Hit the ground running Chemistry

Name: ………………………………………………………………………….

What is this booklet for:

- This is simply designed to be a *bridging* Chemistry booklet.
- It has work to prepare you for the A level you are starting in September.
- It contains a series of topics that you will have covered in GCSE and it is then extended into some A level standard work.

How to use the booklet:

1) Read over the explanation notes and examples
2) Look over work from your GCSE exercise books and revision guides
3) Look on the internet for other guidance, google the chapter titles!
4) COMPLETE the Tasks in the ANSWER booklet section.

Bonding

When elements react together they form new compounds which have two or more elements chemically joined. Atoms bond in order to have a full outer shell as this is more stable.

There are two main types of chemical bond.

- **Ionic**: between a Metal and Non-metal
- **Covalent**: between Non-metal and Non- metal

Task 1

Decide if the compounds below are ionically or covalently bonded together and why?

Compound	Type of bonding
Ammonia NH_3	
Zinc Oxide ZnO	
Methane CH_4	
Benzene C_6H_6	
Potassium Dichromate $K_2Cr_2O_7$	

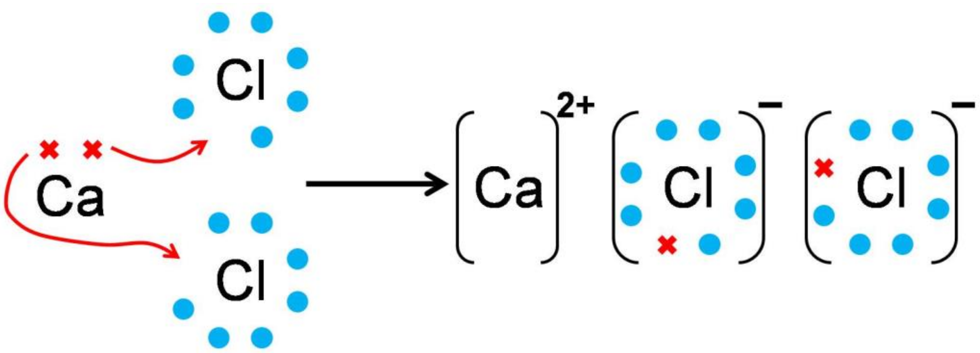
Ionic Bonding

This is an ELECTROSTATIC ATTRACTION between 2 oppositely charged species called IONS.

The compound is formed is neutral, which means it has no overall charge.

i.e. it has an equal amount of positive and negative charge from the different ions that are making it up.

How are IONS made?



This is seen by the diagram above:

METALS: (Cations)	**NON- METALS (anions)**
They form Positive ions as they lose their outer electrons to form a FULL OUTER SHELL.	They form NEGATIVE ions as they gain electrons to form a FULL OUTER SHELL.
Calcium 2 electrons in its outer shell as an element so LOSES 2 electrons to become a 2+ ion	Chlorine has 7 electrons in its outer shell so will GAIN 1 electron to become a 1- ion

Task 2

Draw out Atom and Ions for the following ionic compounds (like the calcium Oxide diagram above)

1) Aluminium Oxide

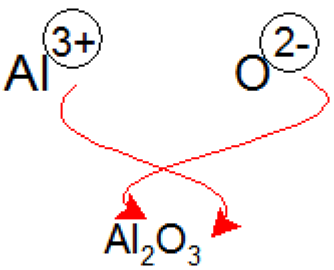
2) Lithium Oxide

3) Barium Nitride

Formula of Ionic compounds

When we form an Ionic compound we have oppositely charged ions attracted together so that a neutral compound is formed.

This means there is a balance between the positive metals ions and negative non-metal ions.



You swap the NUMBERS of the charge over

If a 1 you ignore it

If get 2 numbers the same ignore them

Aluminium Oxide made from Aluminium ions and Oxide ions.

Task 3

Work out the formula of the following ionic compounds.

