

Bridging Booklet

What is this booklet for:

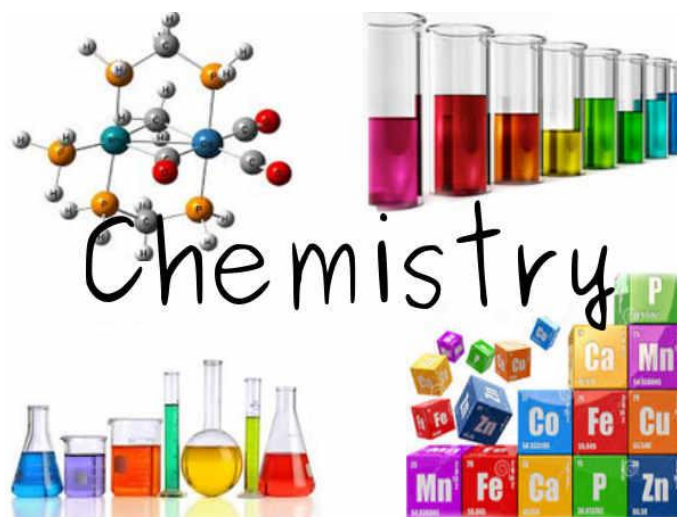
This is simply designed to be a *bridging* Chemistry booklet.

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.

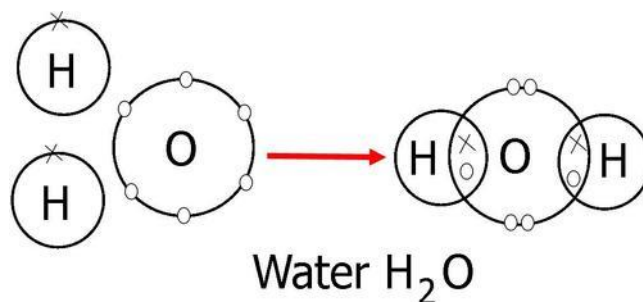




**KEEP
CALM
AND
STUDY
CHEMISTRY**

Example of a typical covalently bonded compound

Water



Chapter 1

Bonding

This is a cornerstone of chemistry, when elements react together they form new compounds which have two or more elements chemically joined.

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?

a) Ammonia NH_3

b) Zinc Oxide ZnO

c) Methane CH_4

d) Benzene C_6H_6

e) Potassium Dichromate $K_2Cr_2O_7$

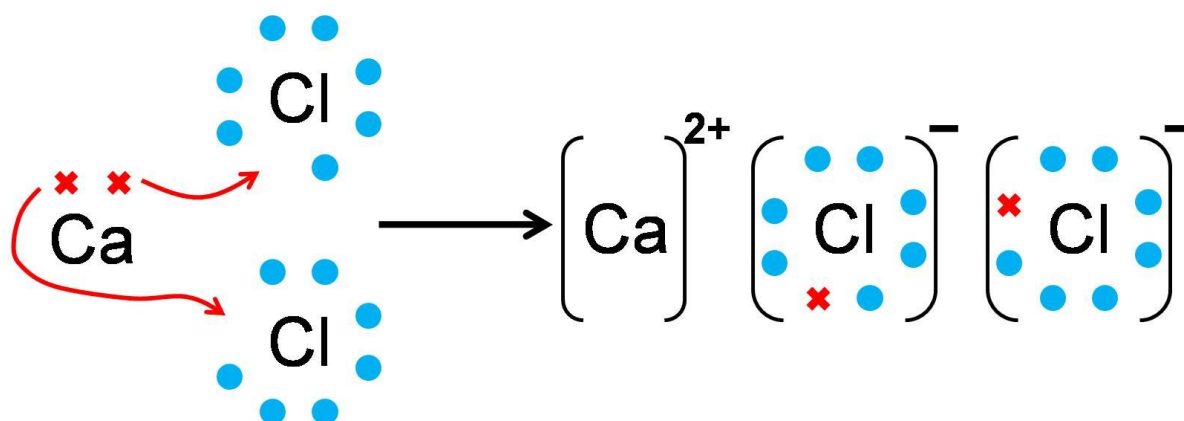
Ionic Bonding

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: (Calcium)	NON- METALS (Chlorine)
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

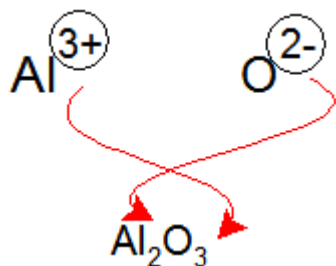
Draw out Atom and Ions for the following ionic compounds (like the calcium chloride diagram above)

- 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.



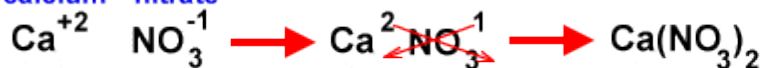
You swap the NUMBERS of the charge over

If a 1 you ignore it

If get 2 numbers the same ignore them

Aluminium Oxide made from Aluminium ions and Oxide ions.

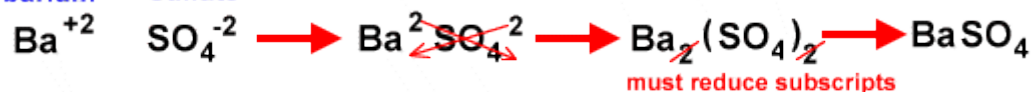
calcium nitrate



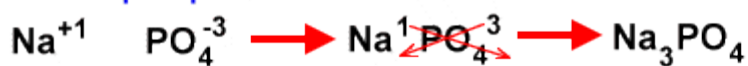
aluminum hydroxide



barium sulfate



sodium phosphate



only use parenthesis with polyatomic ions

potassium sulfate



can't reduce polyatomic formula

Other examples above (don't worry about the writing in red)

Task 3 (Use appendix I)

Using the table of common ions work out the formula of the following ionic compounds.

