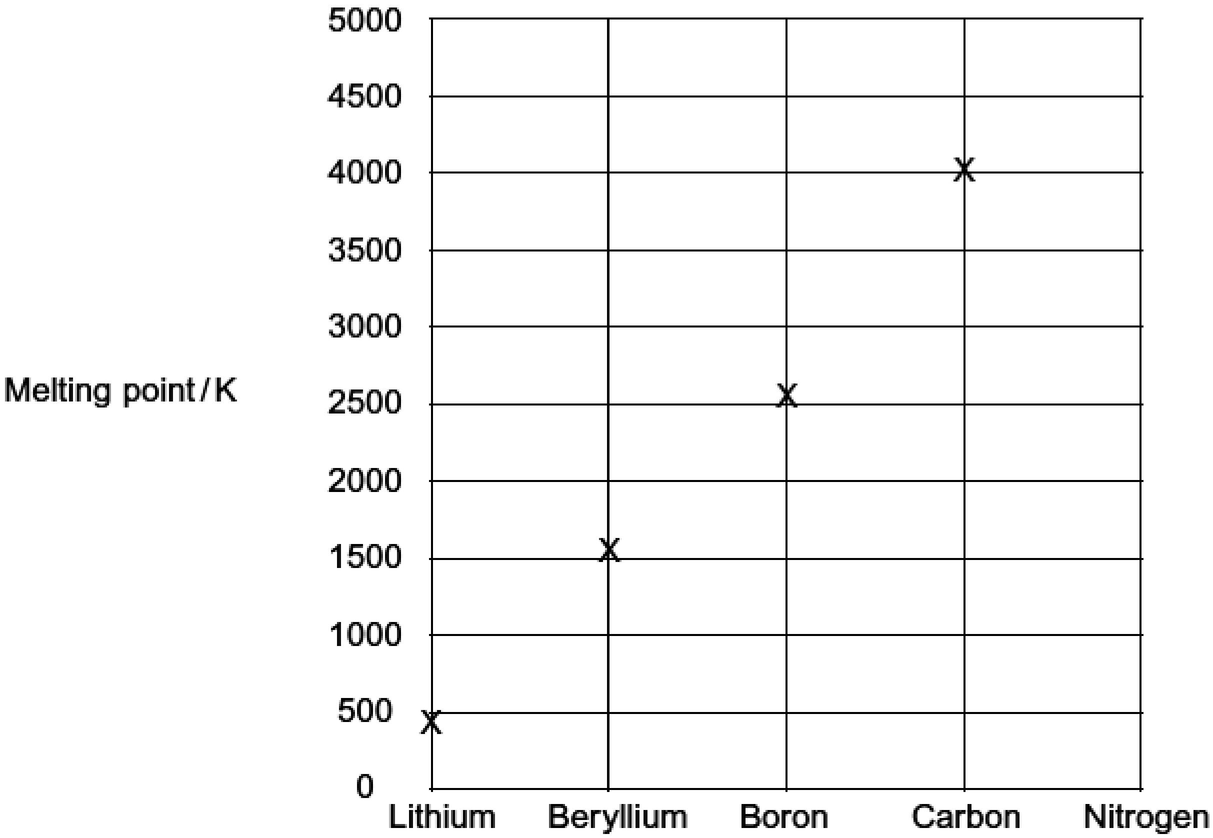
(c) Identify the Period 2 element that has the following successive ionisation energies.

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

....

(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) ....

....

....

(3)
(Total 10 marks)

13 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.

....

(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.

....

(1)

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

....

....

....

....

(Extra space) ....

....

(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.

....

....

(1)
(Total 7 marks)

14 Iodine and graphite are both solids. When iodine is heated gently a purple vapour is seen. Graphite will not melt until the temperature reaches 4000 K. Graphite conducts electricity but iodine is a very poor conductor of electricity.

(a) State the type of crystal structure for each of iodine and graphite.

....

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....

(2)

(b) Describe the structure of and bonding in graphite and explain why the melting point of graphite is very high.

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(4)

(c) Explain why iodine vaporises when heated gently.

....

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....

(2)

(d) State why iodine is a very poor conductor of electricity.

....

....

(1)
(Total 9 marks)

15 The table below shows the boiling points of some hydrogen compounds formed by Group 6 elements.

	H_2O	H_2S	H_2Se	H_2Te
Boiling point / K	373	212	232	271

(a) State the strongest type of intermolecular force in water and in hydrogen sulfide (H_2S).

Water ....

Hydrogen sulfide ....

....

(2)

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

(3)

(c) Explain why the boiling point of water is much higher than the boiling point of hydrogen sulfide.

....

....

(1)

(d) Explain why the boiling points increase from H_2S to H_2Te

....

....

(2)

(e) When H^+ ions react with H_2O molecules, H_3O^+ ions are formed.

Name the type of bond formed when H^+ ions react with H_2O molecules.
Explain how this type of bond is formed in the H_3O^+ ion.

Type of bond ....

Explanation ....

....

(2)

(f) Sodium sulfide (Na_2S) has a melting point of 1223 K.
Predict the type of bonding in sodium sulfide and explain why its melting point is high.

Type of bonding ....

Explanation ....

....

....

(3)
(Total 13 marks)

16 (a) Complete the electronic configuration for the sodium ion, Na^+

ls^2 ....

(1)

(b) (i) Write an equation, including state symbols, to represent the process for which the energy change is the second ionisation energy of sodium.

....

(2)

(ii) Explain why the second ionisation energy of sodium is greater than the second ionisation energy of magnesium.

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(3)

(iii) An element **X** in Period 3 of the Periodic Table has the following successive ionisation energies.

	First	Second	Third	Fourth
Ionisation energies / $kJ\ mol^{-1}$	577	1820	2740	11600

Deduce the identity of element **X**.

....

(1)

(c) State and explain the trend in atomic radius of the Period 3 elements from sodium to chlorine.

Trend ....

Explanation ....

....

....

(3)

(d) Explain why sodium has a lower melting point than magnesium.

....

....

....

....

(3)

(e) Sodium reacts with ammonia to form the compound $NaNH_2$ which contains the NH_2^- ion.

Draw the shape of the NH_2^- ion, including any lone pairs of electrons.

Name the shape made by the three atoms in the NH_2^- ion.

Shape of NH_2^-

Name of shape ....

(2)

(f) In terms of its electronic configuration, give **one** reason why neon does not form compounds with sodium.