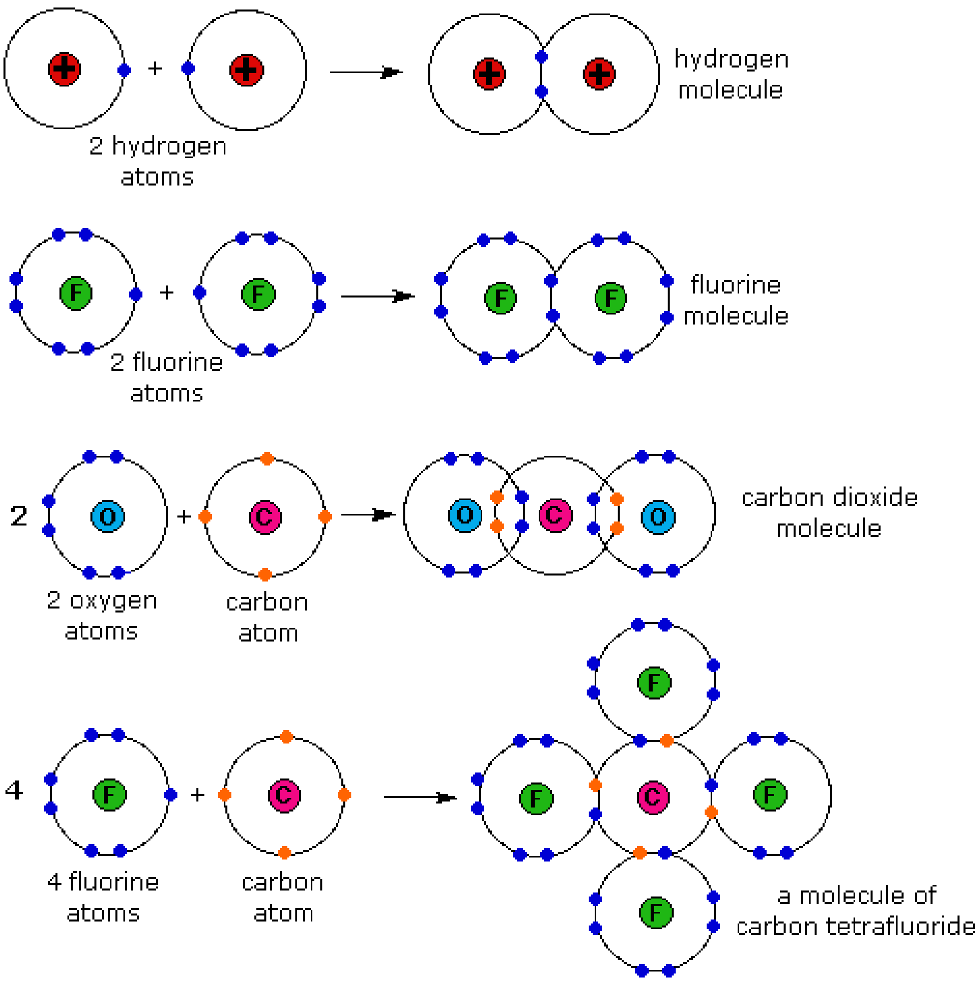
Silver chloride	
Lithium sulphate	
Ammonium Hydroxide	
Potassium Dichromate	
Iron (II) Nitrate	
Magnesium bromide	

Barium oxide	
Zinc chloride	
Ammonium chloride	
Ammonium carbonate	
Aluminium bromide	
Iron(II) sulfate	

Covalent bonding

The covalent bond is made up from non-metal atoms that want to bond together.

Covalent bonds are made from the atoms sharing their electrons to get a FULL OUTER SHELL.



