

Covalent Bonding & Shapes of Molecules

Question Paper 2

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	Chemical Bonding
Sub-Topic	Covalent Bonding & Shapes of Molecules
Paper Type	Theory
Booklet	Question Paper 2

Time Allowed: 58 minutes

Score: /48

Percentage: /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	77.5%	70%	62.5%	57.5%	45%	<45%

- 1 (a) Describe how the behaviour of the oxides of tin and lead in their +4 oxidation states differ on heating.

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..... [1]

- (b) Explain the following by using data from the *Data Booklet* where appropriate, and writing equations for all reactions.

- (i) A sample of liquid PbCl_4 is placed in a flask and the flask is gently warmed. A gas is evolved and a white solid is produced. When the gas is bubbled through KI(aq) , purple fumes are produced.

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- (ii) Repeating the same experiment using liquid SnCl_4 instead of PbCl_4 results in no evolution of gas, and no reaction with KI(aq) .

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..... [4]

- (c) The molecule dichlorocarbene, CCl_2 , can be produced under certain conditions. It is highly unstable, reacting with water to produce carbon monoxide and a strongly acidic solution.

- (i) Suggest the electron arrangement in CCl_2 and draw a dot-and-cross diagram showing this. Predict the shape of the molecule.

- (ii) Construct an equation for the reaction of CCl_2 with water.

..... [3]

[Total: 8]

2 (a) (i) By means of a clear, labelled diagram, describe the shape of the tin(IV) chloride molecule.

(ii) Explain the shape of the tin(IV) chloride molecule in terms of its bonding.

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[2]

(b) (i) What would you expect to observe when tin(IV) chloride reacts with water? Suggest an explanation for your answer.

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(ii) Write an equation for the reaction between tin(IV) chloride and water.

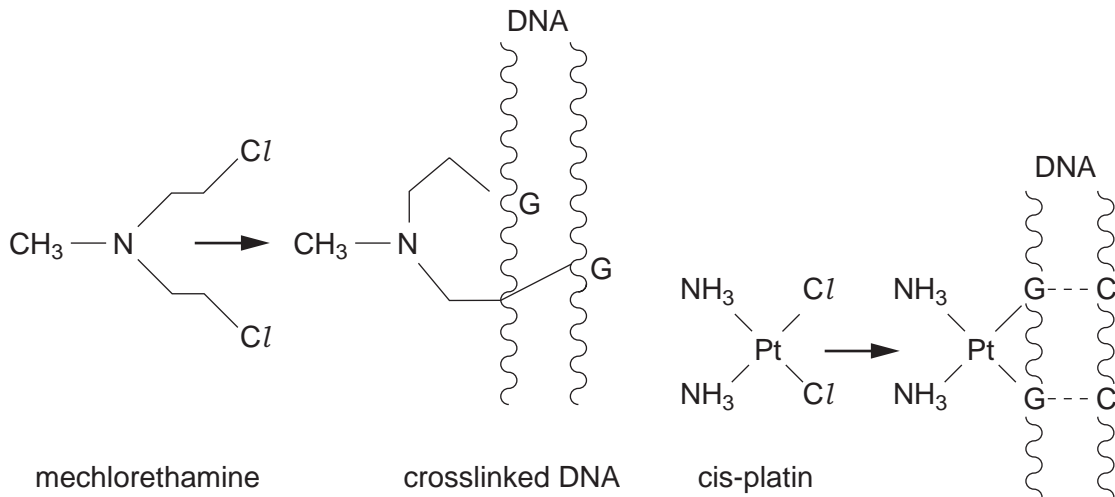
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[3]

[Total: 5]

- 3 In recent years a great deal of research has been carried out into finding different anti-cancer drugs. Tumours, which are often symptoms of cancer, are produced when cells replicate uncontrollably. This in turn is brought about by the replication of DNA in these cells.

Two anti-cancer agents are mechlorethamine and *cis*-platin. They work by binding to the DNA and preventing replication.



- (a) (i) What type of bonding attaches both anti-cancer agents to the DNA?

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- (ii) Suggest how **each** of the anti-cancer agents prevents replication of the DNA.