- 1) Silver chloride
- 2) Lithium sulphate
- 3) Ammonium Hydroxide
- 4) Potassium Dichromate
- 5) Iron (II) Nitrate

Formula interpretation

When we have calculated the formula of a compound it is important we can interpret the information about the number of atoms and types of elements in the compound.

e.g.

Calcium Carbonate

CaCO_3

1 Ca

1 C

3 O

Task 4

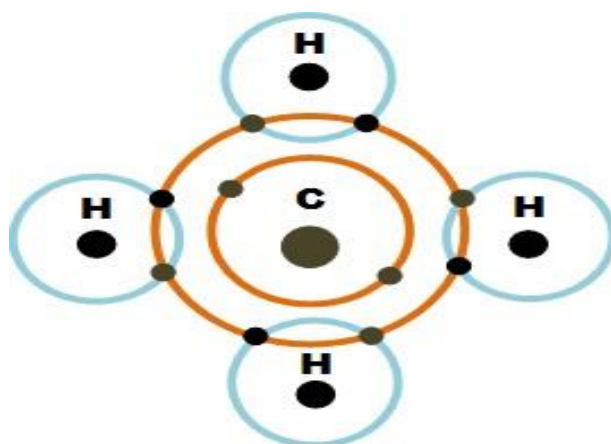
Look at the following compounds and work out the number and type of elements in the compound.

1) AgNO_3

2) PbCO_3

3) SnCl_2

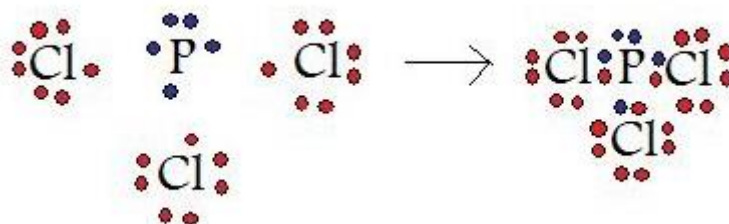
4) Mg(OH)_2



Covalent bonding

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

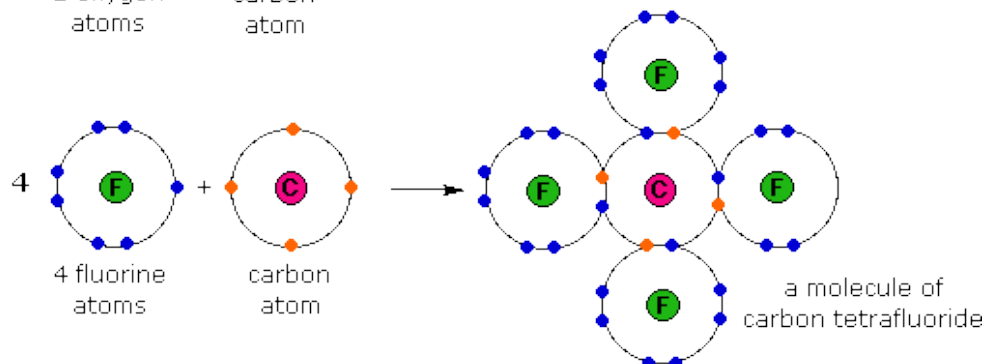
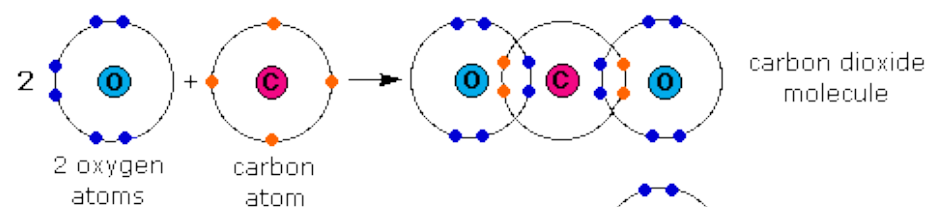
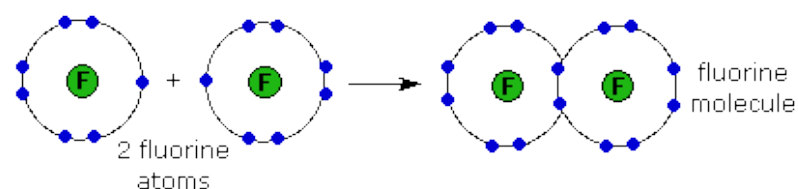
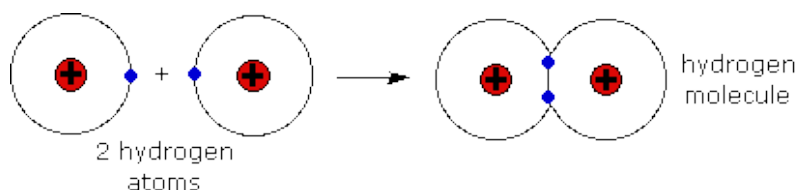
Covalent bonds are made from the atoms sharing their electrons to get a FULL OUTER SHELL.



The above example shows,

Phosphorus in group 5 with 5 outer electrons sharing 1 electron each with a chlorine atom which is in group 7.

Both the Phosphorus and Chlorine NOW have their FULL OUTER SHELL.



More examples

The example shows a series of covalently bonded molecules where the atoms have all got a FULL OUTER SHELL.