Task 4

Draw out the Dot/ Cross diagrams and Line diagram of the following molecules:

1) Ethene, C_2H_6

2) Ammonia, NH_3

3) Hydrogen Peroxide, H_2O_2

4) Hydrogen Sulphide, H_2S

5) Nitrogen, N_2

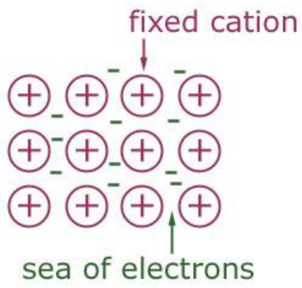
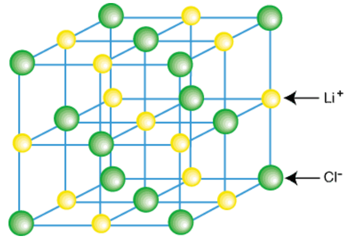
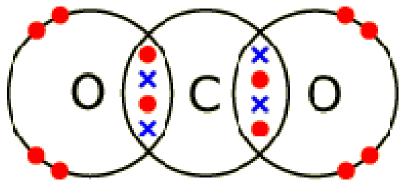
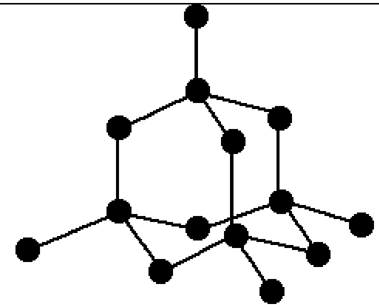
6) Carbon dioxide, CO_2

Structure

There are 4 main structures you need to be aware of

1) Metallic structure
2) Giant Ionic
3) Giant covalent / Macromolecular
4) Simple Molecular

Task 5: Fill in the table:

	Metallic bonding	**Ionic**	**Covalent**	
			Simple molecular covalent	**Giant molecular covalent**
Definition				
Structure				
Examples				
Strength of bond				Strong bonds between atoms (strong **intramolecular** forces)
Melting point/ boiling point		High- often solids at room temperature		
Solubility			Some dissolve in water	
Do they conduct electricity?			They do not conduct electricity	

Equations

State symbols

- Gas (g)
- Liquid (l)
- Solid (s)
- Aqueous (aq)

Rules:

1. You must have the same number of each type of atom on both sides of the equation
2. You can only add big numbers to the front of substances
3. Big numbers in the front of substances multiply every atom in that substance
4. Balance:
   a. Metals first
   b. Then non-metals (not including hydrogen and oxygen)
   c. Then balance hydrogen and oxygen
   d. Finally do a final check

Task 6

Balance the following equations:

1) $N_2 + H_2 \rightarrow NH_3$

2) $CH_4 + O_2 \rightarrow CO_2 + H_2O$

3) $Na + H_2SO_4 \rightarrow Na_2SO_4 + H_2$

4) $SO_2 + NaOH \rightarrow Na_2SO_3 + H_2O$

5) $C_2H_5OH + O_2 \rightarrow CO_2 + H_2O$

6) …..C + …..O_2 $\rightarrow$ …..CO

7) …..Ba + …..H_2O $\rightarrow$ …..$Ba(OH)_2$ + …..H_2

8) …..C_2H_6 + …..O_2 $\rightarrow$ …..CO_2 + …..H_2O

9) …..HCl + …..$Mg(OH)_2$ $\rightarrow$ …..$MgCl_2$ + H_2O

10) …..N_2 + …..O_2 $\rightarrow$ …..NO

11) …..Fe_2O_3 + …..C $\rightarrow$ …..Fe + …..CO_2

12) …..CH_3CH_2OH + …..[O] $\rightarrow$ …..CH_3COOH + …..H_2O

13) …..HNO_3 + …..CuO $\rightarrow$ …..$Cu(NO_3)_2$ + H_2O

14) …..Al^{3+} + …..e^- $\rightarrow$ …..Al

15) …..$[Fe(H_2O)_6]^{3+}$ + …..CO_3^{2-} $\rightarrow$ …..$Fe(OH)_3(H_2O)_3$ + …..CO_2 + …..H_2O

Task 7:

For each one, write a balanced symbol equation for the process.

