UNIT 1

TOPIC 3 : BONDING AND STRUCTURE

SECTION A

Answer ALL questions. Write your answers in the spaces provided.

For each question, select one answer from A to D and put a cross in the box ☒. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☒.

1.

Which of these has the **greatest** electrical conductivity?

☒ **A** $SF_6(g)$

☒ **B** $H_2O(l)$

☒ **C** $Hg(l)$

☒ **D** $Na_2O(s)$

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2.

Which of these ions has the **greatest** ionic radius?

☒ **A** N^{3-}

☒ **B** F^-

☒ **C** Na^+

☒ **D** Al^{3+}

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3.

Which of these ions has the **greatest** polarising power?

- ☒ **A** S^{2-}
- ☒ **B** Cl^{-}
- ☒ **C** K^{+}
- ☒ **D** Ca^{2+}

4.

Which of these does **not** have a structure formed by a giant lattice of carbon atoms?

- ☒ **A** C_{60} fullerene
- ☒ **B** diamond
- ☒ **C** graphene
- ☒ **D** graphite

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5.

Which of these molecules is the **most** polar?

- ☒ **A** HF
- ☒ **B** OF_2
- ☒ **C** BF_3
- ☒ **D** CF_4

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6.

Which of these isoelectronic ions has the **largest** radius?

- ☐ **A** Na^+
- ☐ **B** Mg^{2+}
- ☐ **C** O^{2-}
- ☐ **D** F^-

7.

Which ion is the most polarisable?

- ☐ **A** Mg^{2+}
- ☐ **B** Ca^{2+}
- ☐ **C** Cl^-
- ☐ **D** I^-

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8.

Which substance has a giant lattice of atoms?

- ☐ **A** diamond
- ☐ **B** ice
- ☐ **C** poly(ethene)
- ☐ **D** sodium chloride

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9.

Which compound has bonds that are the most polar?

- ☒ **A** H_2O
- ☒ **B** H_2S
- ☒ **C** NH_3
- ☒ **D** PH_3

10.

Which molecule is planar?

- ☒ **A** CF_4
- ☒ **B** C_2F_4
- ☒ **C** PF_5
- ☒ **D** SF_6

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11.

In which series are the ions in order of **decreasing** ionic radius?

- ☒ **A** $Al^{3+} > Mg^{2+} > Na^+$
- ☒ **B** $Li^+ > Na^+ > K^+$
- ☒ **C** $N^{3-} > O^{2-} > F^-$
- ☒ **D** $O^{2-} > S^{2-} > Se^{2-}$

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12.

(b) Ammonium sulfate is used in the preparation of the double salt.

What types of bond are present in ammonium sulfate?

(1)

- ☒ **A** ionic only
- ☒ **B** covalent and ionic only
- ☒ **C** dative covalent and ionic only
- ☒ **D** ionic, covalent and dative covalent

13.

Which row gives the correct polarities of the S—F bond and the SF_6 molecule?

	Polarity of S—F bond	Polarity of SF_6 molecule
☒ **A**	polar	polar
☒ **B**	polar	non-polar
☒ **C**	non-polar	polar
☒ **D**	non-polar	non-polar

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14.

Element **X** is in Group 2 of the Periodic Table and element **Y** is in Group 7.
X and **Y** are not the symbols of the elements.

(a) What is the formula of the compound formed from **X** and **Y**?

(1)

- ☒ **A** XY
- ☒ **B** X_2Y
- ☒ **C** XY_2
- ☒ **D** X_2Y_2

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15.

Which of these compounds would you expect to have the highest melting temperature?

- ☒ **A** NaCl
- ☒ **B** NaF
- ☒ **C** KCl
- ☒ **D** KF

16.

In which series are the elements in order of **increasing** melting temperature?

- ☒ **A** $I_2 < Br_2 < Cl_2 < F_2$
- ☒ **B** Li < Be < B < C
- ☒ **C** Li < Na < K < Rb
- ☒ **D** Si < P < S < Cl

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17.

A drop of an aqueous solution of green copper(II) chromate(VI) is placed in the centre of a strip of damp filter paper.
The ends of the filter paper are connected to a DC power supply.

What is observed after a few minutes?

- ☒ **A** a green colour has moved to the negative end
- ☒ **B** a green colour has moved to the positive end
- ☒ **C** a yellow colour has moved to the positive end and a blue colour to the negative end
- ☒ **D** a blue colour has moved to the positive end and a yellow colour to the negative end

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18.

Which of these isoelectronic ions has the smallest ionic radius?

- ☒ **A** N^{3-}
- ☒ **B** F^{-}
- ☒ **C** Na^{+}
- ☒ **D** Al^{3+}

19.

Which properties of a **cation** result in the greatest polarising power?

- ☒ **A** large radius and large charge
- ☒ **B** large radius and small charge
- ☒ **C** small radius and small charge
- ☒ **D** small radius and large charge

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20.

Which properties of an **anion** result in it being most easily polarised?

- ☒ **A** large radius and large charge
- ☒ **B** large radius and small charge
- ☒ **C** small radius and small charge
- ☒ **D** small radius and large charge

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21.

What is the ionic equation for the reaction between aqueous solutions of barium nitrate and sodium sulfate?

- ☒ **A** $Na^+(aq) + NO_3^-(aq) \rightarrow NaNO_3(s)$
- ☒ **B** $2Ba^+(aq) + SO_4^{2-}(aq) \rightarrow Ba_2SO_4(s)$
- ☒ **C** $Na^{2+}(aq) + 2NO_3^-(aq) \rightarrow Na(NO_3)_2(s)$
- ☒ **D** $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$

22.

Which of these molecules is **not** polar?

- ☒ **A** CO_2
- ☒ **B** HCl
- ☒ **C** H_2O
- ☒ **D** NH_3

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23.

Elements in their most stable state exist as

- ☒ **A** atoms in giant structures only
- ☒ **B** atoms in molecules and atoms in giant structures only
- ☒ **C** isolated atoms and atoms in giant structures only
- ☒ **D** isolated atoms, atoms in molecules and atoms in giant structures

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24.

Which row in the table shows the correct forces in a crystal of lithium iodide?