Please note

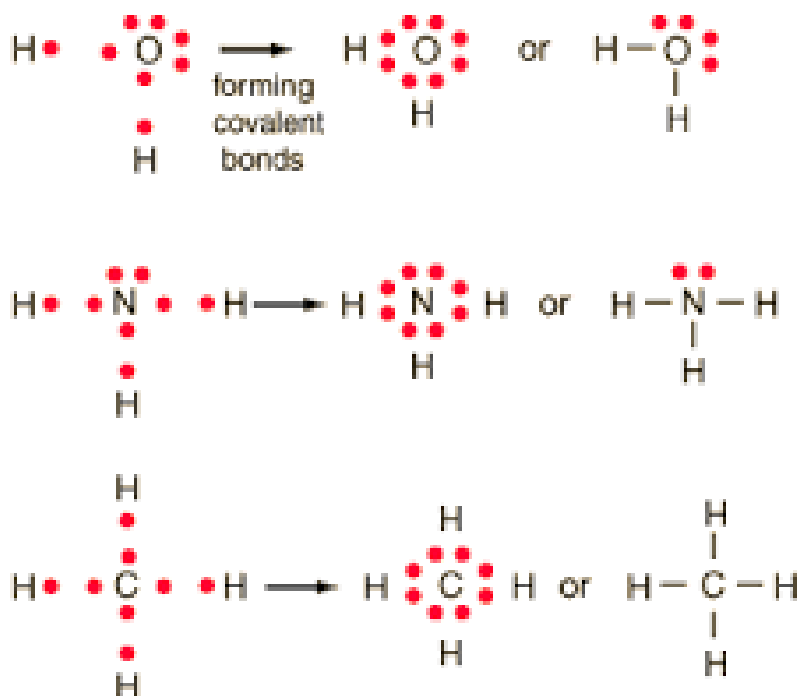
DOUBLE BOND on the CO₂ molecule .

The 4 SINGLE BONDS from the carbon attached to each individual F in the CF₄ molecule.

EXT Line diagrams

These are simpler versions of the shown DOT-CROSS diagrams where you show each bond (PAIR of ELECTRONS) as a line between the atoms in the molecule

e.g.



The extra pair of electrons that are not involved in the bonds are called LONE PAIR of electrons.

These are shown by the pair of 'dots' around the central atom.

Task 5

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

- 1) Ethane C₂H₆
- 2) Propene C₃H₆
- 3) Hydrogen Peroxide H₂O₂
- 4) Hydrogen Sulphide H₂S

Chapter 2

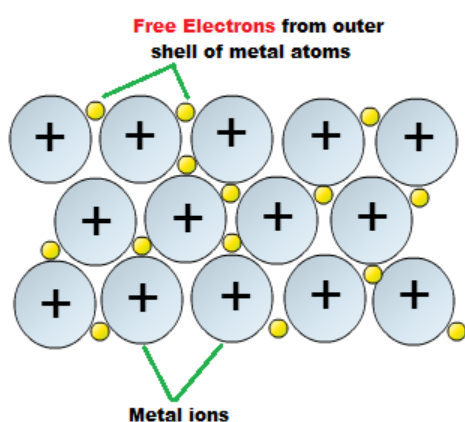
Structure

There are 4 main structures you need to be aware of

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

1) Metallic

This occurs in metals.



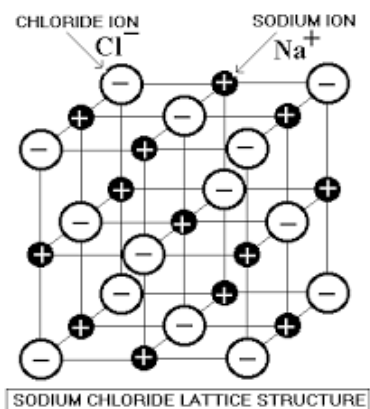
These are strongly bonded structures which have HIGH boiling and melting points.

They CAN conduct electricity due to the FREE ELECTRONS.

2 Giant Ionic

This occurs as a LATTICE of IONS electrostatically attached together with the positive ions being attracted to the negative ions.

It occurs in Ionically bonded compounds.

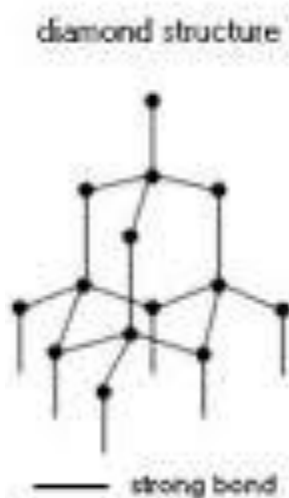


3 Giant covalent / Macromolecular

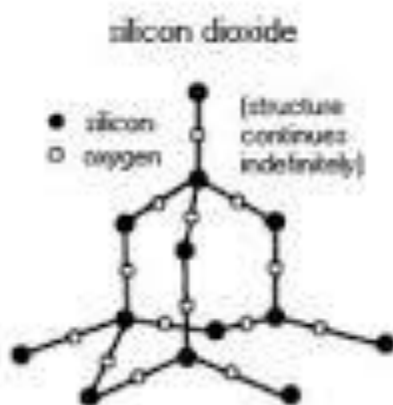
This occurs in a select number of covalently bonded compounds which have ALL their atoms covalently bonded together in a large structure.

Key examples are ALLOTROPES of carbon (look up what Allotrope means!) and silicon dioxide

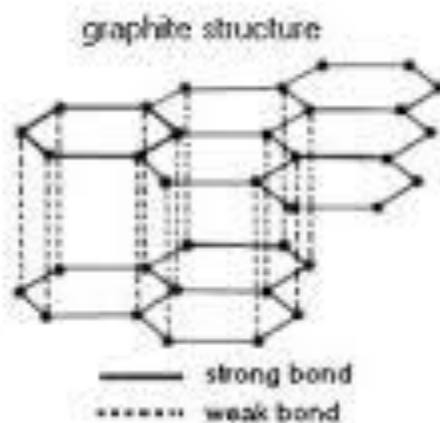
Diamond



Silicon Dioxide

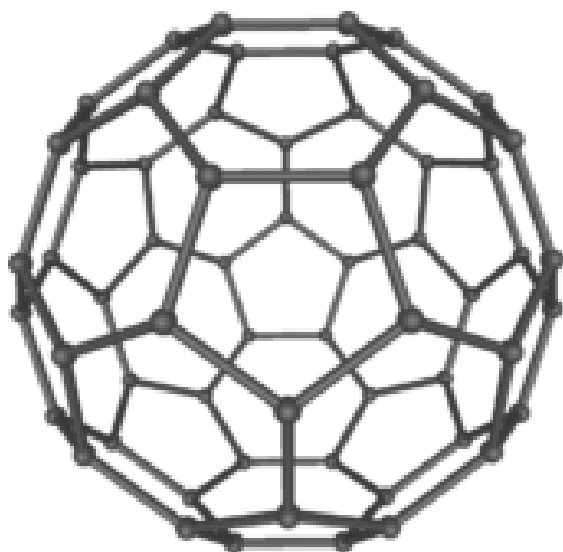


Graphite



EXT

Buckminster Fullerene



This is a C₆₀ molecule in the shape of a football.