....

(1)

(Total 16 marks)

17 (a) (i) Define the term *relative atomic mass* (A_r) of an element.

....

....

....

....

(2)

(ii) A sample of the metal silver has the relative atomic mass of 107.9 and exists as two isotopes. In this sample, 54.0% of the silver atoms are one isotope with a relative mass of 107.1

Calculate the relative mass of the other silver isotope.

State why the isotopes of silver have identical chemical properties.

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(4)

(b) The isotopes of silver, when vaporised, can be separated in a mass spectrometer.

Name the **three** processes that occur in a mass spectrometer before the vaporised isotopes can be detected.

State how each process is achieved.

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(6)

(c) State the type of bonding involved in silver.

Draw a diagram to show how the particles are arranged in a silver lattice and show the charges on the particles.

....

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(3)

(d) Silver reacts with fluorine to form silver fluoride (AgF).

Silver fluoride has a high melting point and has a structure similar to that of sodium chloride.

State the type of bonding involved in silver fluoride.

Draw a diagram to show how the particles are arranged in a silver fluoride lattice and show the charges on the particles.

Explain why the melting point of silver fluoride is high.

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(5)
(Total 20 marks)

18 (a) Describe the bonding in, and the structure of, sodium chloride and ice. In each case draw a diagram showing how each structure can be represented. Explain, by reference to the types of bonding present, why the melting point of these two compounds is very different.

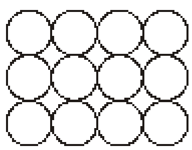
(12)

(b) Explain how the concept of bonding and non-bonding electron pairs can be used to predict the shape of, and bond angles in, a molecule of sulfur tetrafluoride, SF_4.
Illustrate your answer with a diagram of the structure.

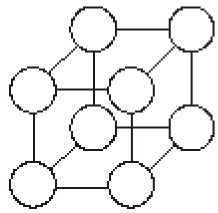
(8)
(Total 20 marks)

19 At room temperature, both sodium metal and sodium chloride are crystalline solids which contain ions.

(a) On the diagrams for sodium metal and sodium chloride below, mark the charge for each ion.



Sodium metal



Sodium chloride

(2)

(b) (i) Explain how the ions are held together in solid sodium metal.

....

....

(ii) Explain how the ions are held together in solid sodium chloride.

....

....

(iii) The melting point of sodium chloride is much higher than that of sodium metal. What can be deduced from this information?

....

....

(3)

(c) Compare the electrical conductivity of solid sodium metal with that of solid sodium chloride. Explain your answer.

Comparison ....

....

Explanation ....

....

....

(3)

(d) Explain why sodium metal is malleable (can be hammered into shape).

....

....

(1)

(e) Sodium chlorate(V), $NaClO_3$, contains 21.6% by mass of sodium, 33.3% by mass of chlorine and 45.1% by mass of oxygen.

(i) Use the above data to show that the empirical formula of sodium chlorate(V) is $NaClO_3$

....

....

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....

....

(ii) Sodium chlorate(V) may be prepared by passing chlorine into hot aqueous sodium hydroxide. Balance the equation for this reaction below.

.... Cl_2 + ... $NaOH \rightarrow$ .... $NaCl + NaClO_3 + 3H_2O$

(3)
(Total 12 marks)

20 Phosphorus exists in several different forms, two of which are white phosphorus and red phosphorus. White phosphorus consists of P_4 molecules, and melts at 44°C. Red phosphorus is macromolecular, and has a melting point above 550°C.

Explain what is meant by the term *macromolecular*. By considering the structure and bonding present in these two forms of phosphorus, explain why their melting points are so different.

(Total 5 marks)

21 Diamond and graphite are both forms of carbon.
Diamond is able to scratch almost all other substances, whereas graphite may be used as a lubricant. Diamond and graphite both have high melting points.

Explain each of these properties of diamond and graphite in terms of structure and bonding. Give **one** other difference in the properties of diamond and graphite.

(Total 9 marks)

22 Iodine and diamond are both crystalline solids at room temperature. Identify one similarity in the bonding, and one difference in the structures, of these two solids.
Explain why these two solids have very different melting points.

(Total 6 marks)

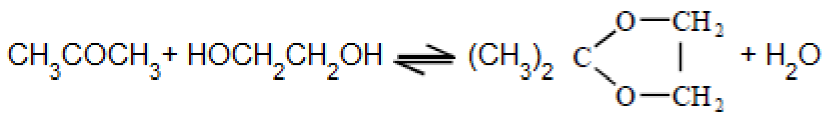
23 (a) Name the strongest type of intermolecular force between hydrogen fluoride molecules and draw a diagram to illustrate how two molecules of HF are attracted to each other.
In your diagram show all lone pairs of electrons and any partial charges. Explain the origin of these charges.
Suggest why this strong intermolecular force is not present between HI molecules.

(7)

(b) Crystals of sodium chloride and of diamond both have giant structures. Their melting points are 1074 K and 3827 K, respectively. State the type of structure present in each case and explain why the melting point of diamond is so high.

(4)
(Total 11 marks)

24 This question is about the reaction between propanone and an excess of ethane-1,2-diol, the equation for which is given below.



Y

In a typical procedure, a mixture of 1.00 g of propanone, 5.00 g of ethane-1,2-diol and 0.100 g of benzenesulphonic acid, $C_6H_5SO_3H$, is heated under reflux in an inert solvent. Benzenesulphonic acid is a strong acid.

Which one of the following statements is **not** true?

A Ethane-1,2-diol and water can form hydrogen bonds.

B Ethane-1,2-diol is soluble in water.

C Propane has a higher boiling point than ethane-1,2-diol.

D **Y** and water are polar molecules.

(Total 1 mark)

25 The table below shows some values of melting points and some heat energies needed for melting.

Substance	I_2	NaCl	HF	HCl	HI
Melting point/K	387	1074	190	158	222
Heat energy for melting /kJ mol^{-1}	7.9	28.9	3.9	2.0	2.9

(a) Name **three** types of intermolecular force.

Force 1 ....

Force 2 ....

Force 3 ....

(3)

(b) (i) Describe the bonding in a crystal of iodine.

....

....

(ii) Name the crystal type which describes an iodine crystal.

....

(iii) Explain why heat energy is required to melt an iodine crystal.

....

....

