CHEMISTRY ONLINE
TUITION

Phone: +442081445350

www.chemistryonlinetuition.com

Email:asherrana@chemistryonlinetuition.com

CHEMISTRY
PHYSICAL CHEMISTRY

Level & Board	CIE (A-LEVEL)
TOPIC:	CHEMICAL BONDING
PAPER TYPE:	QUESTION PAPER - 1
TOTAL QUESTIONS	9
TOTAL MARKS	83

Chemical Bonding

1)

(a) Define the term relative atomic mass.

(b) The mass spectrum of krypton consist of several peaks, due to the existence of isotopes. Calculate the relative atomic mass of Kr to 1 decimal place using the following data.

mass number	Percent abundance
80	2.6
x82	11.6
83	11.5
84	56.9
86	17.4

[2]

(c) Krypton reacts with fluorine to form a fluoride A. A mass of 0.100g of A occupies 104 cm^3 at 2.00×10^4 Pa and 305 K. Calculate the relative molecular mass of A, and hence suggest its formula. [2]

(d) Another noble gas, xenon, forms a tetrafluoride Xe_{F4}.

(i) Suggest a dot – and cross diagram to show the bonding in XeF_4.

(ii) Use your diagram to suggest the shape of XeF_4.

(iii) When added to water, XeF_4 reacts according to the following equation.

Define the values of A, b ad C in this equation.

$$6\ XeF_4 + 12H_2O \longrightarrow a\ XeO_3 + b\ Xe + 3O_2 + c\ HF$$ [4]

2)

Fluorine, the first member of Group VII, does not occur in nature as the element. The main sources of fluorine are the ionic compounds fluorspar, CaF_2. And cryolite, Na3A/F6.

(a) Fluorspar, CaF_2, is a simple ionic compound. Draw a 'dot – and cross' diagram to show the bonding in fluorspar. [1]

3)

(a) Boron forms simple trihalides of formula BX3 with all the halogens. BF3 and BCl3 are the most common. Both find uses as Friedel – Crafts catalysts since they readily react with electron pair donars.

(i) Describe and explain the shape of BF3 molecule.

(i) BF3 and trimethylamine, (CH3)3N react in a 1:1 ration to give a white crystalline solid. Draw a diagram to show the bonding within a molecule of this solid, explaining the type of bonding involved.

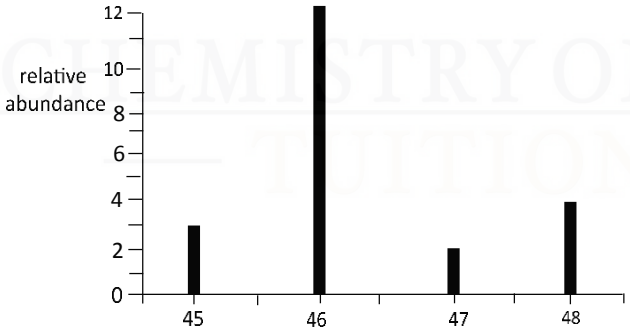
[5]

(b) (i) Define the term relative atomic mass.

Naturally occurring boron has two stable isotopes, ^{10}B and ^{11}B chlorine also has two stable isotopes, ^{35}Cl and ^{37}Cl. The accurate masses of these isotopes are given in the table.

isotope	m/e	Accurate isotopic mass
^{10}B	10	10.013
^{11}B	11	11.009
^{35}Cl	35	34.969
^{37}Cl	37	36.969

Part of the mass spectrum of BCl_3 is shown below.



(ii) State the identity of each peak in the mass spectrum shown.

(iii) Calculate the accurate mass of the peak at m/e = 46.

(iv) Use the spectrum to determine the percentage of ^{10}B in naturally occurring boron, and hence calculate the accurate relative atomic mass of boron, quoting your answer to 2 decimal places. [5]

4)

Ethen, C_2H_4, and hydrazine, N_2H_4, are hydrides of elements which are adjacent in the Periodic Table. Date about the ethane and hydrazine are given in the table below.

	C_2H_4	N_2H_4
Melting Point ^oC	-169	+2
Boiling point ^oC	-104	+114
Solubility in Water	Insoluble	High
Solubility in ethanol	High	high

(a) Ethene and hydrazine have a similar arrangement of atoms but differently shaped molecules.