They were discovered in the UK in 1985 and the chemists involved won the Nobel prize in 1996.

4) Simple Molecular

This occurs in covalently bonded molecules which have STRONG covalent bonds inside the molecules

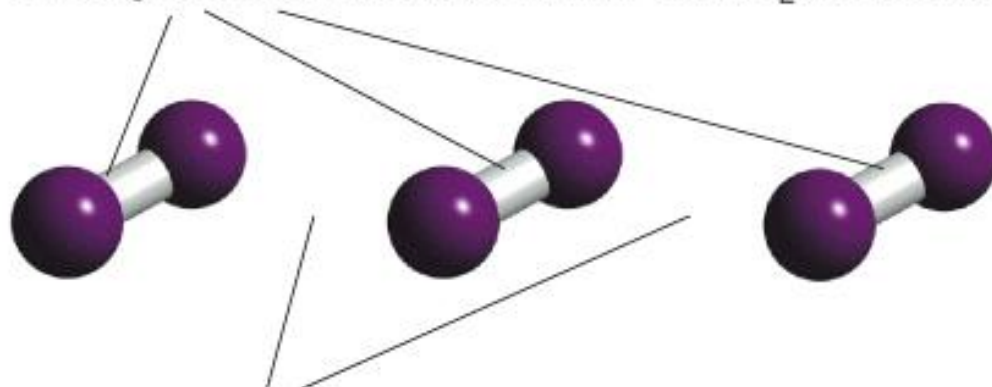
But

Much weaker INTERMOLECULAR bonds between the molecules.

The three types of INTERMOLECULAR bond/ force are:

- Van Der Waals
- Permanent Dipole
- Hydrogen Bond

Strong covalent bonds within each I₂ molecule



Weak van der Waals' forces between I₂ molecules

Task 6

Research task

Find out what the trend in melting/ boiling point is for Na, Mg and Al (the metals in the third period)

Explain why there is this trend (linked to their structure)

<http://www.creative-chemistry.org.uk/alevel/module1/trends8.htm>

(basic source exemplar)

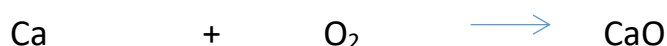
Chapter 3

Equations

We will be most interested in BALANCED symbol equations.

These show us exactly what elements are in the reactants and the products and we need the SAME amount on both sides of the equation.

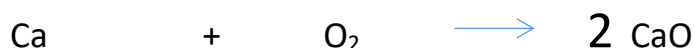
Example



This is not balanced,

So we need to ADD large numbers in front of the formula given to balance it.

Firstly



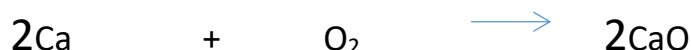
Added a 2 in front to get the right number of oxygen's.

But

This means we know have too many calcium's.

So we now need to add

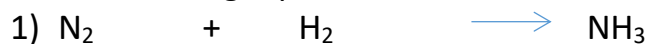
2 on this side as well



It is now a Balanced equation.

Task 7

Balance the following equations:



State symbols

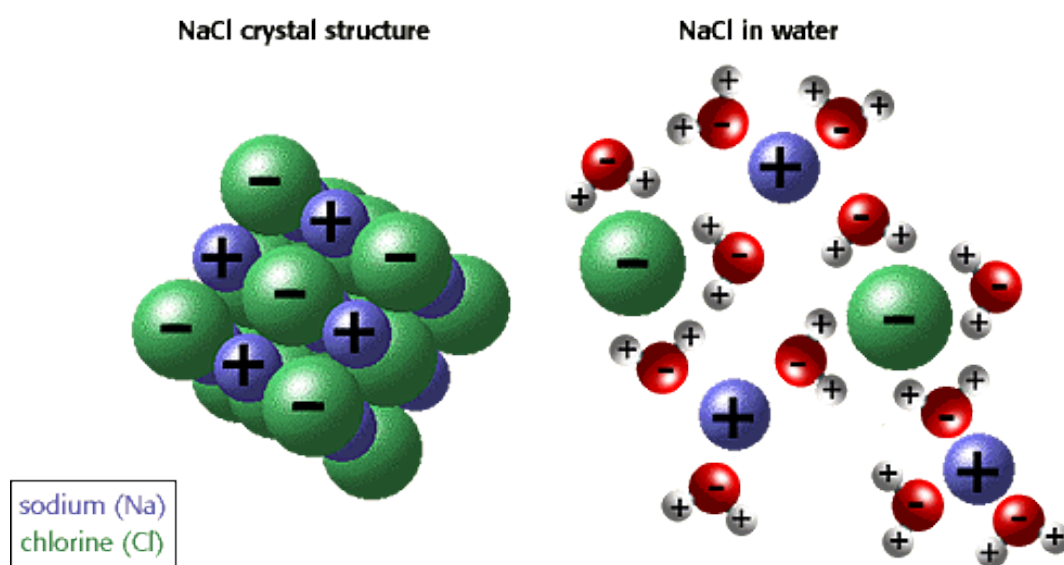
These are linked to the three states of matter

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

Also we have (aq) for a solution.

