

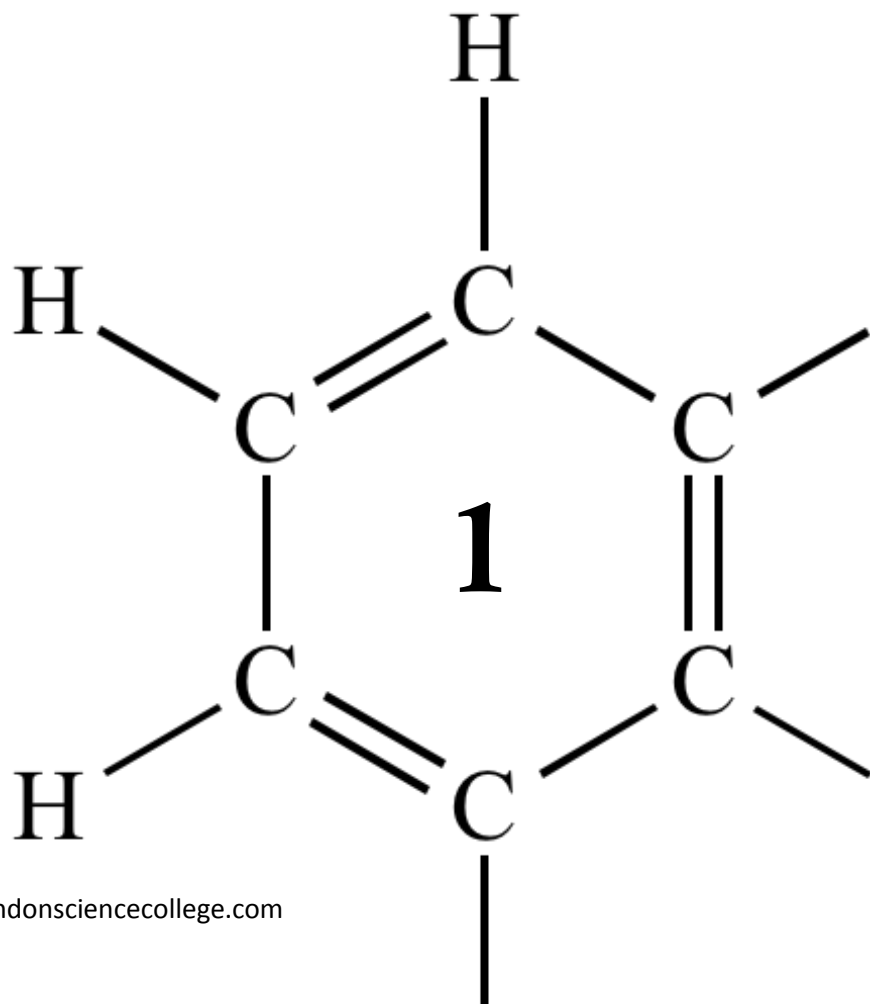
OCR AS CHEMISTRY

MODULE 2

BONDING

SHAPES OF MOLECULES

INTERMOLECULAR FORCES



1

Lithium hydride, LiH, is an ionic compound containing the hydride ion, H⁻
The reaction between LiH and aluminium chloride, AlCl₃, produces the ionic compound LiAlH₄

(a) Balance the equation below which represents the reaction between LiH and AlCl₃



(b) Give the electronic configuration of the hydride ion, H⁻

..... (1)

(c) Predict the shape of the AlH₄⁻ ion. Explain why it has this shape.

Shape

Explanation

.....

..... (3)

(d) A bond in AlH₄⁻ can be represented by H → Al

Name this type of bond and explain how it is formed.

Type of bond

Explanation

.....

..... (3)

(Total 8 marks)

2

(a) Complete the following table.

	Relative mass	Relative charge
Neutron		
Electron		

(2)

- (b) An atom has twice as many protons as, and four more neutrons than, an atom of ${}^9\text{Be}$. Deduce the symbol, including the mass number, of this atom.