1. The reaction between silicon and nitrogen to form silicon nitride Si_3N_4.

....

2. The neutralisation of sulfuric acid with sodium hydroxide.

....

3. The preparation of boron trichloride from its elements.

....

4. The reaction of nitrogen and oxygen to form nitrogen monoxide.

....

5. The combustion of ethanol (C_2H_5OH) to form carbon dioxide and water only.

....

6. The formation of silicon tetrachloride ($SiCl_4$) from SiO_2 using chlorine gas and carbon.

....

7. The extraction of iron from iron(III) oxide (Fe_2O_3) using carbon monoxide.

....

8. The complete combustion of methane.

....

9. The formation of one molecule of ClF_3 from chlorine and fluorine molecules.

....

10. The reaction of nitrogen dioxide with water and oxygen to form nitric acid.

....

Calculating relative formula mass

E.g. Carbon dioxide, CO_2
The relative formula mass is therefore Mr = $(12.0 \times 1) + (16.0 \times 2) = 44.0$

E.g. Magnesium hydroxide $Mg(OH)_2$
The relative formula mass is therefore: $(24.3 \times 1) + (2 \times (16.0 + 1.0)) = 58.3$

Task 8:

Calculate the relative formula mass of the following compounds:

1. Magnesium oxide MgO
2. Sodium hydroxide $NaOH$
3. Copper sulfate $CuSO_4$
4. Ammonium chloride NH_4Cl
5. Ammonium sulfate $(NH_4)_2SO_4$

Empirical formula

Task 9:

1. The smell of a pineapple is caused by ethyl butanoate. A sample is known to contain only 0.180 g of carbon, 0.030 g of hydrogen and 0.080 g of oxygen. What is the empirical formula of ethyl butanoate?

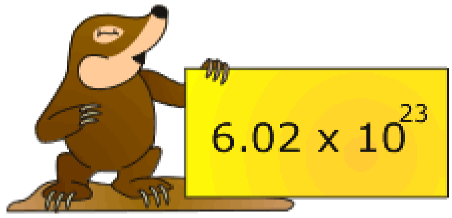
2. Find the empirical formula of a compound containing 0.0578 g of titanium, 0.288 g of carbon, 0.012 g of hydrogen and 0.384 g of oxygen.

3. 300 g of a substance are analysed and found to contain only carbon, hydrogen and oxygen. The sample contains 145.9 g of carbon and 24.32 g of hydrogen. What is the empirical formula of the compound?

4. Another 300 g sample is known to contain only carbon, hydrogen and oxygen. The percentage of carbon is found to be exactly the same as the percentage of oxygen. The percentage of hydrogen is known to be 5.99%. What is the empirical formula of the compound?

Moles

In its most basic form the 'MOLE' is just a word used to describe a number.



e.g.	Couple	2
	Dozen	12
	Mole	6.02×10^{23}

Why this large number?

It was found that this number of ATOMS of any element is equal to the MASS NUMBER of this element in grams.

e.g.

6.02×10^{23} carbon atoms is equal to 12g

6.02×10^{23} neon atoms is equal to 20g

This leads to the FIRST mole equation.

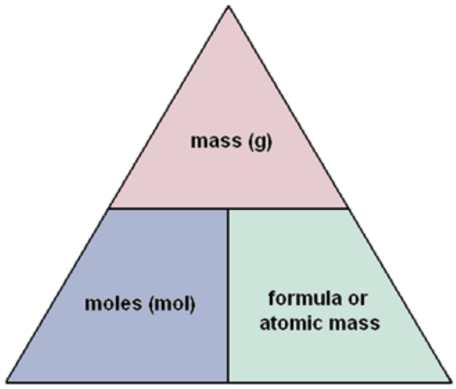
$$\text{Moles} = \frac{\text{Mass}}{\text{R.A.M}} \qquad \text{(relative atomic mass)}$$

e.g. How many moles are there in 24g of carbon?