EXT

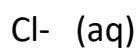
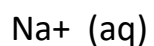
Ionic compounds in solutions

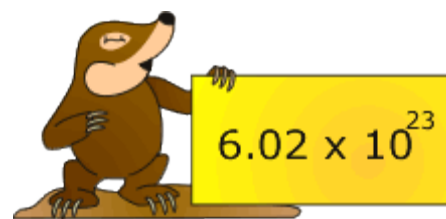


When we dissolve an ionic compound it is the separate ions in the compound being split apart and bonded to the water.



Is in fact





Chapter 4

Mole work.

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} (602000000000000000000000)

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.

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

e.g.

How many moles are there in 24g of carbon?

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

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

$$\text{Moles} = 2 \text{ moles of carbon}$$

Task 8

Calculate the number of moles in the following elements?

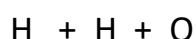
- 1) 59 g of cobalt
- 2) 4.14 g of lead
- 3) 1.08g of gold

This can get increased very quickly to include compounds and not just elements.

In this we use a very similar Mole equation:

$$\text{Moles} = \frac{\text{Mass}}{\text{R.F.M}} \quad \text{This is the Relative formula mass}$$

e.g. H_2O



$$1 + 1 + 16 = 18$$

e.g.

How many moles are there in 88g of carbon dioxide?

$$\begin{aligned} \text{Moles} &= \frac{\text{Mass}}{\text{R.F.M}} && \text{CO}_2 \\ &= \frac{88}{44} && \text{C} + \text{O} + \text{O} \\ &= 2 \text{ mole} && 12 + 16 + 16 = 44 \end{aligned}$$

NOTE- Good practice

It is always good practice to start with the equation in word form then put the numbers in from the questions

It is also good practice to show how you have worked out the RFM so if there is an error you can still get method marks.

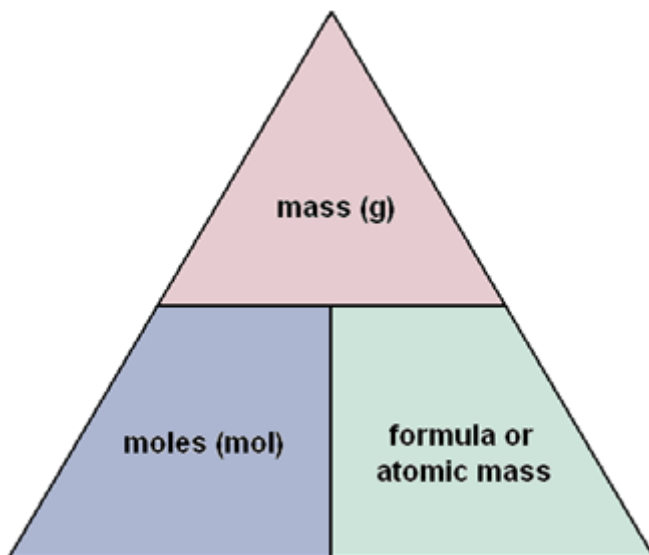
Task 9

How many moles are there in the following:

- 1) 62 g of sodium Oxide Na_2O
- 2) 174 g of lithium bromide LiBr
- 3) 3.2 g of oxygen
- 4) 1.24 g of Ammonia

Changing the equation

We can have this mole equation in a simple MAGIC TRIANGLE and easily change the aspect we are trying to work out.



So we may get asked to calculate the Mass or Relative formula mass.

Task 10

Calculate the :

- 1) Mass of 2 moles of calcium metal
- 2) 0.25 moles of lead carbonate PbCO_3
- 3) The formula mass of a compound which has 0.5 moles of mass 14g

EXT

Harder question

Task 11

250g of hydrated copper sulphate ($\text{CuSO}_4 \cdot x \text{H}_2\text{O}$) is collected and 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 and 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.

$$\text{Moles} = \frac{\text{Molarity / M} \quad \text{ml or cm}^3}{1000} \times \text{Vol}$$

Mol/dm³

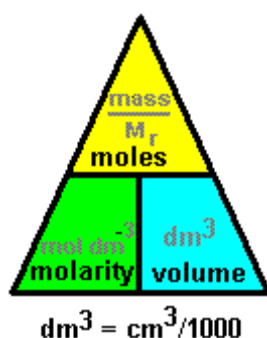
Conc x Vol

e.g.

How many moles are there in 250 cm³ of 0.1 M Hydrochloric acid ?

$$\begin{aligned} \text{Moles} &= \frac{\text{Conc} \times \text{Vol}}{1000} \\ &= \frac{0.1 \times 250}{1000} \\ &= \underline{0.025 \text{ Moles}} \end{aligned}$$

This equation can again be moved around if you have to calculate the concentration using the moles and volume.



Task 12

- 1) Calculate the moles in 40 ml of 5M of sodium hydroxide solution
- 2) What is the concentration when you dissolve 2 moles of acid in 100ml of water
- 3) How many moles are there in 500ml of 0.1 mol/dm³ of salt solution
- 4) What is the concentration of 0.25 moles of alkali in 25 ml

EXT

Combining our work

We often need to combine this work on moles and work out the mass of a solid we need to make up a set concentration of a solution.

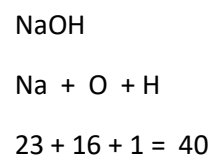
I.e. we want to make 100ml volume of a 0.5 M solution of sodium Hydroxide, how much mass do we need to dissolve?

1) How many moles are in this solution,

$$\begin{aligned}\text{Moles} &= \frac{\text{Conc} \times \text{Vol}}{1000} \\ &= \frac{0.5 \text{ M} \times 100\text{ml}}{1000} \\ &= \underline{0.05} \text{ Moles of sodium hydroxide in solution}\end{aligned}$$

2) What mass do we need for that many moles,

$$\begin{aligned}\text{Mass} &= \text{moles} \times \text{RFM} \\ &= 0.05 \times 40 \\ &= \underline{2 \text{ g}}\end{aligned}$$



So we will need to dissolve 2 g in the 100ml to make the required solution concentration of 0.5M.