	Attractive forces between ions with opposite charges	Repulsive forces between ions with like charges	Some covalent bonding forces
☒ A	✓	×	×
☒ B	✓	✓	×
☒ C	✓	×	✓
☒ D	✓	✓	✓

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25.

Some physical properties of five substances are shown.
The letters are **not** element symbols.

Substance	Electrical conductivity			Melting temperature /°C
	Solid	Liquid	Solution in water	
L	poor	good	good	770
M	good	good	reacts	98
N	good	good	insoluble	1083
P	poor	poor	insoluble	113
Q	poor	poor	good	10

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(a) Which of these substances could be metals?

(1)

- ☒ **A** N only
- ☒ **B** L and M only
- ☒ **C** M and N only
- ☒ **D** L, M and N only

(b) Which substance has properties showing that it changes from a molecular structure to ions when it dissolves in water?

(1)

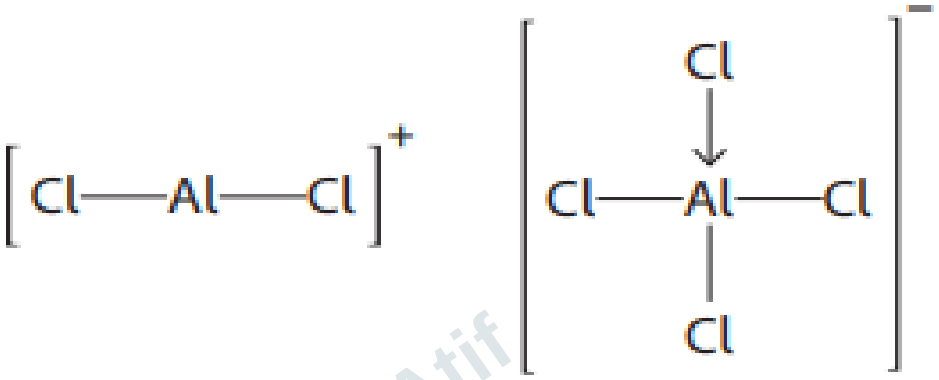
- ☒ **A** L
- ☒ **B** M
- ☒ **C** P
- ☒ **D** Q

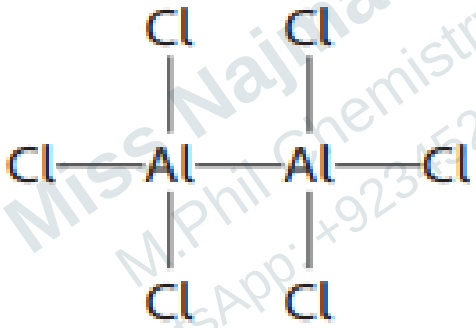
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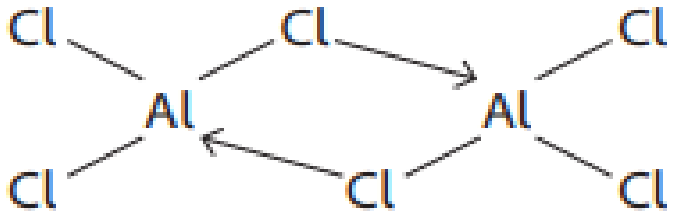
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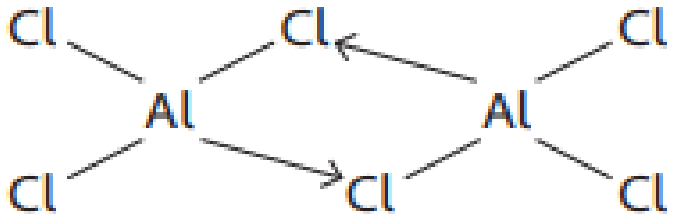
At 180 °C, aluminium chloride exists as Al_2Cl_6.

What is the structure of Al_2Cl_6?

☒ **A** 

☒ **B** 

☒ **C** 

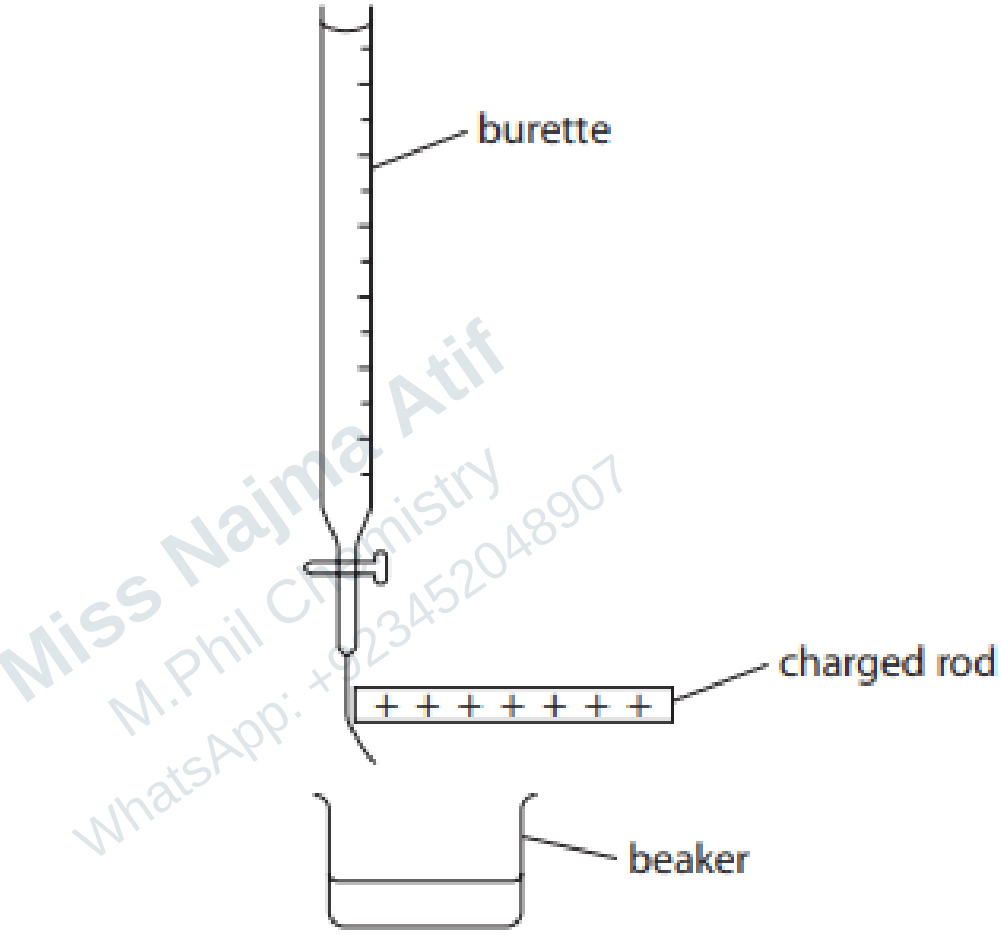
☒ **D** 

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27.