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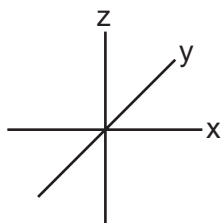
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[5]

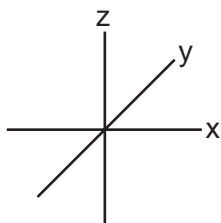
[Total: 5]

4 This question is about the bonding of covalent compounds.

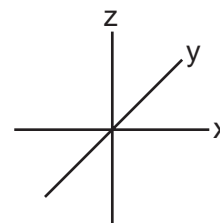
(a) On the axes below, sketch the shapes of a 1s, a 2s, and a 2p_x orbital.



1s



2s



2p_x

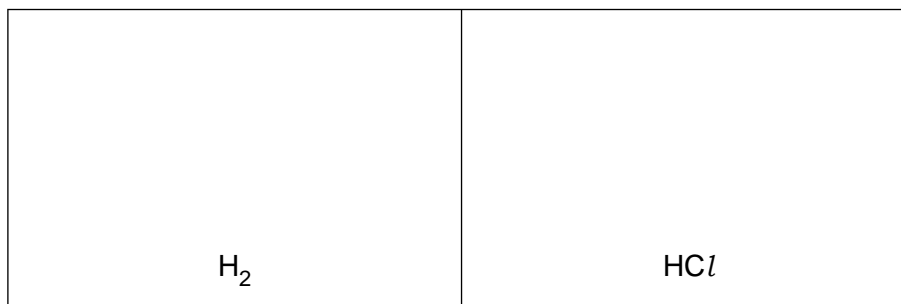
[3]

(b) Covalent bonding occurs when two atoms share a pair of electrons. Covalent bonding may also be described in terms of orbital overlap with the formation of σ bonds.

(i) How are the two atoms in a covalent bond held together? In your answer, state which particles are attracted to one another and the nature of the force of attraction.

.....

(ii) Draw sketches to show orbital overlap that produces the σ bonding in the H₂ and HCl molecules.



[4]

(c) The bond in the HCl molecule is said to be ‘polar’.

(i) What is meant by the term *bond polarity*?

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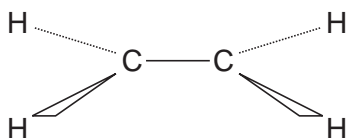
(ii) Explain why the HCl molecule is polar.

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[2]

- (d) The bonding in ethene may be described as a mixture of σ and π bonding.

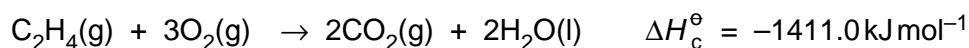
Each carbon atom in ethene forms three σ bonds as shown below.



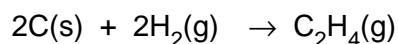
On the diagram, sketch the π bond that is also present in ethene.

[1]

- (e) Carbon, hydrogen and ethene each burn exothermically in an excess of air.



Use the data to calculate the standard enthalpy change of formation, ΔH_f^\ominus , in kJ mol^{-1} , of ethene at 298 K.



$$\Delta H_f^\ominus = \dots\dots\dots \text{kJ mol}^{-1}$$

[3]

[Total: 13]

5 (a) Explain what is meant by the term *nucleon number*.

.....
..... [1]

(b) Bromine exists naturally as a mixture of two stable isotopes, ^{79}Br and ^{81}Br , with relative isotopic masses of 78.92 and 80.92 respectively.

(i) Define the term *relative isotopic mass*.

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..... [2]

(ii) Using the relative atomic mass of bromine, 79.90, calculate the relative isotopic abundances of ^{79}Br and ^{81}Br .

[3]

(c) Bromine reacts with the element **A** to form a compound with empirical formula ABr_3 . The percentage composition by mass of ABr_3 is **A**, 4.31; Br, 95.69.

Calculate the relative atomic mass, A_r , of **A**.
Give your answer to **three** significant figures.

A_r of **A** = [3]

(d) The elements in Period 3 of the Periodic Table show different behaviours in their reactions with oxygen.

(i) Describe what you would **see** when separate samples of magnesium and sulfur are reacted with oxygen.

Write an equation for each reaction.

magnesium

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sulfur

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[4]

(ii) Write equations for the reactions of aluminium oxide, Al_2O_3 , with sodium hydroxide,

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hydrochloric acid.

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[2]

(e) Phosphorus reacts with chlorine to form PCl_5 .

State the shape of and two different bond angles in a molecule of PCl_5 .

shape of PCl_5

bond angles in PCl_5

[2]

[Total: 17]