$$\text{Moles} = \frac{\text{Mass}}{\text{R.A.M}}$$

$$\text{Moles} = \frac{24}{12}$$

Moles = 2 moles of carbon



Task 10:

1. Calculate the number of moles in the following?

a) 59 g of cobalt

b) 4.14 g of lead

c) 1.08g of gold

d) 62 g of sodium Oxide Na_2O

e) 174 g of lithium bromide LiBr

f) 3.2 g of oxygen

g) 1.24 g of Ammonia

2. Calculate the :

a) Mass of 2 moles of calcium metal

b) 0.25 moles of lead carbonate $PbCO_3$

c) The formula mass of a compound which has 0.5 moles of mass 14g

3. 250g of hydrated copper sulphate ($CuSO_4 .x H_2O$) is collected & a student want to calculate the number of moles of water attached to the copper sulphate, the x value. The student completely dried the copper sulphate & the new mass was found to be 160g

a) Calculate the moles of copper sulphate

b) Calculate the mass of lost water

c) Calculate the number of moles of lost water

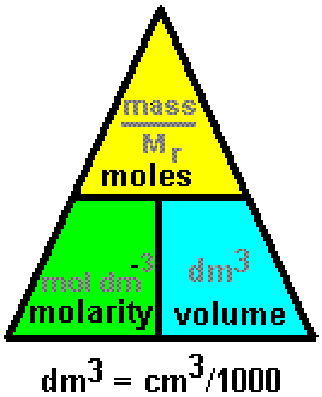
d) Therefore deduce the formula of the hydrated copper sulphate.

Moles and solution

When we dissolve a solid in water we create a solution.
We use a different mole equation to calculate the moles in the solutions we create.

Molarity / M
Mol/dm³ ml or cm³

$$\text{Moles} = \frac{\text{Conc} \times \text{Vol}}{1000}$$



e.g. How many moles are there in 250 cm 3 of 0.1 M Hydrochloric acid ?

$$\text{Moles} = \frac{\text{Conc} \times \text{Vol}}{1000}$$

$$= \frac{0.1 \times 250}{1000}$$

$$= 0.025 \text{ Moles}$$

Task 11

1) Calculate the moles in 40 cm^3 of 5M of sodium hydroxide solution

2) What is the concentration when you dissolve 2 moles of acid in 100cm^3 of water

3) How many moles are there in 500 cm^3 of 0.1 mol/dm^3 of salt solution

4) What is the concentration of 0.25 moles of alkali in 25 cm^3

5) How many grams of potassium oxide (K_2O) are needed to make 100 cm^3 of a 0.5M solution ?

6) What is the concentration of a solution when we dissolve 730g of hydrochloric acid in 350 cm^3?

7) What is the mass of calcium oxide, CaO needed to make a 250 cm^3 volume of 0.5 M solution?

Final mole equation work

E.g. Calcium oxide reacts with water to form calcium hydroxide.

$CaO + H_2O \rightarrow Ca(OH)_2$

If I started with 28g of the calcium oxide what mass of calcium hydroxide would I make, and if it was in 100cm^3 of water what would its concentration be

1	:	1		1	Molar Ratio
CaO	+	H_2O	$\rightarrow$	$Ca(OH)_2$	
28g					

$$\text{Moles} = \frac{\text{Mass}}{\text{RFM}} = \frac{28}{56} = 0.5 \text{ moles}$$

0.5 0.5 0.5 *New molar ratio*

$$\text{Mass} = \text{Moles} \times \text{RFM} = 0.5 \times 74 = \underline{37g}$$

And the solution concentration would be:

0.5 moles

100ml

$$\text{Conc} = \frac{1000 \times \text{mole}}{\text{Vol}}$$

$$\text{Conc} = \frac{1000 \times 0.5}{100}$$

$$\underline{\text{Conc} = 5 \text{ mol/dm}^3}$$

Task 12

1) Calcium cyanamide $CaCN_2$ reacts with water to form calcium carbonate and ammonia

   $\mathbf{CaCN_2 + 3H_2O \rightarrow CaCO_3 + NH_3}$

   What mass of calcium carbonate is formed if 20g of the $CaCN_2$ is reacted with excess water.