A stream of liquid from a burette is deflected by a charged rod.



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Which substance, in its liquid state, will be deflected the most?

- ☒ **A** C_5H_{12}
- ☒ **B** CCl_4
- ☒ **C** BCl_3
- ☒ **D** CH_2Cl_2

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28.

Which combination of ions would be expected to form the compound with the **highest** melting temperature?

- ☒ **A** Li^+ and Br^-
- ☒ **B** Mg^{2+} and O^{2-}
- ☒ **C** Sr^{2+} and S^{2-}
- ☒ **D** Rb^+ and Cl^-

29.

Which is a use of graphene based on its electrical properties?

- ☒ **A** drill tips
- ☒ **B** pencils
- ☒ **C** touch screens
- ☒ **D** body armour

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30.

Which molecule has the **largest** bond angle?

- ☒ **A** BCl_3
- ☒ **B** CO_2
- ☒ **C** H_2O
- ☒ **D** NH_3

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31.

Which molecule is polar?

- ☒ **A** 1,1-dibromopropane
- ☒ **B** *E*-1,2-dibromoethene
- ☒ **C** hexafluoroethane
- ☒ **D** tetrachloromethane

32.

Which compound has the greatest covalent character?

- ☒ **A** $MgBr_2$
- ☒ **B** MgF_2
- ☒ **C** NaBr
- ☒ **D** NaF

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33.

Which has the smallest ionic radius?

- ☒ **A** F^-
- ☒ **B** Mg^{2+}
- ☒ **C** Na^+
- ☒ **D** O^{2-}

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34.

A piece of filter paper is soaked in water and attached to a microscope slide.

A few crystals of green copper(II) chromate(VI) are placed in the centre of the filter paper.

The filter paper is connected to a DC supply of 20V.

What colours are observed on the paper after a few minutes?



☒	**A**	blue	yellow
☒	**B**	green	blue
☒	**C**	yellow	green
☒	**D**	yellow	blue

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35.

The melting temperature of beryllium is greater than that of barium.

What is the best explanation for this statement?

☒ **A** beryllium ions are smaller than barium ions

☒ **B** beryllium atoms have fewer outer shell electrons than barium atoms

☒ **C** beryllium ions have a smaller charge density than barium ions

☒ **D** beryllium atoms have a higher electronegativity than barium atoms

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36.

Which molecule has the largest bond angle?

- ☒ **A** BF_3
- ☒ **B** CF_4
- ☒ **C** H_2O
- ☒ **D** NH_3

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37.

Which molecule is polar?

- ☒ **A** CO_2
- ☒ **B** SF_6
- ☒ **C** SO_2
- ☒ **D** $SiCl_4$

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38.

The formula of calcium carbide is CaC_2.

(a) What is the formula of the carbide ion?

(1)

- ☒ **A** C_2^-
- ☒ **B** C_2^+
- ☒ **C** C_2^{2-}
- ☒ **D** C_2^{2+}

39.

Which diagram best represents the electron density map of sodium chloride?

☒ **A**



☒ **B**



☒ **C**



☒ **D**



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40.

What types of bonding are present in the compound ammonium chloride, NH_4Cl?

	Ionic	Covalent	Dative covalent
☒ A	✓	×	✓
☒ B	×	✓	×
☒ C	✓	✓	×
☒ D	✓	✓	✓

41.

Which molecule is polar?

☒ **A** $CO_2(g)$

☒ **B** $CCl_4(g)$

☒ **C** $BeCl_2(g)$

☒ **D** $NH_3(g)$

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42.

Which are the correct bonding and structure for one of the substances listed?

	Substance	Bonding	Structure
☒ A	copper(II) sulfate	covalent	giant
☒ B	graphene	covalent	simple molecular
☒ C	iodine	metallic	simple molecular
☒ D	sodium	metallic	giant

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43.

Which compound shows the greatest degree of polarisation?

- ☒ **A** sodium chloride
- ☒ **B** sodium iodide
- ☒ **C** magnesium chloride
- ☒ **D** magnesium iodide

44.

This question is about bond angles.

(a) What is the expected bond angle in a boron trichloride molecule, BCl_3?

(1)

- ☒ **A** 90°
- ☒ **B** 107°
- ☒ **C** 109.5°
- ☒ **D** 120°

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(b) What is the expected bond angle in an ammonium ion?

(1)

- ☒ **A** 90°
- ☒ **B** 104.5°
- ☒ **C** 107°
- ☒ **D** 109.5°

(c) What is the expected bond angle in an oxygen difluoride molecule, OF_2?

