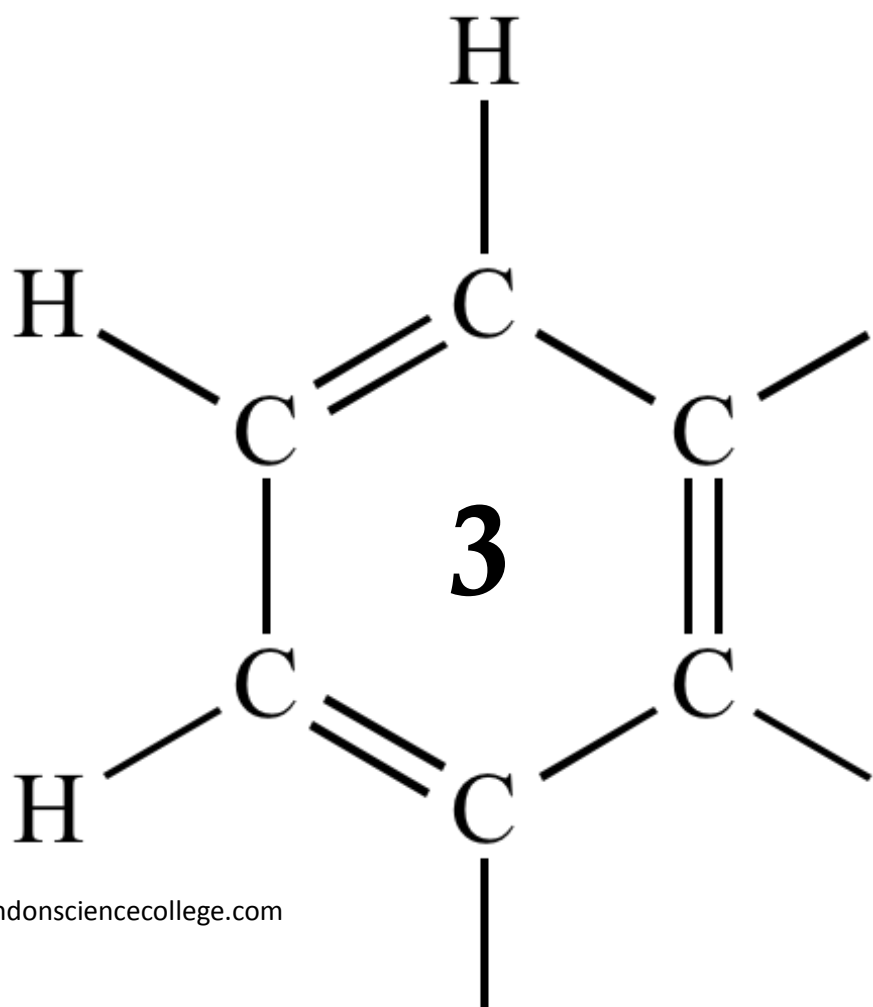


AQA AS CHEMISTRY

BONDING



1

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.

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(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.

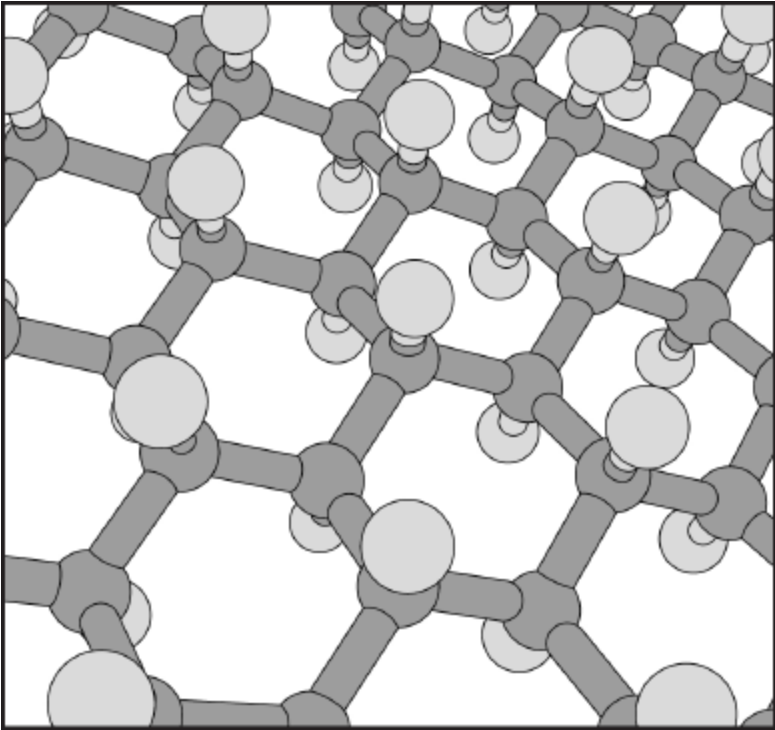
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(1)

(Total 8 marks)

2

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



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

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(1)

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

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(1)

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

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(1)

(d) Deduce the empirical formula of graphane.