(4)

(c) In terms of the intermolecular forces involved, suggest why

(i) hydrogen fluoride requires more heat energy for melting than does hydrogen chloride,

....

....

....

....

(ii) hydrogen iodide requires more heat energy for melting than does hydrogen chloride.

....

....

....

(5)

(d) (i) Explain why the heat energy required to melt sodium chloride is large.

....

....

(ii) The heat energy needed to vaporise one mole of sodium chloride (171 kJ mol^{-1}) is much greater than the heat energy required to melt one mole of sodium chloride. Explain why this is so.

....

....

(3)

(e) In terms of its structure and bonding, suggest why graphite has a very high melting point.

....

....

....

(2)
(Total 17 marks)

26 (a) (i) Describe the bonding in a metal.

....

....

....

(ii) Explain why magnesium has a higher melting point than sodium.

....

....

....

(4)

(b) Why do diamond and graphite both have high melting points?

....

....

....

....

(3)

(c) Why is graphite a good conductor of electricity?

....

(1)

(d) Why is graphite soft?

....

....

....

(2)
(Total 10 marks)

27 Which one of the following does **not** contain any delocalised electrons?

A poly(propene)

B benzene

C graphite

D sodium

(Total 1 mark)

Mark schemes

1

Structures

M1 Bromine is (simple) molecular / simple molecules

Chemical Error penalties

1

M2 Magnesium is metallic / consists of (positive) ions in a (sea) of delocalised electrons

If Br_2 (covalent) bonds broken lose M3 and M4

1

Strength

M3 Br_2 has weak (van der Waals) forces between the molecules / weak IMFs

If eg Mg molecules or Mg ionic bonds lose M2 and M4

1

M4 so more energy is needed to overcome the Stronger (metallic) bonds or converse. The comparison could be direct or implied.

1

Liquid range

M5 Mg has a much greater liquid range because forces of attraction in liquid / molten metal are strong(er) OR converse argument for Br_2

Must refer to liquid range to score M5

1

[5]

2

B

[1]

3

(a) Macromolecular / giant covalent / giant molecule

Not giant atomic

1

(b) No delocalised electrons / no free ions / no free charged particles

1

(c) $SiO_2 + 6HF \longrightarrow H_2SiF_6 + 2H_2O$

Accept multiples

1

[3]

4

(a) M1 $550 \times \frac{100}{95}$ = 579 g would be 100% mass

Allow alternative methods.

There are 4 process marks:

1

M2 So $\frac{579}{65}$ = 8.91 moles NaN_3

or

M1 $\frac{550}{65}$ = 8.46 moles NaN_3 (this is 95%)

M2 So 100% would be 8.46 × $\frac{100}{95}$ = 8.91 moles NaN_3

1: mass ÷ 65

2: mass or moles × 100 / 95 or × 1.05

3: moles NaN_3 × 2

4: moles $NaNH_2$ × 39

1

Then M3 Moles $NaNH_2$ = 8.91 <u>× 2</u> = (17.8(2) moles)

1

M4 mass $NaNH_2$ = 17.8(2) <u>× 39</u>

1

M5 <u>693</u> or <u>694</u> or <u>695</u> (g)

If 693, 694 or 695 seen to 3 sig figs award 5 marks

1

(b) M1 308 K and 150 000 Pa

1

M2 n = $\frac{PV}{RT}$ or $\frac{150\ 000 \times 7.5 \times 10^{-2}}{8.31 \times 308}$

1

M3 = 4.4(0) or 4.395 moles N_2

Allow only this answer but allow to more than 3 sig figs

1

M4 Moles NaN_3 = 4.395 <u>×</u> $\frac{2}{3}$ (= 2.93)

M4 is for M3 × $\frac{2}{3}$

1

M5 Mass NaN_3 = (2.93) <u>× 65</u>

M5 is for moles M4 × 65

1

M6 = 191 g

Allow 190 to 191 g allow answers to 2 sig figs or more

1

(c) (i) 150 / 65 = 2.31 moles NaN_3 or 2.31 moles nitrous acid

1

Conc = 2.31 × $\frac{1000}{500}$

M2 is for M1 × 1000 / 500

1

4.6(1) or 4.6(2) (mol dm^{-3})

Only this answer

1

(ii) $3HNO_2 \longrightarrow HNO_3 + 2NO + H_2O$

Can allow multiples

1

(d) Ionic

If not ionic then CE = 0 / 3

1

Oppositely charged <u>ions</u> / Na^+ and N_3^- ions

Penalise incorrect ions here but can allow M3

1

Strong <u>attraction</u> between (oppositely charged) ions / lots of energy needed to overcome (strong) <u>attractions</u> (between ions)

M3 dependent on M2

1

(e) (i) $N \equiv N \longrightarrow N^-$

Only

1

(ii) CO_2 / N_2O / BeF_2 / HN_3

Allow other correct molecules

1

(iii) MgN_6

Only

1

[21]

5 (a) (i) d (block) **OR** D (block)

Ignore transition metals / series.

Do not allow any numbers in the answer.

1

(ii) Contains positive (metal) ions or protons or nuclei and <u>delocalised / mobile / free / sea of</u> electrons

Ignore atoms.

1

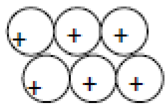
<u>Strong attraction</u> between them or <u>strong metallic</u> bonds

Allow 'needs a lot of energy to break / overcome' instead of 'strong'.

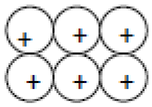
If strong attraction between incorrect particles, then CE = 0 / 2.

If molecules / intermolecular forces / covalent bonding / ionic bonding mentioned then CE=0.

1

(iii) 

OR



M1 is for regular arrangement of atoms / ions (min 6 metal particles).

M2 for + sign in each metal atom / ion.

Allow 2^+ sign.

2

(iv) <u>Layers / planes / sheets of atoms or ions</u> can slide over one another

QoL.

1

(b) (i) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^8\ (4s^0)$

Only.

1

(ii) $NiCl_2.6H_2O$ + **6** $SOCl_2 \longrightarrow NiCl_2$ + **6** SO_2 + **12** HCl

Allow multiples.

1

$NaOH$ / NH_3 / $CaCO_3$ / CaO

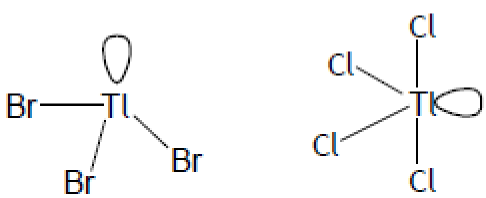
Allow any name or formula of alkali or base.