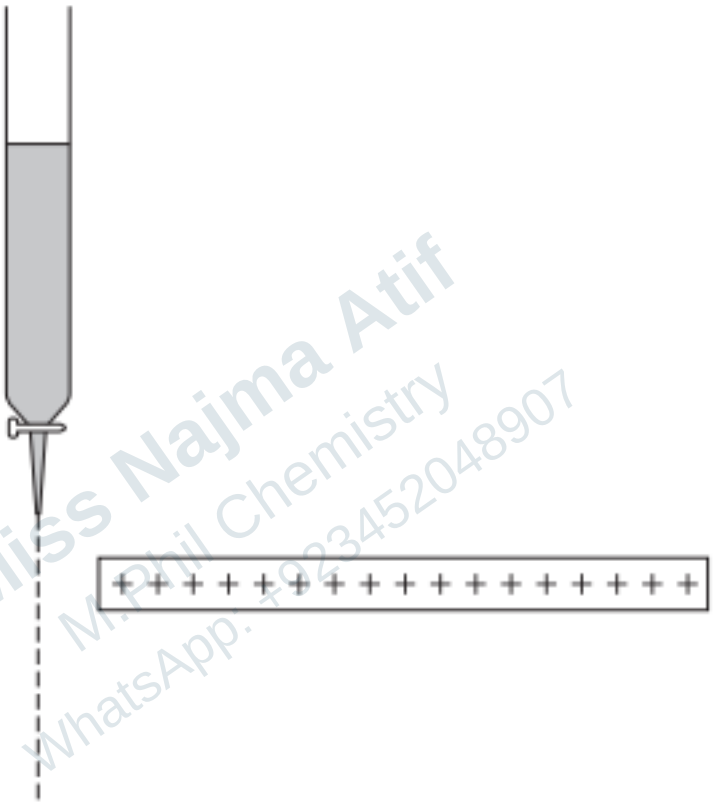
(1)

- ☒ **A** 90°
- ☒ **B** 104.5°
- ☒ **C** 109.5°
- ☒ **D** 180°

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45.

To compare polar and non-polar liquids, a stream of liquid from a burette and a positively charged plastic rod can be used. Which row of the table shows the correct direction of deflection?



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		Direction of deflection	
		Polar liquid	Non-polar liquid
☐	A	towards the rod	away from the rod
☐	B	away from the rod	no deflection
☐	C	towards the rod	no deflection
☐	D	no deflection	towards the rod

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46.

This question is about the isoelectronic ions N^{3-}, O^{2-}, F^-, Na^+, Mg^{2+} and Al^{3+}.

(a) Which ions are shown in order of **decreasing** ionic radius?

(1)

- ☒ **A** $Na^+ > Mg^{2+} > Al^{3+}$
- ☒ **B** $Mg^{2+} > Na^+ > Al^{3+}$
- ☒ **C** $Al^{3+} > Na^+ > Mg^{2+}$
- ☒ **D** $Al^{3+} > Mg^{2+} > Na^+$

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(b) Which ions are shown in order of **increasing** ionic radius?

(1)

- ☒ **A** $F^- < O^{2-} < N^{3-}$
- ☒ **B** $F^- < N^{3-} < O^{2-}$
- ☒ **C** $O^{2-} < N^{3-} < F^-$
- ☒ **D** $N^{3-} < O^{2-} < F^-$

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47.

The first ionisation energies of four successive elements in the Periodic Table are shown.

Element	P	Q	R	S
First ionisation energy / kJ mol^{-1}	1251	1521	419	590

(b) Which element could be X in a gaseous covalent compound with the formula HX?

- ☒ **A** element P
- ☒ **B** element Q
- ☒ **C** element R
- ☒ **D** element S

(c) Which element could be Y in an ionic compound with the formula YF_2?

- ☒ **A** element P
- ☒ **B** element Q
- ☒ **C** element R
- ☒ **D** element S

(d) Which element has atoms with the largest atomic radius?

- ☒ **A** element P
- ☒ **B** element Q
- ☒ **C** element R
- ☒ **D** element S

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48.

(b) The melting temperatures of these elements are shown in the table.

Element	Na	Mg	Al	Si	P	S	Cl
Melting temperature / K	371	922	933	1683	317	392	172

Which of the elements has the strongest **intermolecular** forces?

(1)

☒ **A** Al

☒ **B** Si

☒ **C** P

☒ **D** S

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49.

Which row of the table shows properties consistent with the type of bonding shown?

	Bonding	Solubility in water	Melting temperature	Electrical conductivity of solid
☒ **A**	ionic	soluble	high	poor
☒ **B**	ionic	soluble	low	good
☒ **C**	metallic	soluble	low	good
☒ **D**	metallic	insoluble	high	poor

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SECTION B

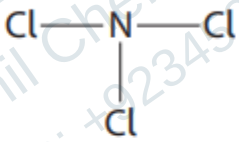
Answer ALL the questions. Write your answers in the spaces provided.

QUESTION NO 1:

This question is about the structure and bonding of Group 5 chlorides.

(a) Nitrogen trichloride, NCl_3, has a molecular structure.

The displayed formula of a molecule of NCl_3 is shown.



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Complete the table for this molecule.

(3)

Number of bond pairs around N atom	
Number of lone pairs around N atom	
Cl-N-Cl bond angle	
Name of shape of molecule	

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(b) Under standard conditions, phosphorus(V) chloride (PCl_5) is a solid made up of PCl_4^+ cations and PCl_6^- anions.

Antimony(V) chloride ($SbCl_5$) is a liquid made up of $SbCl_5$ molecules.

(i) Explain why PCl_5 has a higher melting temperature than $SbCl_5$.

(2)

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(ii) Draw a dot-and-cross diagram to show the bonding in a molecule of $SbCl_5$.

Use dots (•) to represent the Sb electrons, and crosses (**x**) to represent the Cl electrons. Show outer electrons only.

(2)

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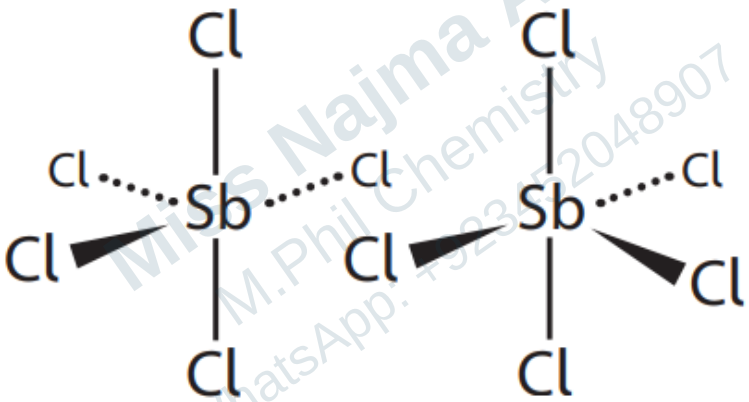
(c) At low temperatures, $SbCl_5$ converts to Sb_2Cl_{10} which contains dative covalent bonds.

(i) State what is meant by the term dative covalent bond.