2) Magnesium burns in air to make magnesium oxide

   $\mathbf{2Mg + O_2 \rightarrow 2MgO}$

   What mass of magnesium would you need to create 0.8g of magnesium oxide powder.

3) Iron reacts with water to form iron oxide and hydrogen

   $\mathbf{3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2}$

   If the student starts with 1.68g of iron and it undergoes a complete reaction

   i) Number of moles of iron started with?
   ii) Moles of tri Iron oxide formed
   iii) Mass of tri iron oxide formed
   iv) The concentration of this solution if we had 500ml of water in the reaction?

4) 25 cm^3 of 0.1 M HCl reacts with 50cm^3 of NaOH solution fully

   What is the concentration of the NaOH solution.

HCl + NaOH → NaCl + H_2O

Atom economy

CALCULATION OF ATOM ECONOMY

$$\text{atom economy} = \frac{\text{mass of atoms in desired products}}{\text{mass of atoms in reactants}} \times 100\%$$

This is a measure of the useful products compared to all the products.

e.g. Ethanol is decomposed into useful ethane and waste water.

	Ethanol	⇒	**Ethene**	**+**	**Water**
	C_2H_5OH		**C_2H_4**	**+**	**H_2O**
RFM	46		28		18

Atom economy $= \dfrac{\text{mass of useful product}}{\text{mass of all reactants}} \times 100$

$= \dfrac{28}{46} \times 100$

= **60.9%**

Task 13

What is the Atom economy in:

1) Hydrogen is used in synthesising ammonia and is made on a large scale from reacting methane with water

methane + water ==> hydrogen + carbon monoxide

$CH_4 + H_2O$ ==> $3H_2$ + CO

2) In the blast furnace where we form Iron .

$Fe_2O_{3(s)} + 3CO_{(g)}$ ===> $2Fe_{(l)} + 3CO_{2(g)}$

Percentage yield

This is the second method we use to calculate the efficiency of the reaction. This gives an idea of what is actually formed in reality as compared to what we would expect to be formed.

$$\text{Percent Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100\%$$

e.g. Ethanol is decomposed into useful ethane and waste water.

Ethanol	$\Rightarrow$	Ethene	+	Water
C_2H_5OH	$\Rightarrow$	C_2H_4	+	H_2O

We create 1.4 g of the ethene from a starting mass of 4.6g of ethanol, what is the percentage yield.

CALC Moles = $\frac{\text{Mass}}{\text{RFM}}$

Moles = $\frac{4.6}{46}$

= 0.1 moles   0.1 moles : 0.1 moles

Mass = Moles x RFM

= 0.1 x 28

= 2.8 g

This is the theoretical yield amount
i.e this is the full amount that could possibly be formed

Final calc   percentage yield = $\frac{\text{Actual}}{\text{Theoretical}}$ x 100

= $\frac{1.4}{2.8}$ x 100

= 50%

Task 14

1) When 5.00 g of $KClO_3$ is heated it decomposes according to the equation:

$$\mathbf{2KClO_3 \rightarrow 2KCl + 3O_2}$$

a) Calculate the theoretical yield of oxygen.
b) Give the % yield if 1.78 g of O_2 is produced.
c) How much O_2 would be produced if the percentage yield was 78.5%?

2) The electrolysis of water forms H_2 and O_2.

$$\mathbf{2H_2O \rightarrow 2H_2 + O_2}$$

What is the % yield of O_2 if 12.3 g of O_2 is produced from the decomposition of 14.0 g H_2O?