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(1)

(Total 4 marks)

3

Fritz Haber, a German chemist, first manufactured ammonia in 1909. Ammonia is very soluble in water.

- (a) State the strongest type of intermolecular force between one molecule of ammonia and one molecule of water.

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(1)

- (b) Draw a diagram to show how one molecule of ammonia is attracted to one molecule of water. Include all partial charges and all lone pairs of electrons in your diagram.

(3)

- (c) Phosphine (PH_3) has a structure similar to ammonia.

In terms of intermolecular forces, suggest the main reason why phosphine is almost insoluble in water.

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(1)

(Total 5 marks)

4

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

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

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(1)

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

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

Type of bond

Explanation

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(2)

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

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

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(1)

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

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(1)

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

Shape of the TlBr_5^{2-} ion.

Name of shape

(2)

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

(1)

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

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(1)

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

Tick (✓) one box.

First

Second

Third

(1)
(Total 10 marks)

5

Zinc forms many different salts including zinc sulfate, zinc chloride and zinc fluoride.

(a) People who have a zinc deficiency can take hydrated zinc sulfate ($\text{ZnSO}_4 \cdot x\text{H}_2\text{O}$) as a dietary supplement.

A student heated 4.38 g of hydrated zinc sulfate and obtained 2.46 g of anhydrous zinc sulfate.

Use these data to calculate the value of the integer x in $\text{ZnSO}_4 \cdot x\text{H}_2\text{O}$
Show your working.

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(3)

- (b) Zinc chloride can be prepared in the laboratory by the reaction between zinc oxide and hydrochloric acid.

The equation for the reaction is



A 0.0830 mol sample of pure zinc oxide was added to 100 cm³ of 1.20 mol dm⁻³ hydrochloric acid.

Calculate the maximum mass of anhydrous zinc chloride that could be obtained from the products of this reaction.

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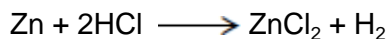
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(4)

- (c) Zinc chloride can also be prepared in the laboratory by the reaction between zinc and hydrogen chloride gas.



An impure sample of zinc powder with a mass of 5.68 g was reacted with hydrogen chloride gas until the reaction was complete. The zinc chloride produced had a mass of 10.7 g.

Calculate the percentage purity of the zinc metal.
Give your answer to 3 significant figures.

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(4)

- (d) Predict the type of crystal structure in solid zinc fluoride and explain why its melting point is high.

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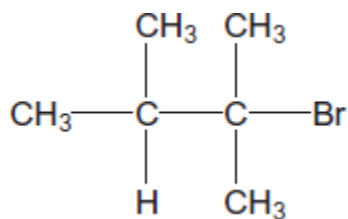
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(3)

(Total 14 marks)

6

(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.

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(2)
(Total 5 marks)

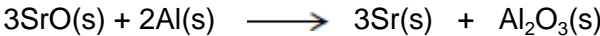
7

Group 2 metals and their compounds are used commercially in a variety of processes.

- (a) Strontium is extracted from strontium oxide (SrO) by heating a mixture of powdered strontium oxide and powdered aluminium.

Consider these standard enthalpies of formation.

	SrO(s)	Al ₂ O ₃ (s)
$\Delta H_f^\ominus / \text{kJ mol}^{-1}$	- 590	- 1669



Use these data and the equation to calculate the standard enthalpy change for this extraction of strontium.

The use of powdered strontium oxide and powdered aluminium increases the surface area of the reactants.

Suggest **one** reason why this increases the reaction rate.

Suggest **one** major reason why this method of extracting strontium is expensive.

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(5)

(b) Explain why calcium has a higher melting point than strontium.

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(2)

(c) Magnesium is used in fireworks. It reacts rapidly with oxygen, burning with a bright white light. Magnesium reacts slowly with cold water.

Write an equation for the reaction of magnesium with oxygen.

Write an equation for the reaction of magnesium with cold water.

Give a medical use for the magnesium compound formed in the reaction of magnesium with cold water.

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(3)
(Total 10 marks)

8

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 OF₂

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(1)

(ii) Write an equation to show how OF₂ 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)

9

Chlorine can form molecules and ions that contain only chlorine, or that contain chlorine combined with another element.

- (a) Use your understanding of the electron pair repulsion theory to draw the shape of the AsCl_3 molecule and the shape of the Cl_3^+ ion. Include any lone pairs of electrons that influence the shape.

Name the shape made by the atoms in the AsCl_3 molecule and in the Cl_3^+ ion.

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(Extra space)
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(4)

- (b) Explain why the AsCl_4^+ ion has a bond angle of 109.5° .

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(Extra space).....
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(2)

(Total 6 marks)

10

The following equation shows the reaction of a phosphine molecule (PH₃) with an H⁺ ion.



- (a) Draw the shape of the PH₃ molecule. Include any lone pairs of electrons that influence the shape.

(1)

- (b) State the type of bond that is formed between the PH₃ molecule and the H⁺ ion. Explain how this bond is formed.

Name of bond

How bond is formed

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(2)

- (c) Predict the bond angle in the PH₄⁺ ion.

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(1)

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

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(1)

(Total 5 marks)