(1)

(ii) Complete the diagram to show the dative covalent bonds in Sb_2Cl_{10}.

(1)



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(d) Arsenic also forms a pentachloride with the formula $AsCl_5$.

Give **one** possible reason why nitrogen is the only Group 5 element that does **not** form a pentachloride.

(1)

TOTAL FOR QUESTION 1: 10 MARKS

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QUESTION NO 2:

(b) The melting temperatures of sodium, sodium chloride and chlorine are given in the table.

Complete the table to show the type of structure, the type of bond or force broken on melting and the particles involved.

(6)

Substance	Sodium	Sodium chloride	Chlorine
Melting temperature / °C	98	801	−101
Type of structure	giant		simple molecular
Type of bond or force broken on melting			
Particles involved			chlorine molecules

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(c) Solid phosphorus(V) chloride contains PCl_4^+ ions.

(i) Draw a dot-and-cross diagram of a PCl_4^+ ion.

Show only outer shell electrons.

(1)

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(ii) Predict the shape of a PCl_4^+ ion.

Justify your answer.

(3)

Shape .....

Justification

.....

.....

.....

.....

.....

.....

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QUESTION NO 3:

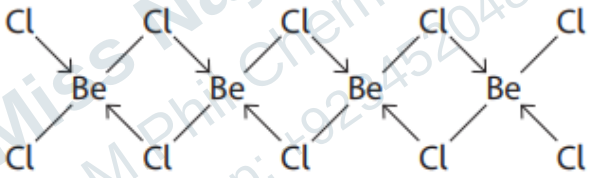
(b) In the gaseous state, beryllium chloride is molecular.

Draw a dot-and-cross diagram to show the bonding in a molecule of beryllium chloride, $BeCl_2$.

(2)

(c) In the solid state, beryllium chloride forms a polymeric structure.

The diagram shows part of this structure.



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The diagram uses lines and arrows to represent the two different types of covalent bond.

Describe how each type of bond is formed.

(2)

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(d) The Cl—Be—Cl bond angle is different in the two forms of beryllium chloride.

Predict the two bond angles, justifying your answers by referring to electron-pair repulsion theory.

(4)

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(e) Anhydrous calcium chloride is a crystalline, ionic solid which melts at 772 °C.

Draw a dot-and-cross diagram for calcium chloride.
Show the outer electrons only.

(2)

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(f) Explain why gaseous beryllium chloride and solid calcium chloride have different types of bonding.

(3)

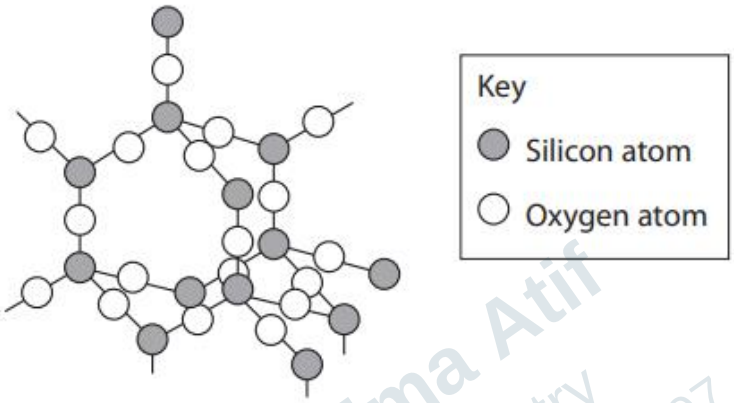
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TOTAL FOR QUESTION 3: 13

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QUESTION NO 4:

(b) Silicon dioxide, SiO_2, is the main constituent of sand and has a giant lattice structure similar to that of diamond.



Crystalline silicon dioxide is used on the surface of semiconductor devices to provide a heat-resistant, electrically insulating layer.

Explain how the structure and bonding of silicon dioxide make it useful for this application.

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TOTAL FOR QUESTION 4: 3

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QUESTION NO 5:

(c) (i) Describe the bonding in aluminium metal.

(2)

(ii) Give two possible reasons why aluminium is used for overhead power cables.

(2)

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TOTAL FOR QUESTION 5: 4

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QUESTION NO 6:

This question is about the bonding in the elements of Period 3 in the Periodic Table.

The melting temperatures of the Period 3 elements are shown in the table.

Element	Na	Mg	Al	Si	P	S	Cl	Ar
Melting temperature / °C	98	650	660	1423	44	120	−101	−189

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(a) Sodium, magnesium and aluminium are metals.

(i) State what is meant by metallic bonding.

(1)

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(ii) Melting temperature depends on the strength of metallic bonding.

Explain why the metallic bonding in magnesium is much stronger than that in sodium.

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(b) (i) In the elements silicon, phosphorus, sulfur and chlorine, the atoms are joined by covalent bonds.

Describe the attraction between the atoms in a covalent bond.

(1)

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(ii) Explain why the melting temperature of silicon is much higher than that of phosphorus, by referring to their structures.

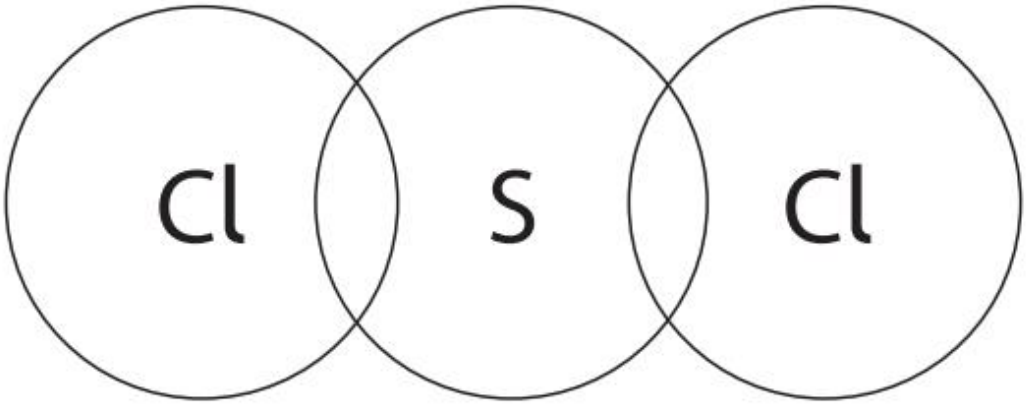
(3)

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(c) Sulfur reacts with chlorine to form sulfur dichloride, SCl_2.