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(2)

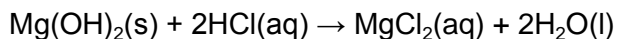
- (c) Draw the shape of a molecule of BeCl_2 and the shape of a molecule of Cl_2O . Show any lone pairs of electrons on the central atom. Name the shape of each molecule.



Name of shape Name of shape

(4)

- (d) The equation for the reaction between magnesium hydroxide and hydrochloric acid is shown below.



Calculate the volume, in cm^3 , of 1.00 mol dm^{-3} hydrochloric acid required to react completely with 1.00 g of magnesium hydroxide.

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(4)

(Total 12 marks)

3

- (a) Ammonia, NH_3 , reacts with sodium to form sodium amide, NaNH_2 , and hydrogen.

- (i) Write an equation for the reaction between ammonia and sodium.

.....

- (ii) Draw the shape of an ammonia molecule and that of an amide ion, NH_2^- .
In each case show any lone pairs of electrons.



- (iii) State the bond angle found in an ammonia molecule.

.....

- (iv) Explain why the bond angle in an amide ion is smaller than that in an ammonia molecule.

.....

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.....

.....

(6)

- (b) A salt, **X**, contains 16.2% by mass of magnesium, 18.9% by mass of nitrogen and 64.9% by mass of oxygen.

- (i) State what is meant by the term *empirical formula*.

.....

.....

(ii) Determine the empirical formula of **X**.

.....
.....
.....
.....

(3)
(Total 9 marks)

4

(a) Write an equation, including state symbols, for the reaction with enthalpy change equal to the standard enthalpy of formation for $\text{CF}_4(\text{g})$.

.....

(1)

(b) Explain why CF_4 has a bond angle of 109.5° .

.....
.....
.....
.....
.....

(2)

(c) **Table 1** gives some values of standard enthalpies of formation ($\Delta_f H^\ominus$).

Table 1

Substance	F ₂ (g)	CF ₄ (g)	HF(g)
$\Delta_f H^\ominus / \text{kJ mol}^{-1}$	0	-680	-269

The enthalpy change for the following reaction is $-2889 \text{ kJ mol}^{-1}$.

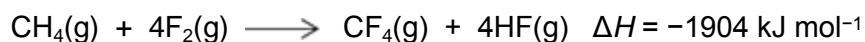


Use this value and the standard enthalpies of formation in **Table 1** to calculate the standard enthalpy of formation of C₂H₆(g).

Standard enthalpy of formation of C₂H₆(g) = kJ mol⁻¹

(3)

(d) Methane reacts violently with fluorine according to the following equation.



Some mean bond enthalpies are given in **Table 2**.

Table 2

Bond	C-H	C-F	H-F
Mean bond enthalpy / kJ mol^{-1}	412	484	562

A student suggested that one reason for the high reactivity of fluorine is a weak F-F bond.

Is the student correct? Justify your answer with a calculation using these data.

.....

(4)
 (Total 10 marks)

5

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

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.....

.....

.....

.....

Molecular formula

.....

(4)
(Total 14 marks)

6

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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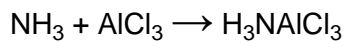
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(Total 5 marks)

7

Ammonia reacts with aluminium chloride as shown by the equation:



- (a) Draw diagrams to illustrate the shapes of NH_3 molecules and of AlCl_3 molecules. Include in your diagrams any lone pairs of electrons that influence the shape. Indicate the values of the bond angles.

(3)

- (b) Name the type of bond formed between N and Al in H_3NAlCl_3 and explain how this bond is formed.

Type of bond

Explanation

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.....

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(2)

- (c) Explain how the value of the Cl-Al-Cl bond angle in AlCl_3 changes, if at all, on formation of the compound H_3NAlCl_3

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(2)
(Total 7 marks)