(i) What is the H – C – H bond angle in ethane?
(ii) Draw a 'dot – and – cross' diagram for hydrazine.
(iii) What is the H – N – H bond angle in hydrazine? [4]

(b) The melting and boiling points of hydrazine are much higher then those of ethene. Suggest reasons for these differences in terms of the intermolecular forces each Compound possesses. [3]

(c) Explain, with the aid of a diagram showing Ione pairs of electrons and dipoles, why hydrazine is very soluble in ethanol. [3]

(d) When ethene is reacted with HCl, C_2H_5Cl is the only product.

(i) Using structural formulae, give an equation for the reaction between ethene and HCl.

(ii) What type of reaction occurs between HCl and ethene?

(iii) Explain why there is no further reaction between C_2H_6Cl and HCl. [3]

(e) When aqueous hydrazine is reacted with HCl, a solid compound of formula N_2H_5Cl may be isolated. When an excess of HCl is used, a second solid, $N_2H_6Cl_2$, is formed.

(i) Suggest what type of reaction occurs between hydrazine and HCl,

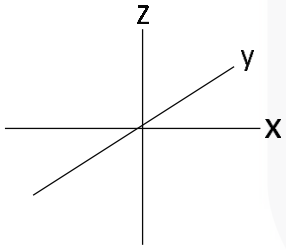
(ii) What feature of the hydrazine molecule enables this reaction to occure?

(iii) Suggest why one molecule of hydrazine is able to react with one or two molecules of HCl. [3]

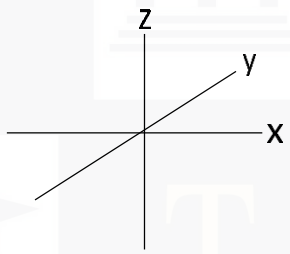
5)

This question is about the bonding of covalent compounds.

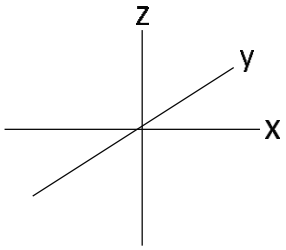
(a) On the axes below, sketch the shapes of a 1s, a 2s, and a 2px orbital.



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 a bonds.

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

(ii) Draw sketches to show orbital overlap that produces the σ bonding in the H_2 and HCl molecules.

H_2	HCl

[4]

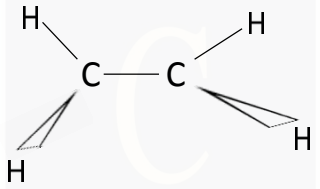
(c) The bond in the HCl molecule is said to be 'polar'

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

(ii) Explain why the HCl molecule is polar. [3]

(c) 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]

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

$C(s) + O_2(g) \rightarrow CO_2$ $\quad \Delta H_C^\theta$ = -393.7 KJmol^{-1}

$H_2(g) + 1/2)O_2(g) \rightarrow H_2O(l)$ $\quad \Delta H_C^\theta$ = -285.9 KJmol^{-1}

$C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(l)$ $\quad \Delta H_C^\theta$ = -1411.0 KJmol^{-1}

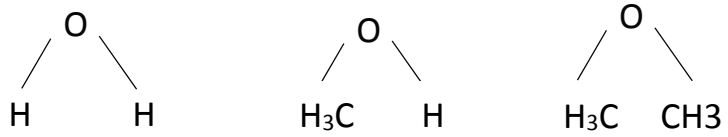
Use the data to calculate the standard enthalpy change of formation,

ΔH_t^θ = in KJmol^{-1}, of ethene at 298 K.

$2C(s) + 2H2(g) \rightarrow C_2H_4(g)$ [3]

6)

The structural formulae of water, methanol and methoxymethane, CH_3OCH_3,



(a) (i) How many lone pairs of electrons are there around the oxygen atom in methoxymethane?

(ii) Suggest the size of the C – C – C bond angle in methoxymethane. [2]

The physical properties of a covalent compound, such as its melting point, boiling Point, vapour pressure, or solubility, are related to the strength of attractive forces between the molecules of that compound.

These relatively weak attractive forces are called intermolecular forces. They differ in their strength and include the following.