(i) Complete the dot-and-cross diagram of a molecule of sulfur dichloride.
Use dots (•) for the chlorine electrons and crosses (×) for the sulfur electrons.
Show the outer shell electrons only.

(2)



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(ii) Suggest a value for the Cl—S—Cl bond angle. Justify your answer.

(3)

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TOTAL MARKS FOR QUESTION 6: 13

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QUESTION NO 7:

(c) The mass spectrum of a sample of bromine is obtained.

(i) Draw a dot-and-cross diagram to show the bonding in a molecule of bromine. Only the outer electrons should be shown.

(2)

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QUESTION NO 8:

The elements carbon and silicon both form dioxides.

(a) Carbon dioxide is a simple covalent molecule but silicon dioxide has a giant covalent structure.

(i) Describe the covalent bond between a silicon atom and an oxygen atom in silicon dioxide, in terms of the particles involved.

(2)

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(ii) Compare and contrast the covalent bonding in carbon dioxide and silicon dioxide in terms of orbital overlap.

(3)

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(b) The shape of the carbon dioxide molecule affects its physical properties.

(i) Explain the shape of the carbon dioxide molecule.

(3)

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(ii) Explain the polarity of the carbon–oxygen bond.

(2)

(iii) State whether or not the carbon dioxide molecule is polar.
Justify your answer.

(1)

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(c) The structure of silicon dioxide may be referred to as a diamond structure.



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(i) Using your knowledge of the structure of diamond, suggest how the structure of silicon dioxide is similar to that of diamond.

(1)

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(ii) Give a possible reason why silicon dioxide has a lower melting temperature than diamond, even though the Si—O bond is stronger than the C—C bond.

(1)

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QUESTION NO 9:

(b) An acidified aqueous solution of barium chloride, $BaCl_2$, is used to test for sulfate ions.

(i) Draw a dot-and-cross diagram for barium chloride.
Show the outer electrons only.

(2)

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(c) Give a reason why solid barium chloride does not conduct electricity.

(1)

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QUESTION NO 10:

(ii) Germane can donate a proton to ammonia, forming the ion GeH_3^-.

$$NH_3 + GeH_4 \rightarrow NH_4^+ + GeH_3^-$$

Draw a dot-and-cross diagram of the ion GeH_3^-. Show the outer electrons only. (2)

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(iii) Use your answer to (d)(ii) and electron-pair repulsion theory to predict the name of the shape and bond angle of the ion GeH_3^-. (2)

Name of the shape

Bond angle

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QUESTION NO 11:

(ii) Nitrogen molecules bind to zeolite using their outer electrons.

Draw a dot-and-cross diagram of the bonding in a nitrogen molecule.
Show outer electrons only.

(2)

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QUESTION NO 12:

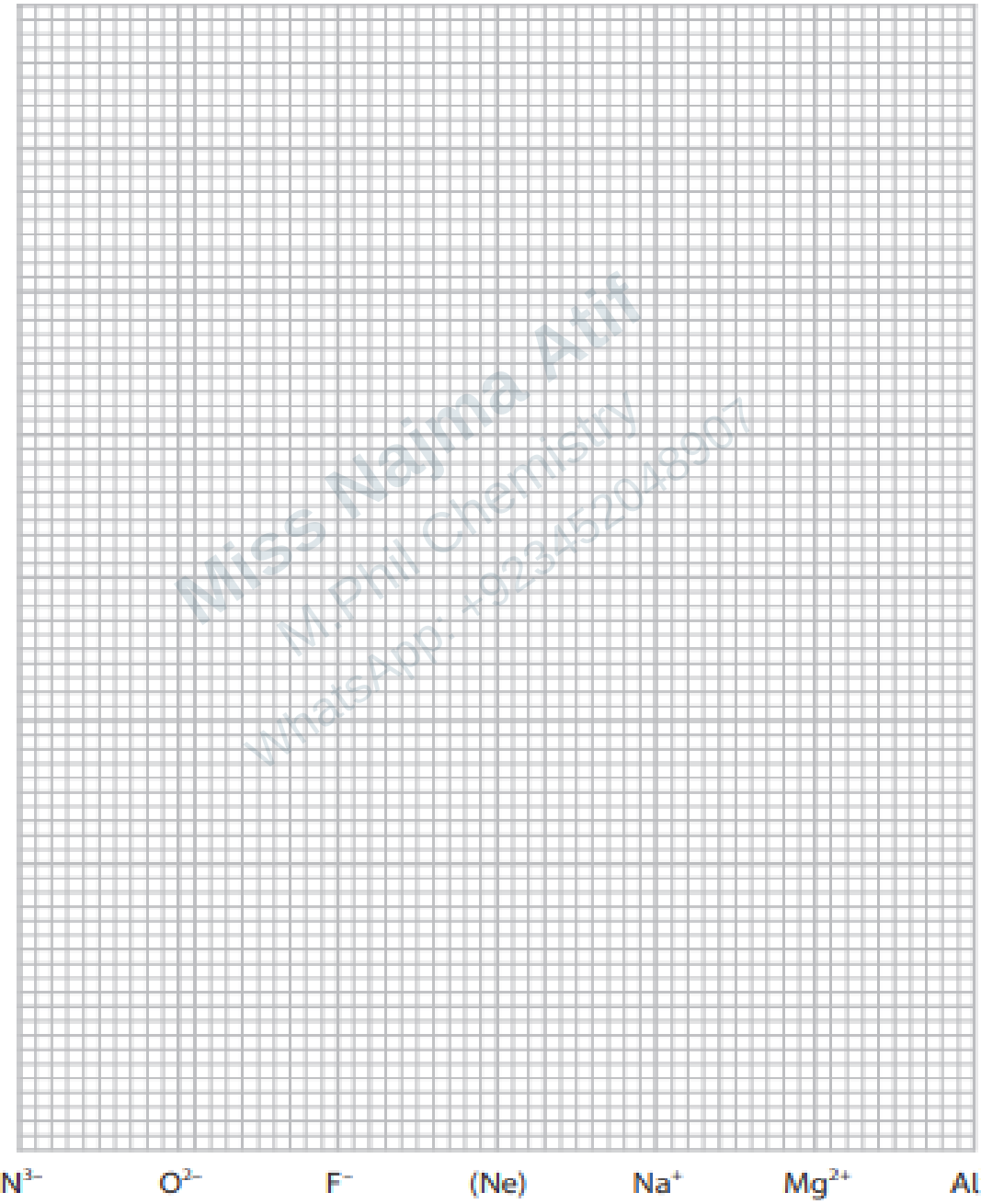
The radii of ions of some successive elements in the Periodic Table are shown.