Allow water.

1

[9]

6 (a)



Mark is for correct number of bonds and lone pair in each case.

Ignore charges if shown.

2

Pyramidal / trigonal pyramid

Allow tetrahedral.

1

107°

Allow 107 to 107.5°.

1

(b) M1 Ionic

CE = 0 / 3 if not ionic.

1

M2 Oppositely charged ions / Tl^+ and Br^- ions

If molecules / intermolecular forces / metallic bonding, CE=0.

1

M3 <u>Strong attraction</u> between ions

M3 dependent on M2.

Allow 'needs a lot of energy to break / overcome' instead of 'strong'.

1

(c) $Tl + \frac{1}{2}Br_2 \longrightarrow TlBr$

Allow multiples.

Ignore state symbols even if incorrect.

1

[8]

7 (a) Giant covalent / giant molecular / macromolecular

Not giant alone.

Not covalent alone.

1

(b) Shared pair of electrons / one electron from each C atom

1

(c) No delocalised / free / mobile electrons

Allow all (outer) electrons involved in (covalent) bonds.

Ignore ions.

1

(d) CH

Allow HC

C and H must be capital letters.

1

[4]

8 (a) 2-bromo-2,3-dimethylbutane

Ignore punctuation.

1

$C_nH_{2n+1}Br$ or $C_nH_{2n+1}X$ or $C_xH_{2x+1}Br$

Any order.

1

Stronger / more <u>vdw</u> (forces) <u>between molecules</u> (of 1-bromohexane)

QoL

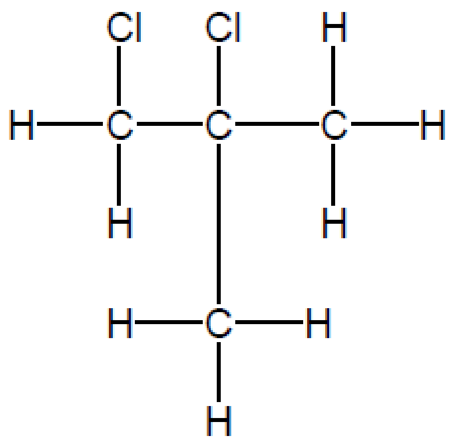
Allow converse arguments for Z

Not just more IMF.

Ignore size of molecule.

1

(b)



1

C_2H_4Cl

Any order

1

[5]

9 (a) (i) The power of an <u>atom</u> or <u>nucleus</u> to withdraw or attract electrons ***OR*** electron density ***OR*** a pair of electrons (towards itself)

Ignore retain

1

In a <u>covalent</u> bond

1

(ii) More protons / bigger nuclear charge

1

Same or similar shielding / electrons in the same shell or principal energy level / atoms get smaller

Not same sub–shell
Ignore more electrons

1

(b) Ionic

If not ionic then CE = 0 / 3
If blank lose M1 and mark on

1

Strong or many or lots of (electrostatic) <u>attractions</u> (between ions)

If molecules / IMF / metallic / atoms lose M2 + M3, penalise incorrect ions by 1 mark

1

Between + and − ions / between Li^+ and F^- ions / oppositely charged ions

Allow strong (ionic) bonds for max 1 out of M2 and M3

1

(c) Small electronegativity difference / difference = 0.5

Must be comparative

Allow 2 non-metals

1

(d) (i) (simple) <u>molecular</u>

Ignore simple covalent

1

(ii) $OF_2 + H_2O \longrightarrow O_2 + 2HF$

Ignore state symbols
Allow multiples
Allow OF_2 written as F_2O

1

(iii) 45.7% O

1

$$\left(\begin{array}{cc} O & F \\ \frac{45.7}{16} & \frac{54.3}{19} \end{array}\right)$$

If students get M2 upside down lose M2 + M3
Check that students who get correct answer divide by 16 and 19 (not 8 and 9). If dividing by 8 and 9 lose M2 and M3 but could allocate M4 ie max 2

1

(2.85 2.85)
(1 1)

EF = <u>OF or FO</u>

Calculation of OF by other correct method = 3 marks
Penalise Fl by 1 mark

1

MF (= 70.0 / 35) = O_2F_2 or F_2O_2

1

[14]

10 (a) (i) Macromolecular / giant covalent / giant molecular / giant atomic

If covalent, molecular, giant, lattice, hexagonal or blank mark on.

If metallic, ionic or IMF chemical error CE = 0 for (a)(i), (a)(ii) and (a)(iii).

1

(ii) <u>Delocalised electrons / free electrons</u>

1

Able to move / flow (through the crystal)

Allow M2 for electrons can move / flow.

Ignore electrons can carry a current / charge.

1

(iii) Covalent bonds

1

Many /strong / hard to break / need a lot of energy to break

M2 dependent on M1.

Ignore van der Waals' forces.

1

(b) (i) (Giant) metallic / metal (lattice)

If FCC or BCC or HCP or giant or lattice, mark on.

If incorrect (b)(i), chemical error CE for (b)(ii) and (c)(ii).

1

(ii) Nucleus / protons / positive ions and delocalised electrons (are attracted)

QWC Must be delocalised electrons – not just electrons.

Chemical error = 0/2 for (b)(ii) if other types of bonding or IMF mentioned.

1

Strong attraction

Allow strong metallic bonding for one mark if M1 and M2 are not awarded.

1

(c) (i) Layers of atoms/ions slide (over one another)

Do not allow just layers.

1

(ii) (Strong) (metallic) bonding re-formed / same (metallic) bonding / retains same (crystal) structure / same bond strength / same attraction between protons and delocalised electrons as before being hammered or words to that effect

If IMF, molecules, chemical error CE = 0/1 for (c)(ii).

If metallic not mentioned in (b)(i) or (b)(ii) it must be mentioned here in (c)(ii) to gain this mark.

Do not allow metallic bonds broken alone.

Ignore same shape or same strength.

1

(d) (giant) Ionic

If not ionic, chemical error CE = 0/3

1

Between + and – ions / oppositely charged ions or Mg^{2+} and O^{2-}

If molecules mentioned in explanation lose M2 and M3

Allow one mark for a strong attraction between incorrect charges on the ions.