A interactions involving permanent dipoles

B Interactions involving temporary or induced dipoles

C hydrogen bonds

(b) By using the letters A, B, or C, state the strongest intermolecular force present in each of the following compounds.

For each compound,, write the answer on the dotted line.

Ethanol	CH_3CHO	.....
Ethanol	CH_3CH_2OH	.....
methoxymethane	CH_3OCH_3	.....
2-methylpropane	$(CH_3)_2CHCH_3$	.....

[4]

(c) Methanol and water are completely soluble in each other.

(i) Which intermolecular force exists between methanol molecules and water Molecules that makes these two liquids soluble in each other?

(ii) Draw a diagram that clearly shows this intermolecular force. Your diagram should show any Ione pairs or dipoles present on either molecule that you consider to to be important. [4]

(d) When equal volumes of ethoxyethane, $C_2H_5OC_2H_5$, and water are mixed, shaken, And then allowed to stand, two layers are formed.

Suggest why ethoxyethane does not fully dissolve in water. Explain your answer. [2]

7)

(a) Hydrogen fluoride, HF, behaves as a weak acid in water, with $K_a = 5.6 \times 10^{-4}$ mole dm^{-3}

Calculate the pH of a 0.050 mole dm^{-3} solution of HF. [2]

(b) Gaseous ammonia and hydrogen fluoride react together to give solid ionic ammonium Fluoride.

$NH_3(g) + HF(g) \rightleftharpoons NH_4F(s)$ $\Delta H = -147$ KJ $mole^{-1}$

(i) What type of reaction is this?

(ii) Draw dot – and – cross diagrams (outer shells only) describing the bonding In the three compounds involved in this reaction.

(iii) There are three types of bonding in NH4F.
Give the names of each of the three types, and state where in the compound Each types occurs.

(iv) The reaction between NH3 and HF is reversible. What conditions of temperature and pressure would favour the reverse reaction, i.e. the dissociation of NH_4F?

Explain your answer. [9]

8)

(a) Describe and explain the trend in the volatilities of the halogens Cl_2, and I_2 [3]

(b) For each of the following pairs of compounds predict which compound has the boiling Point, and explain the reasons behind your choice.

Use diagrams in your answers where appropriate.

(i) H_2O and H_2S

(ii) $CH_3 – CH_2 – CH_3$ and $CH_3 – O – CH_3$ [4]

(C) Briefly explain the shape of the SF6 molecule, drawing a diagram to illustrate your answer. [2]

9)

Valence shell Electron Pair Repulsion theory (VSEPR)is a model of electron – pair Repulsion (including Ione pairs)that can be used to deduce the shapes of, and bond Angles in, simple molecules.

(a) Complete the table below by using simple hydrogen – containing compounds. One example has been included.

Number of Bond pairs	Number of Ione pairs	Shape of Molecule	Formula of a molecule With this shape
3	0	trigonal planer	BH_3
4	0		
3	1		
2	2		

[3]

(b) Tellurium, Te, proton number 52, is used in photovoltaic cells.

When fluorine gas is passed over tellurium at 15^0C, the colourless gas gas TeF_6.

Is formed.

(i) Draw a 'dot – and – cross' diagram of the TeF_6 molecule, showing outer electrons only.

(ii) What will be the shape of the TeF_6 molecule?

(iii) What is the F – Te – F bond angle in TeF_6? [3]

I am Sorry !!!!!

DR. ASHAR RANA

M.B.B.S / MS. CHEMISTRY

CHEMISTRY ONLINE TUITION

Phone: +442081445350
www.chemistryonlinetuition.com
Email: asherrana@chemistryonlinetuition.com

- Founder & CEO of Chemistry Online Tuition Ltd.
- Completed Medicine (M.B.B.S) in 2007
- Tutoring students in UK and worldwide since 2008
- CIE & EDEXCEL Examiner since 2015
- Chemistry, Physics, Math's and Biology Tutor

CONTACT INFORMATION FOR **CHEMISTRY ONLINE TUITION**

- UK Contact: 02081445350
- International Phone/WhatsApp: 00442081445350
- Website: www.chemistryonlinetuition.com
- Email: asherrana@chemistryonlinetuition.com

Address: 210-Old Brompton Road, London SW5 OBS, UK