Ion	N^{3-}	O^{2-}	F^{-}	Na^{+}	Mg^{2+}	Al^{3+}
Ionic radius / pm	171	140	133	102		54

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(a) (i) Plot a graph of the data.

(2)



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(ii) Predict the radius of the magnesium ion using a straight line of best fit on your graph.

(2)

(iii) Explain the trend in the ionic radii from the nitride ion to the aluminium ion.

(3)

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(b) Sodium and fluorine react to form a compound.

(i) State the structure and bonding of sodium fluoride.

(1)

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(ii) Explain how the electrical conductivity of sodium fluoride provides evidence for the existence of ions.

(3)

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(iii) Explain why the fluoride ion is difficult to polarise.

(2)

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QUESTION NO 13:

This question is about aluminium and its compounds.

(a) (i) State the shape of a molecule of aluminium trichloride, $AlCl_3$.

(1)

(ii) Aluminium chloride can exist as a dimer formed from two molecules of aluminium trichloride.

Draw a diagram of this dimer, showing the bonding between the two molecules.

(2)

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(d) (i) Describe the metallic bonding in aluminium.

(3)

(ii) Explain how metallic bonding leads to the properties of electrical conductivity and malleability shown by aluminium.

(2)

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QUESTION NO 14:

(d) (i) Draw a dot-and-cross diagram of a PCl_3 molecule.
Show outer electrons only.

(2)

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(ii) Explain the shape of a PCl_3 molecule.

(3)

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QUESTION NO 15:

(iii) Barium chloride has a melting temperature of 962 °C.
Caesium chloride has a melting temperature of 646 °C.

Explain, by considering the ions involved, the difference between the melting temperatures of these Period 6 chlorides.

(4)

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(iv) Covalent and ionic bonding are the extremes of a continuum of bonding type.

Explain the difference in bonding between barium chloride and beryllium chloride, using the electronegativity values shown.

Element	Electronegativity
Ba	0.9
Be	1.5
Cl	3.0

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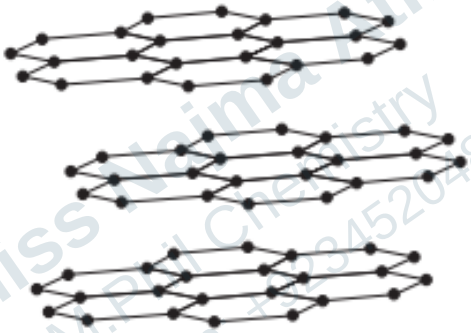
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QUESTION NO 16:

Graphite electrodes are used in the extraction of aluminium by the electrolysis of aluminium oxide, Al_2O_3, dissolved in a solvent (molten cryolite) at a temperature of 950 °C.

(a) Explain how the structure and bonding in graphite make it suitable for this application.
Refer to the diagram in your answer.



graphite

(3)

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(ii) Every year in the United Kingdom, about 7.2 billion aluminium cans are recycled.

Suggest three ways this recycling reduces energy consumption.

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QUESTION NO 17:

(c) Beryllium reacts with chlorine to form beryllium chloride.

In the gas phase, beryllium chloride exists both as a simple molecule, $BeCl_2$, and as a dimer, Be_2Cl_4.

(i) Draw a dot-and-cross diagram of the molecule, $BeCl_2$.

(1)

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(ii) Explain the shape and bond angle in the molecule $BeCl_2$.

(4)

Shape

Bond angle

Explanation

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(iii) Draw a diagram to show how two beryllium chloride molecules bond together to form the dimer, Be_2Cl_4, stating the type of bond involved.

(2)

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Type of bond

.....

QUESTION NO 18:

(b) Magnesium oxide and magnesium sulfate are ionic compounds.

(i) Draw a dot-and-cross diagram to show the bonding in magnesium oxide, MgO.
Show outer electrons only.

(2)

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(ii) The melting temperatures of magnesium oxide and magnesium sulfate are 2852°C and 1124°C respectively.

Explain why the melting temperature of magnesium oxide is significantly higher than that of magnesium sulfate.

(2)

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(c) The table gives some data about the electrical conductivity of magnesium and magnesium oxide.

	Electrical conductivity	
State	Magnesium	Magnesium oxide
solid	high	low
liquid	high	high

Explain the similarities and differences in the electrical conductivity of the two substances.

(2)

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(ii) Give **two** observations you would make when the reaction is taking place.

(2)

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(iv) State how the magnesium sulfate solution could be separated from the mixture produced in this experiment.

(1)

QUESTION NO 19:

(b) The formula of boric acid can also be written as $B(OH)_3$.

(i) Draw a dot-and-cross diagram for this molecule.
Show outer electrons only.

(3)

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(ii) Suggest a value for the O—B—O bond angle. Justify your answer.

(2)

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QUESTION NO 20:

(c) (i) Describe the bonding in pure silver metal.
Include a 2D diagram to show the arrangement of 12 of the silver particles involved.

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(ii) Pure silver cups are too soft so small amounts of copper are added to make an alloy.

Explain why copper makes the silver less malleable.

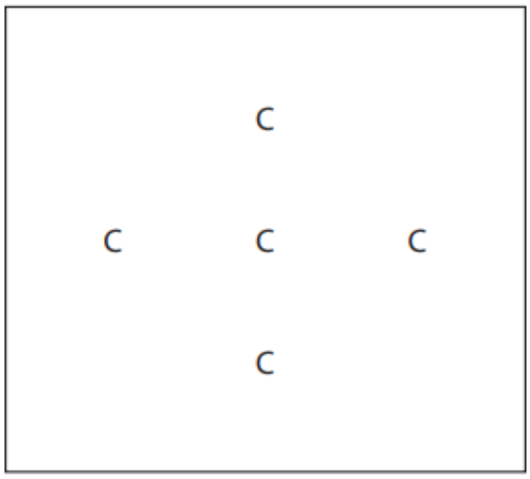
(2)

QUESTION NO 21:

Carbon exists as several different structures called allotropes.