1

<u>Strong attraction</u>

1

[13]

11 (a) Covalent

If not covalent CE = 0/2

If dative covalent CE = 0/2

If blank mark on

Ignore polar

If number of pairs of electrons specified, must be 3

1

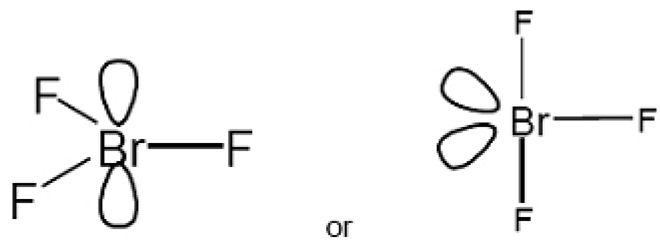
Shared <u>pair</u>(s) of electrons / one electron from Br and one electron from F

Not 2 electrons from 1 atom

Not shared pair between ions/molecules

1

(b) (i)



BrF_3 should have 3 bp and 2 lp and correct atoms for the mark

Penalise Fl

1

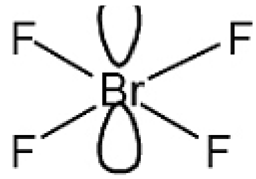
BrF_3 if trigonal planar shown = 120°

Allow 84 – 90° or 120° and ignore 180°

or if T shape shown 84 – 90°

Irrespective of shape drawn

1

(ii) 

BrF_4^- should have 4 bp and 2 lp and all atoms for the mark (ignore sign)

Allow Fl

1

BrF_4^- 90°

Only

Ignore 180°

1

(c) Ionic or (forces of) attraction between ions / bonds between ions

If molecules, IMF, metallic, CE =0

If covalent bonds mentioned, 0/3, unless specified <u>within</u> the BrF_4^- ion and not broken

Ignore atoms

1

Strong (electrostatic) attraction / strong bonds / lots of energy needed to break bonds

1

Between K^+ and BrF_4^- ions/oppositely charged ions / + and – ions

If ions mentioned they must be correct

Strong bonds between + and – ions =3/3

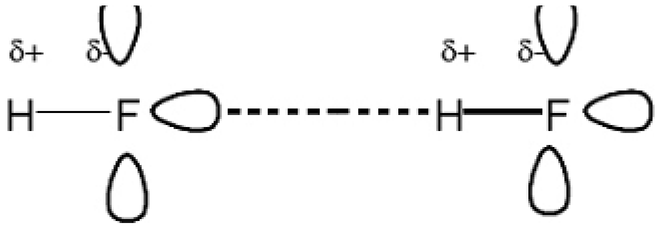
1

(d) (i) Hydrogen <u>bonds</u>/hydrogen <u>bonding</u>/H <u>bonds</u>/H <u>bonding</u>

Not just hydrogen

1

(ii)



One mark for 4 partial charges

One mark for 6 lone pairs

One mark for H bond from the lone pair to the Hδ+

Allow Fl

If more than 2 molecules are shown they must all be correct. Treat any errors as contradictions within each marking point.

CE = 0/3 if incorrect molecules shown.

3

(e) vdw / van der Waals forces between molecules

QoL

Not vdw between HF molecules, CE = 0/2

vdw between atoms, CE = 0/2

If covalent, ionic, metallic, CE=0/2

1

IMF are weak / need little energy to break IMF / easy to overcome IMF

1

[15]

12 (a) Lithium / Li

Penalise obvious capital I (second letter).

1

(b) (i) Increase / gets bigger

Ignore exceptions to trend here even if wrong

1

(ii) Boron / B

If not Boron, CE = 0/3

1

Electron removed from (2)p orbital /sub-shell / (2)p electrons removed

If p orbital specified it must be 2p

1

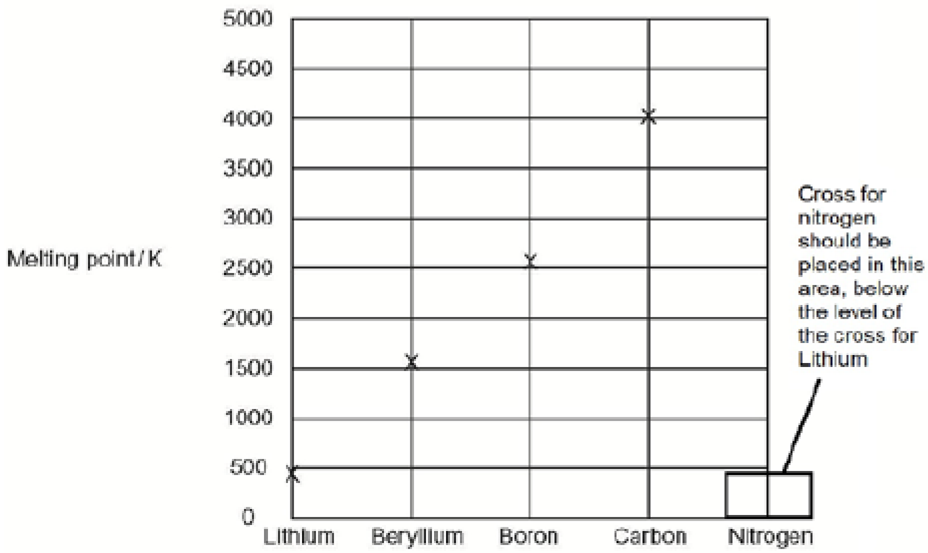
Which is higher in energy (so more easily lost) / more shielded (so more easily lost) / further from nucleus

1

(c) C / carbon

1

(d) Below Li



The cross should be placed on the diagram, on the column for nitrogen, below the level of the cross printed on the diagram for Lithium.