Task 13

- 1) How many grams of potassium oxide (K_2O) are needed to make 100ml of a 0.5M solution ?
- 2) What is the concentration of a solution when we dissolve 730g of hydrochloric acid in 350 cm^3 ?
- 3) What is the mass of calcium oxide, CaO needed to make a 250 ml volume of 0.5 M solution?

NOTE- HINT

Keep looking carefully at the units

ml = cm^3 for volume

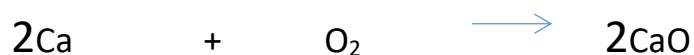
mol/dm^3 = Molarity = M for concentration

Molar Ratio

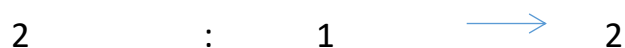
This is the link between the balanced symbol equations and the amount of moles of each substance in the reaction.

Simply it is the ratio of the numbers in front of the compounds in the balanced symbol equation.

e.g.



In this equation the Molar ratio is:

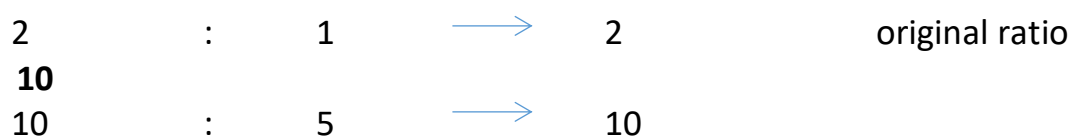


Means:

2 moles of calcium will react with 1 mole of oxygen and we will make 2 moles of the calcium oxide.

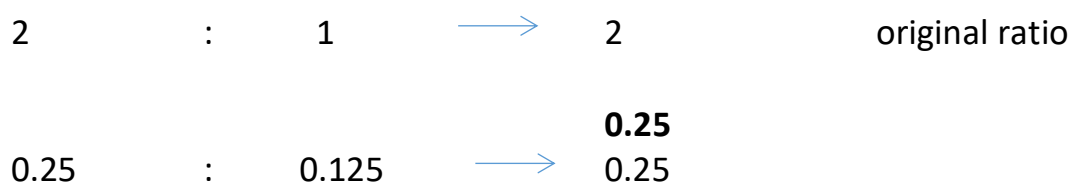
As it is a ratio these numbers can be varied,

So if we actually had **10** moles of the calcium?



So 10 moles of the calcium would react with 5 moles of the oxygen and form 10 moles of the calcium oxide

Or if we wanted to make **0.25** moles of the calcium oxide



We would need 0.25 moles of the CaO

Final mole equation work

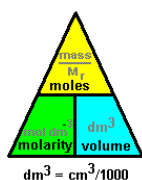
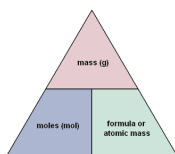
We are often asked to calculate how much we will produce in a reaction from a certain starting amount of reactants, or how much reactants we will need to make a set amount of products.

We put together the :

- Molar ratio work with the balanced equation
- The different moles equations

NOTE

If it involves a SOLID it is ...



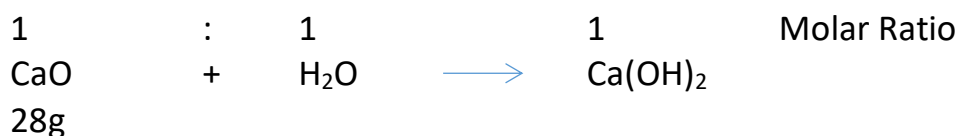
If it involves a solution it is ..

e.g.

Calcium oxide reacts with water to form calcium hydroxide.

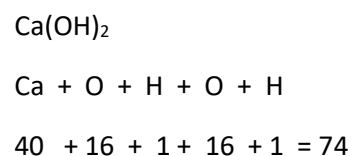


If I started with 28g of the calcium oxide what mass of calcium hydroxide would I make, and if it was in 100ml of water what would its concentration be



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

$$\begin{aligned} &= \frac{28}{56} \\ &= 0.5 \text{ moles} \end{aligned}$$



$$\begin{aligned} \text{Mass} &= \text{Moles} \times \text{RFM} \\ &= 0.5 \times 74 \\ &= \underline{37\text{g}} \end{aligned}$$

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 14

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



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



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



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

- Number of moles of iron started with?
 - Moles of tri Iron oxide formed
 - Mass of tri iron oxide formed
 - The concentration of this solution if we had 500ml of water in the reaction?
- 4) 25 ml of 0.1 M HCl reacts with 50ml of NaOH solution fully
What is the concentration of the NaOH solution.