(a) Complete the dot-and-cross diagram by adding all the electrons in the outer shells of the five carbon atoms in a diamond tetrahedral unit.

(2)



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(b) Draw a labelled 3D structure of graphite, showing two layers of at least 13 carbon atoms each and the forces between the layers.

(2)

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(c) Suggest why diamond has a greater density than graphite.

(2)

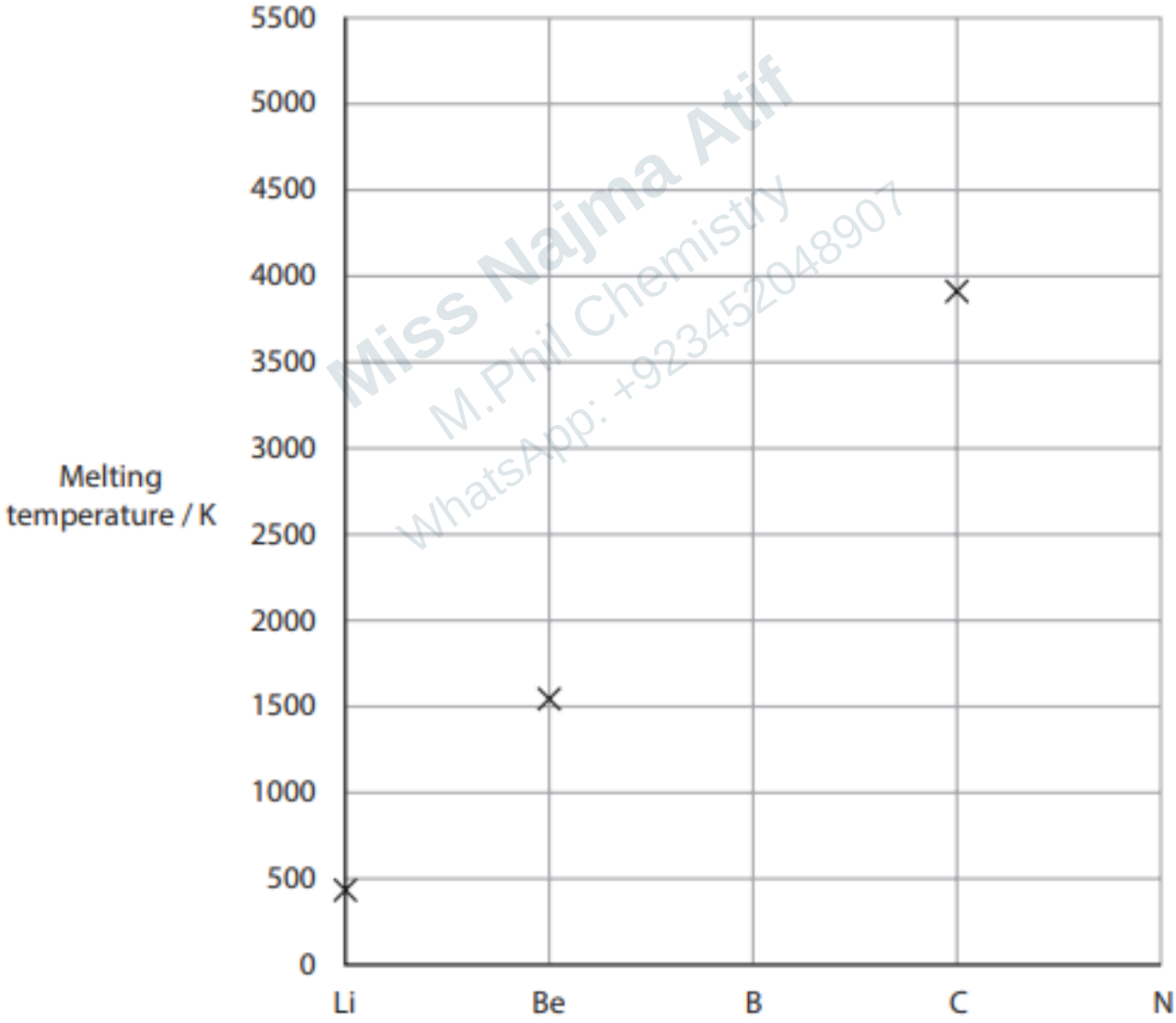
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QUESTION NO 22:

(c) (i) The diagram shows the melting temperatures of the elements in Period 2 from lithium to nitrogen.

Complete the diagram by putting crosses to show the approximate melting temperatures of boron and nitrogen.

(2)



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(ii) Explain why the melting temperature of carbon is high, with reference to its structure and bonding.

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QUESTION NO 23:

Boron, aluminium and thallium are in Group 3 of the Periodic Table.
These elements form molecular compounds with chlorine with the formulae BCl_3, $AlCl_3$ and $TlCl_3$. The shape of these molecules depends on the electronic structures of the Group 3 elements.

(a) (i) Give the electronic configuration of aluminium.

(1)

(ii) Compare and contrast the electronic structures of boron, aluminium and thallium.

(2)

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(iii) Deduce, using electron-pair repulsion theory, the expected shape of BCl_3, $AlCl_3$ and $TlCl_3$. Justify your answer.

(3)

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(ii) Draw the dot-and-cross diagram for Al_2Cl_6. Use dots (•) for the electrons of aluminium and crosses (×) for the electrons of chlorine.

(3)

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(c) Thallium also forms ions containing chlorine, for example the $TlCl_4^{3-}$ ion.
In this ion, the thallium atom has 10 electrons in its outermost shell.
Phosphorus in phosphorus pentachloride, PCl_5, also has 10 electrons in its outer shell.

Draw the shape of the $TlCl_4^{3-}$ ion and predict the bond angles.
Include any lone pairs of electrons that influence the shape.

(3)

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