1

(e) Macromolecular / giant molecular / giant atomic

Allow giant covalent (molecule) = 2

1

<u>Covalent</u> bonds in the structure

1

<u>Strong</u> (covalent) <u>bonds must be broken or overcome /</u> (covalent) <u>bonds need a lot of energy to break</u>

Ignore weakening / loosening bonds

If ionic / metallic/molecular/ dipole dipole/ H bonds/ bonds between molecules, CE = 0/3

Ignore van der Waals forces

Ignore hard to break

1

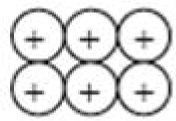
[10]

13 (a) (i) Metallic

Allow body centred cubic

1

(ii)

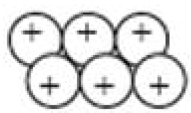


One mark for regular arrangement of particles. Can have a space between them

Do not allow hexagonal arrangement

1

OR



Na^+ Na^+ Na^+

Na^+ Na^+ Na^+

One mark for + in each

Ignore electrons

If it looks like ionic bonding then CE = 0/2

1

(b) (i) <u>Ionic</u>

CE = 0 for (b)(i) and (b)(ii) if not ionic

1

(ii) Strong (electrostatic) attraction

Any mention of IMF or molecules / metallic / covalent in (b)(ii) then CE 0/2

1

Between <u>oppositely</u> charged ions / particles

Or + and – ions

1

(c) Iodide / I^- bigger (ion) (so less attraction to the Na+ ion)

Need comparison

Do not allow iodine is a bigger atom

Ignore I^- has one more e^- shell

CE = 0 if IMF / covalent / metallic mentioned

1

[7]

14 (a) Iodine – <u>molecular</u>

Not covalent lattice

1

Graphite – macromolecular/giant covalent/giant atomic

1

(b) <u>Layers</u> of (C atoms)

1

Connected by <u>covalent bonds</u> within each layer

1

<u>Van der Waals forces</u>/<u>IMF</u> between layers/weak forces between layers

1

<u>Many/strong covalent bonds need to be broken</u>

If any other element mentioned other than C, CE = 0

Ignore the no of covalent bonds around the C if mentioned
The first 3 marks could be scored with a <u>labelled</u> diagram. Need to label or state covalent bonds within the layers.
Covalent or ionic or metallic bonds between molecules CE = 0

1

(c) Van der Waals forces are weak or easily broken

Not vdw between atoms

1

Van der Waals <u>between molecules</u> (or implied)

Allow weak IMF = 2

1

(d) Does not have delocalised/free electrons

Only allow answer with respect to iodine
Not all electrons used in bonding
Ignore free ions

1

[9]

15 (a) Hydrogen/H bonds

Not just hydrogen

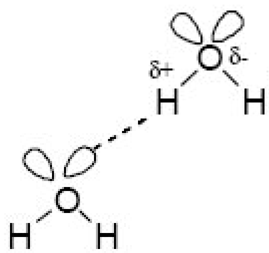
1

van der Waals/vdw/dipole-dipole/London/temporarily induced dipole/dispersion forces

Not just dipole

1

(b)



M1 for partial charges as indicated in diagram (correct minimum)
M2 for all four lone pairs
M3 for H bond from the lp to the H (δ+) on the other molecule
Lone pair on hydrogen CE = 0
OHO CE = 0
If only one molecule of water shown
CE = 0

3

(c) Hydrogen bonds/IMF (in water) stronger

OR

IMF/VDW/dipole-dipole forces (in H_2S) are weaker

OR

H bonding is the strongest IMF

Ignore energy references
Comparison must be stated or implied

1

(d) Atoms/molecules get larger/more shells/more electrons/more surface area

Not heavier/greater Mr

1

therefore increased Van der Waals/IMF forces

Ignore references to dipole-dipole forces

1

(e) Dative (covalent)/coordinate

If not dative/coordinate CE = 0/2
If covalent or blank read on

1

(Lone) pair/both electrons/two electrons on $O(H_2)$ donated (to H^+)
OR pair/both electrons come from $O(H_2)$

Explanation of a coordinate bond specific to oxygen or water required
Not just H+ attracted to lone pair since that is nearer to a H bond

1

(f) ionic

1

if not ionic CE = 0

oppositely charged ions/+ and – ions or particles

atoms or molecules loses M2 and M3

1

ions attract strongly OR strong/many (ionic) bonds must be broken

S^- loses M2
Reference to IMF loses M2 and M3

1

[13]

16 (a) $2s^2\ 2p^6$;

If ignored the $1s^2$ given and written $1s^22s^22p^6$ mark as correct
Allow capitals and subscripts

1

(b) (i) $Na^{+}(g) \rightarrow Na^{2+}(g) + e^{(-)}$;

One mark for equation and one mark for state symbols

$Na^{+}(g) + e^{(-)} \rightarrow Na^{2+}(g) + 2e^{(-)}$;

M2 dependent on M1

Allow $Na^{+}(g) - e^{(-)} \rightarrow Na(g)$

Allow $X^{+}(g) \rightarrow X^{2+}(g) + e$ = 1 mark

2

(ii) $Na^{(2+)}$ requires loss of e^{-} from a 2(p) orbital or 2nd energy level or 2nd shell <u>and</u> $Mg^{(2+)}$ requires loss of e^{-} from a 3(s) orbital or 3rd energy level or 3rd shell / $Na^{(2+)}$ loses e from a lower (energy) orbital/ or vice versa;

Not from 3p

1

Less shielding (in Na);

Or vice versa for Mg

1

$e^{(-)}$ closer to nucleus/ more attraction (of electron to nucleus) (in Na);

M3 needs to be comparative

1

(iii) Aluminium /Al;

1

(c) Decreases;

If not decreases CE = 0
If blank, mark on

1

Increasing nuclear charge/ increasing number of protons;

1

Electrons in same shell or level/ same shielding/ similar shielding;

1

(d) Answer refers to Na;

Allow converse answers relating to Mg.

Na fewer protons/smaller nuclear charge/ fewer delocalised electrons;

Allow Mg is 2+ and Na is +.
If vdw CE = 0.

1

Na is a bigger ion/ atom;

1

Smaller attraction between nucleus and delocalised electrons;

If mentioned that charge density of Mg^{2+} is greater then allow first 2 marks.
(ie charge / size / attraction).
M3 allow weaker metallic bonding.

1

(e) (Bent) shape showing 2 lone pairs + 2N−H bond pairs;

Atoms must be labelled.
Lone pairs can be with or without lobes.

1

Bent / v shape/ triangular;

Not tetrahedral.
Allow non-linear.
Bent-linear = contradiction.

1

(f) Ne has full sub-levels/ can't get any more electrons in the sub-levels/ Ne has full shells;

Not $2s^2\ 2p^6$ alone.
Not stable electron configuration.

1

[16]

17 (a) (i) Average/mean mass of 1 atom (of an element);

Average mass of 1 atom × 12.

1

Mass 1/12 atom of ^{12}C;

Mass 1 atom of ^{12}C.
QWC.