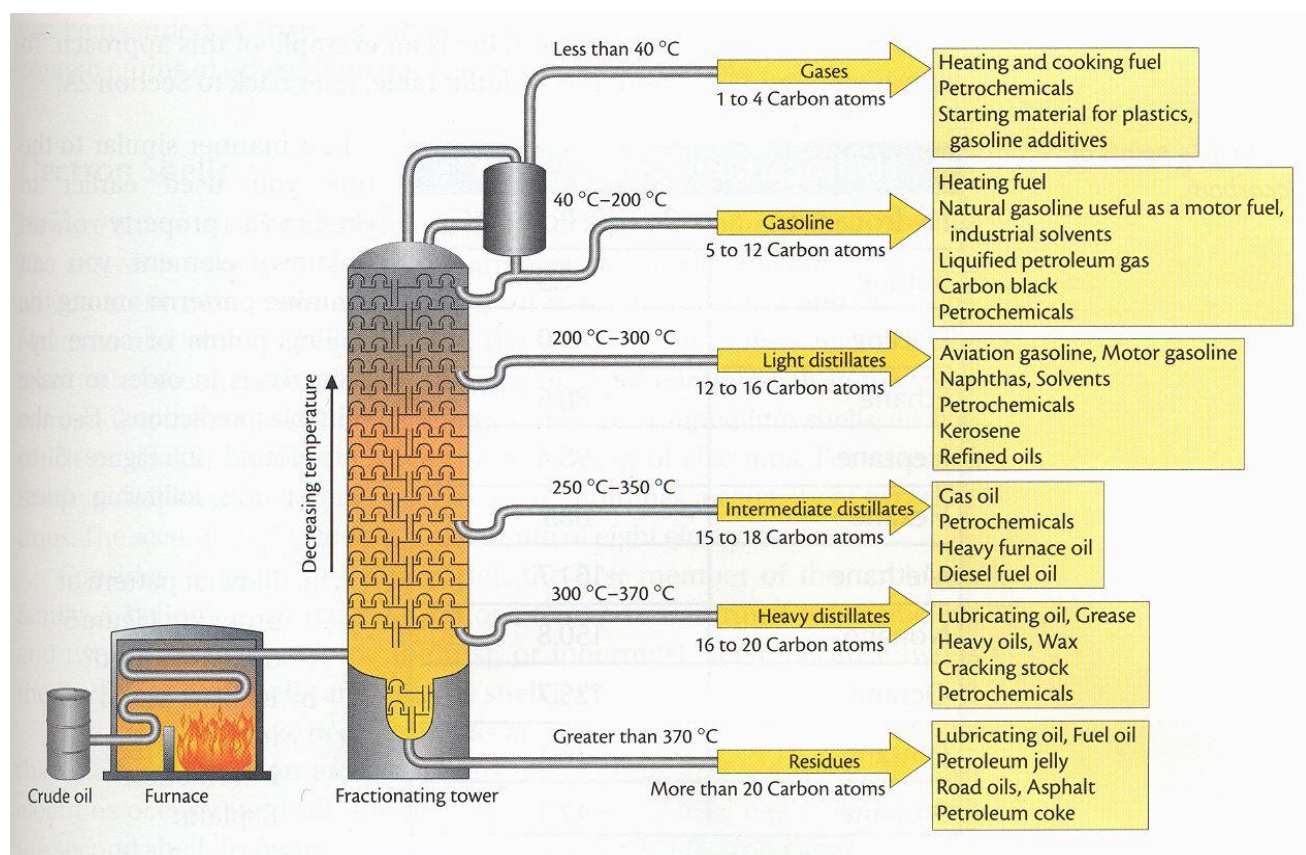
Chapter 5

Organic chemistry

This is a branch of chemistry that looks at compounds of carbon chained molecules.

The main source of these compounds is CRUDE OIL.

We FRACTIONALLY DISTILL this to separate it out into different FRACTIONS which have similar boiling points, size and properties.



Task 15

Imagine you are a small CH_4 molecule in crude oil and you are being fractionally distilled,

What happened to you?

Why?

What happens to other molecules at the same time?

Why?

USE correct technical language to explain what's going on.

Types of organic compound

There are lots of different types of organic compound which are based upon their FUNCTIONAL GROUPS or parts of the compound which determine how they react.

TABLE 25.4 Common Functional Groups in Organic Compounds

Functional Group	Type of Compound	Suffix or Prefix	Example	Systematic Name (common name)
	Alkene	<i>ene</i>		Ethene (Ethylene)
	Alkyne	<i>-yne</i>		Ethyne (Acetylene)
	Alcohol	<i>-ol</i>		Methanol (Methyl alcohol)
	Ether	<i>ether</i>		Dimethyl ether
	Haloalkane	<i>halo-</i>		Chloromethane (Methyl chloride)
<small>(X = halogen)</small>				
	Amine	<i>-amine</i>		Ethylamine
	Aldehyde	<i>-al</i>		Ethanal (Acetaldehyde)
	Ketone	<i>-one</i>		Propanone (Acetone)
	Carboxylic acid	<i>-oic acid</i>		Ethanoic acid (Acetic acid)
	Ester	<i>-oate</i>		Methyl ethanoate (Methyl acetate)
	Amide	<i>-amide</i>		Ethanamide (Acetamide)

The table shows the most common functional groups with examples and naming ideas.

Another aspect of organic compounds is the SERIES (called HOMOLOGOUS SERIES) you have of compounds which all have the same functional group. These all increase by $-\text{CH}_2-$ each time and have a common pattern of naming linked to the number of carbons in the compound.

Name	Molecular formula	Full structural formula
Methane	CH_4	$\begin{array}{c} \text{H} \\ \\ \text{H} - \text{C} - \text{H} \\ \\ \text{H} \end{array}$
Ethane	C_2H_6	$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H} - \text{C} - \text{C} - \text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$
Propane	C_3H_8	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \\ \text{H} - \text{C} - \text{C} - \text{C} - \text{H} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array}$
Butane	C_4H_{10}	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \quad \\ \text{H} - \text{C} - \text{C} - \text{C} - \text{C} - \text{H} \\ \quad \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \end{array}$

Task 16

Research

What are the FIRST 10 stem names for organic compounds using alcohols as an example write out the molecular formula for the first 10, draw out the full structural/ displayed formula for the first 10 and names then as well.

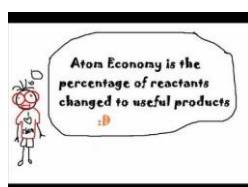
(HINT complete a table like one above but for the first 10 alcohols!)

Chapter 6

Calculations on efficiency of reactions.

There are two main methods that are used to look over the efficiency of chemical reactions.

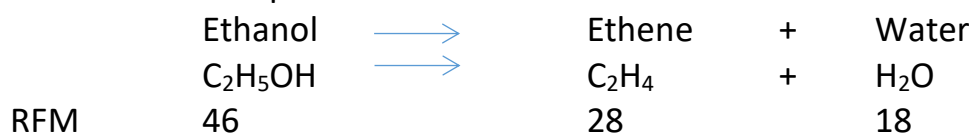
1) Atom economy



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

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

Ethanol is decomposed into useful ethane and waste water.



$$\begin{aligned}\text{Atom economy} &= \frac{\text{mass of useful product}}{\text{mass of all reactants}} \times 100 \\ &= \frac{28}{46} \times 100 \\ &= \underline{\underline{60.9\%}}\end{aligned}$$

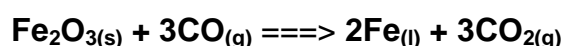
Task 17

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



- 2) In the blast furnace where we form Iron .



2) Percentage yield

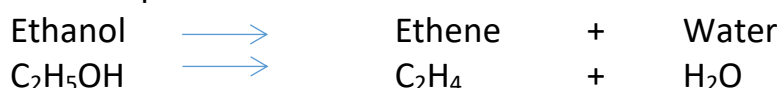
This is the second method we use to calculate the efficiency of the reaction. This gives an idea of what is actually formed in reality as compared to what we would expect to be formed.

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

NOTE

You are often given the actual amount you form BUT you have to work out the theoretical amount from a mole calculation.

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



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

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

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

$$= 0.1 \text{ moles}$$

$$\begin{aligned} 0.1 \text{ moles} & : & 0.1 \text{ moles} \\ \text{Mass} = \text{Moles} \times \text{RFM} & & \\ = 0.1 \times 28 & & \\ = 2.8 \text{ g} & & \end{aligned}$$

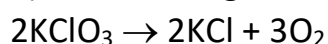
This is the theoretical yield amount

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

$$\begin{aligned} \text{Final calc} \quad \text{percentage yield} & = \frac{\text{Actual}}{\text{Theoretical}} \times 100 \\ & = \frac{1.4}{2.8} \times 100 \\ & = \underline{50\%} \end{aligned}$$

Task 18

1) When 5.00 g of KClO₃ is heated it decomposes according to the equation:

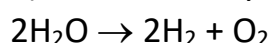


a) Calculate the theoretical yield of oxygen.

b) Give the % yield if 1.78 g of O₂ is produced.

c) How much O₂ would be produced if the percentage yield was 78.5%?

2) The electrolysis of water forms H₂ and O₂.



What is the % yield of O₂ if 12.3 g of O₂ is produced from the decomposition of 14.0 g H₂O?

Appendix I
Common ions

Positive Ions (cations)		Negative Ions (anions)	
Name	Formula	Name	Formula
Hydrogen	H ⁺	Chloride	Cl ⁻
Sodium	Na ⁺	Bromide	Br ⁻
Silver	Ag ⁺	Fluoride	F ⁻
Potassium	K ⁺	Iodide	I ⁻
Lithium	Li ⁺	Hydroxide	OH ⁻
Ammonium	NH ₄ ⁺	Nitrate	NO ₃ ⁻
Barium	Ba ²⁺	Oxide	O ²⁻
Calcium	Ca ²⁺	Sulphide	S ²⁻
Copper(II)	Cu ²⁺	Sulphate	SO ₄ ²⁻
Magnesium	Mg ²⁺	Carbonate	CO ₃ ²⁻
Zinc	Zn ²⁺	Hydrogencarbonate	
Lead	Pb ²⁺		HCO ₃ ⁻
Iron(II)	Fe ²⁺		
Iron(III)	Fe ³⁺		
Aluminium	Al ³⁺		

Appendix II

The Periodic Table of the Elements

3 — Atomic Number
 — Element Symbol
 — Element Name
 — Average Atomic Mass

1 H Hydrogen 1.01	2 He Helium 4.00																																																																																																																		
3 Li Lithium 6.94	4 Be Beryllium 9.01	5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 18.00	10 Ne Neon 20.18	11 Na Sodium 22.99	12 Mg Magnesium 24.31	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95	19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.39	31 Ga Gallium 69.72	32 Ge Germanium 72.61	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80	37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.60	53 I Iodine 126.90	54 Xe Xenon 131.29	55 Cs Cesium 132.91	56 Ba Barium 137.33	57 La Lanthanum 138.91	58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.97	72 Fr Francium (223)	73 Ra Radium (226)	74 Ac Actinium (227)	75 Rf Rutherfordium 178.49	76 Db Dubnium (262)	77 Sg Seaborgium (266)	78 Bh Bohrium (264)	79 Hs Hassium (269)	80 Mt Meitnerium (268)	81 Ds Darmstadtium (281)	82 Rg Roentgenium (272)	83 Cn Copernicium (285)	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)	87 U Uranium 238.03	88 Th Thorium 232.04	89 Pa Protactinium 231.04	90 Ce Cerium 140.12	91 Pr Praseodymium 140.91	92 Nd Neodymium 144.24	93 Pm Promethium (145)	94 Sm Samarium 150.36	95 Eu Europium 151.96	96 Gd Gadolinium 157.25	97 Tb Terbium 158.93	98 Dy Dysprosium 162.50	99 Ho Holmium 164.93	100 Er Erbium 167.26	101 Tm Thulium 168.93	102 No Nobelium (259)	103 Lr Lawrencium (262)	104 Cf Californium (251)	105 Bk Berkelium (247)	106 Cf Californium (251)	107 Es Einsteinium (252)	108 Fm Fermium (257)	109 Md Mendelevium 168.93	110 Cf Californium (251)	111 Es Einsteinium (252)	112 Cn Copernicium (285)	113 Nh Nihonium (284)	114 Fl Flerovium (289)	115 Mc Moscovium (288)	116 Lv Livermorium (293)	117 Ts Tennessine (294)	118 Og Oganesson (294)

Periods are Horizontal across the table

Groups are vertical down the table

Group1 –Alkali metals 7 Halogens 8 Nobel Gases