1

(ii) Other isotope = 46.0%;

1

$107.9 = \frac{(54 \times 107.1) + (46 \times ?)}{100}$;

M2 whole expression.

1

108.8;

Answer 108.8 (3 marks).
Answer min 1 d.p..

1

Same electronic configuration/ same number of electrons (in outer shell)/ both have 47 electrons;

Ignore protons and neutrons unless incorrect.
Not just electrons determine chemical properties.

1

(b) Ionisation;

1

high energy electrons fired at sample;

Allow electron gun /blasted with electrons.

1

Acceleration;

1

With electric field/accelerating potential/potential difference;

Allow by negative plate.

1

Deflection;

1

With electromagnet/ magnet/ magnetic field;

M2 dependent on M1.
M4 dependent on M3.
M6 dependent on M5.

1

(c) (Silver) metallic (bonding);

Vdw/molecules CE=0.

1

Regular arrangement of same sized particles;

1

+ charge in each ion;

Ignore multiple positive charges.
Candidates do not need to show delocalised electrons.

1

(d) Ionic (bonds); 1

Minimum 4 ions shown in 2D square arrangement placed Correctly;

Do not allow multiple charges on ions. 1

Further 3 ions shown correctly in a cubic lattice; 1

Strong (electrostatic) forces/bonds;

If vdw/molecules/covalent mentioned CE = 0 for M4 and M5. 1

Between <u>+ and – ions</u>;

Accept between <u>oppositely charged ions</u>. 1

[20]

18 (a) NaCl is ionic 1

cubic lattice 1

ions placed correctly 1

electrostatic attraction between ions 1

Covalent bonds between atoms in water 1

Hydrogen bonding between water molecules 1

Tetrahedral representation showing two covalent and two hydrogen bonds 1

2 hydrogen bonds per molecule 1

Attraction between ions in sodium chloride is very strong 1

Covalent bonds in ice are very strong 1

Hydrogen bonds between water molecules in ice are much weaker 1

Consequently, less energy is required to break the hydrogen bonds in ice to form separate water molecules than to break the ionic bonds in sodium chloride and make separate ions 1

(b)

Mark Range	The marking scheme for this part of the question includes an overall assessment for the Quality of Written Communication (QWC). There are no discrete marks for the assessment of QWC but the candidates' QWC in this answer will be one of the criteria used to assign a level and award the marks for this part of the question **Descriptor** an answer will be expected to meet most of the criteria in the level descriptor
3	– claims supported by an appropriate range of evidence – good use of information or ideas about chemistry, going beyond those given in the question – argument well structured with minimal repetition or irrelevant points – accurate and clear expression of ideas with only minor errors of grammar, punctuation and spelling
2	– claims partially supported by evidence – good use of information or ideas about chemistry given in the question but limited beyond this – the argument shows some attempt at structure – the ideas are expressed with reasonable clarity but with a few errors of grammar, punctuation and spelling
0-1	– valid points but not clearly linked to an argument structure – limited use of information or ideas about chemistry – unstructured – errors in spelling, punctuation and grammar or lack of fluency

4 bonding electron pairs
1

and one lone pair
1

repel as far apart as possible QWC
1

lone pair - bond pair repulsion > bp—bp QWC
1

pushes S-F bonds closer together
1

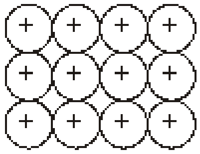
shape is trigonal bipyramidal with lone pair either axial or equatorial QWC
1

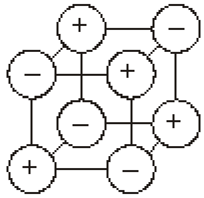
angles <90
1

and < 120
1

[20]

19 (a)


(1)


(1)

[Diagrams must be complete and accurate]

2

(b) (i) Attraction /electrostatic forces/bonds/attractions between (positive) ions/lattice and delocalised/free electrons/sea of electrons.

[Not metallic bonding]

[Not just 'forces']

1

(ii) Electrostatic attractions/forces between ions or attractions between (oppositely charged) ions/ Na^+ & $Cl^–$

[Not ionic bonding]

1

(iii) (Here) the ionic bonding in NaCl is stronger/requires more energy to break than the metallic bonding in Na

QoL Accept 'bonding/forces of attraction in NaCl is strong er than in Na'

[If IMF/molecules/van der Waals'/dipole–dipole mentioned in parts(i) or (ii), then CE = 0 for parts (i) and/or(ii) and CE = 0 for part(iii)]

1

(c) Comparison:
Sodium conducts **and** sodium chloride does NOT conduct

Allow 'only Na conducts'

Accept 'Na conducts, NaCl only conducts when molten'

[Do not accept sodium conducts better than sodium chloride etc.]

1

Explanation:
(Delocalised) electrons flow though the metal

1

Allow $e^–$ move/carry current/are charge carriers/transfer charge.

[Not 'electrons carry electricity']

[Not 'NaCl has no free charged particles']

Ions can't move in solid salt

1

(d) Layers can slide over each other – idea that ions/atoms/particles move

[Not molecules]

[Not layers separate]

1

(e) (i)

Na	Cl	O
$\frac{21.6}{23}$	$\frac{33.3}{35.5}$	$\frac{45.1}{16}$

1

	Na	Cl	O
	0.9(39)	0.9(38)	2.8(2)
Hence:	1	1	3

Accept backwards calculation, i.e. from formula to % composition, and also accept route via M_r to 23; 35.5; 48, and then to 1:1:3

[If % values incorrectly copied, allow M1 only]

[If any wrong A_r values/atomic numbers used = CE = 0]

1

(ii) $3Cl_2 + 6NaOH \rightarrow 5NaCl + NaClO_3 + 3H_2O$

1

[12]

20

M1 macromolecule = <u>a giant/massive/huge</u> molecule/lattice/structure with <u>covalent</u> bonding

(in words, not diagram)

(not just 'very large')

(not 'molecules bonded together'/reference to ions)

1

M2 **White**: IMF = van der Waals'

1

M3 which are weak

(tied to 'IMF' or van der Waals' in M2)

(if H-bonding or dipole-dipole, treat as CE, M2 = M3 = 0)

1

M4 **Red**: (covalent) bonds must be <u>broken/overcome</u>

(not weakened / loosened)

1

M5 (covalent) bonds are strong [tied to M4]

Or there are many (covalent) bonds

Or much energy is required to.

1

- If wrong bonding quoted, e.g. ionic bonding in white phosphorus or an IMF in red phosphorus, award no marks for that allotrope.
- In order for marks to be awarded for red phosphorus, the bonding must be stated to be covalent. One reference to covalent bonding is sufficient; the rest may be inferred as shown above. Thus, failure to refer to covalent bonding anywhere would result in the loss of M1, M4 and M5,
- Mark M1 independently. Allow the criteria for this mark to be earned elsewhere, but do not treat errors in the red allotrope description as contradictions of M1.

[5]

21 Structure and hardness

M1

Q of L both macromolecular/giant atomic/giant covalent/giant molecular;

1

M2
C atoms in diamond joined to 4 other C atoms / diagram with min 5 C atoms i.e. shows tetrahedral shape / coordination number = 4;

1

M3
C atoms in graphite joined to 3 other C atoms diagram with clear extended hexagonal plane/pattern i.e. shows trigonal planar shape / coordination number = 3;

1

M4
diamond hard / crystal strong;
(not diamond stronger than graphite)

1

M5
because of 3-D structure / rigid structure / not layered;

1

M6
graphite (soft) as layer can slide over each other;

1

M7
Q of L as only (weak) van der Waals' forces between layers;

1

Melting point (for either allotrope)

M8
covalent bonds must be broken / overcome; **1**

M9
which are strong / many / hard to break;
(M9 tied to M8) **1**

Other difference

M10
diamond is non-conductor of electricity, graphite is conductor
OR appropriate difference in appearance; **1**

[9]

22

QoL Bonding <u>Both</u> covalent
(linked statement) **1**

Structure Iodine = molecular /I_2 *(stated or in diagram)*
[treat incorrect diagram as contradiction] **1**

Diamond = giant molecular/macromolecular/giant covalent / giant atomic (stated only)
Reference to van der Waals' /dipole-dipole = contradiction **1**

QoL Iodine Weak van der Waals' forces / induced dipole-induced dipole **1**

Diamond Covalent bonds would need to be <u>broken</u> **1**

Many / strong covalent bonds **OR** much energy needed
Tied to M5 *or near miss*
[If ionic/metallic structure suggested then CE for that substance]
[If hydrogen bonding suggested, for I_2 lose M2 & M4; for diamond lose M3,M5&M6] **1**

[6]

23 (a) <u>Hydrogen</u> bonding *(full name)*

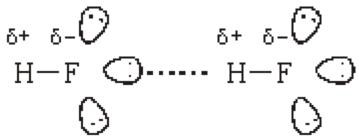
1

Diagram shows at least one $^{\delta+}H$ **and** at least one $^{\delta-}F$

(If full charges shown, M2 = 0)

1

3 lone pairs shown on at least one fluorine atom
H-bond indicated, between H and a lone pair on F



(If atoms not identified, zero for diag)

('Fl' for fluorine - mark to Max 2)

*(Max 1 if only one HF molecule shown, **or** HCl shown)*

1

Dipole results from electronegativity <u>difference</u> **or** values quoted

('difference' may be inferred)

(Allow explanation – e.g. F attracts <u>bonding electrons</u> more strongly than H)

1

QoL Fluorine more/very electronegative **or** iodine less electronegative
or electronegativity difference too small in HI
Comparison required, may be implied.

1

HI dipole weaker or bonding e^- more equally shared - wtte

1

(b) NaCl is <u>ionic</u> (lattice)

(Treat atoms/molecules as a contradiction)

(Accept 'cubic lattice')

1

Diamond is macromolecular/giant covalent/giant atomic/giant molecular

(NOT molecular or tetrahedral)

(Ionic/van der Waals' = CE = 0)

1

(Many) covalent/C-C bonds need to be broken / overcome

(NOT just 'weakened' etc.)

('Covalent' may be inferred from diagram)

(Treat diagram of graphite (without one of diamond) as a contradiction – lose M2 but allow M3/M4])

2

Which takes much energy **or** covalent bonds are strong

(References to van Der Waals' bonds breaking lose M3/M4)

1

[11]

24 C

[1]

25 (a) *Force 1:* Van der Waals' **(1)**

Force 2: dipole - dipole **(1)**

Force 3: hydrogen bonding **(1)**

OR London, Dispersion, temporary dipole

3

(b) (i) covalent <u>between atoms</u> **(1)**

OR within molecule

Van der Waals' <u>between molecules</u> **(1)**

(ii) molecular **(1)**

(iii) Bonds (or forces) between molecules must be broken or loosened **(1)**

OR V.dW forces

OR intermolecular forces

Mention of ions CE=0

4

(c) (i) H-Bonding in HF **(1)**

(dipole-) dipole in HCl **(1)**

OR V.dW

H-bonding is stronger than dipole-dipole or V.dW **(1)**

OR H-bonding is a strongest intermolecular force for 3rd mark

(ii) HI bigger molecule than HCl **(1)**

OR Heavier, more e's, more electron shells, bigger M_r, more polarisable

Therefore the forces between HI molecules are stronger **(1)**

QL mark (Look for unambiguous statements using correct terminology)

5

(d) (i) ionic **(1)**

Strong forces between ions **(1)**

OR lots of energy required to break bonds

(ii) All bonds must be broken **(1)**

mention of molecules etc CE=0

3

(e) macromolecular **(1)**

OR giant molecule / lattice or correct diagram

Strong covalent bonds **(1)**

OR lots of energy required to break bonds

2

[17]

26 (a) (i) positive ions **(1)**

(attract) delocalised electrons **(1)** *(or sea of or free or mobile)* **(1)**

Confusion with -ve ions
or ionic lattice C.E. = 0

(ii) more protons **(1)** (or Mg^{2+} more charge than Na^{+})

attracts delocalised (or bonding) electrons more strongly **(1)**

Delocalised: can be brought forward from (a) (i)

OR more delocalised electrons (1)
Attacks positive ions more (1)
Metallic bonding is stronger scores one mark, only given if no other marks awarded

4

(b) macromolecular **(1)** *(or giant molecule etc)*
covalent **(1)**
<u>strong</u> covalent <u>bonds</u> **(1)**

or bonds require much energy to break

3

(c) delocalised *(OR free or sea of or mobile)* electrons **(1)**

1

(d) Planes **(1)**
weak (bonds) forces between planes **(1)**

2

or v.dw forces between planes

[10]

27 A

[1]