



# CHEMISTRY



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*This booklet reviews the work that you did at GCSE. The work in this booklet is the starting point for your A level Chemistry studies and gives you a small taste of what Chemistry is like at A level and if it is right for you. If you are having difficulty with it please get in touch.*

## **Week 1 - The Language of Chemistry: Symbols, names and formulae**

Use the Periodic table datasheet towards the back of this booklet to help you answer the questions:

### Symbols of the elements

Each of the 90+ chemical elements has its own symbol. The symbol of an element consists either of a single capital letter or a capital letter followed by a small letter. Since there are only 26 letters in the alphabet, not all elements can have a single letter symbol.

Typical examples are:

carbon	hydrogen
aluminium	zinc
nitrogen	sulphur
magnesium	chlorine
oxygen	iodine
calcium	bromine

The reasons for these elements having the symbols listed are obvious. The symbol is either just the first letter of its name or the first letter with either the second or third letter in its name. However, how can we explain the following symbols? They seem to have very little in common with the name of the element.

iron = Fe  
copper = Cu  
sodium = Na  
potassium = K  
silver = Ag

### Writing formula and nomenclature

#### Common formulae of molecules and ions

All elements want to be like the noble/inert gases i.e. have a full outer shell and they do this by either sharing electrons (covalent bonding) or transferring electrons (ionic bonding).

## Week 1 continued

There are eight non-metals that covalently bond to themselves in diatomic (2 atom) molecules to get a full outer shell. Use your periodic table and the internet to identify them and write their formulae below, fluorine has been done for you:

$F_2$							
-------	--	--	--	--	--	--	--

Common ions: Metals lose electrons and non-metals gain electrons to form ions with full outer shells. Identify the charges on each of the groups.

Simple Non-metal ions change their name so it ends in -ide, e.g. Chloride, Bromide, Oxide, Nitride

	Ion charge	examples
Group 1 metals	+1	Li+, Na+, K+, Rb+, Cs+
Group 2 metals		
Group 3 metals		
Group 5 non-metals		
Group 6 non-metals		
Group 7 non-metals		

Extension task: Why is group 4 not on this list?

Complex ions: you are expected to learn & remember the formulae of some complex ions, research the names of the following:

Complex ion formulae	name
$OH^-$	
$NH_4^+$	
$NO_3^-$	
$CO_3^{2-}$	
$SO_4^{2-}$	
$PO_4^{3-}$	

Note: Apart from  $OH^-$ , Non-metal complex ions containing oxygen end their names in -ate, this represents the oxygen

Extension:

$ClO^-$	
$HCO_3^-$	

## ***Week 1 continued***

### Naming Ionic (inorganic) compounds

When a metal reacts with another element which is normally a non-metal (e.g. sodium and oxygen) they form an ionic compound. The name of this compound must tell you the elements that are present in it. In this case, the name of the compound is sodium oxide because we always write the metal (or other positive ion) first, followed by the non-metal (or negative ion). In this case the name of the compound must start with the metal as normal, then the non-metal ending in -ide. Examples: Silver chloride is a compound containing silver and chlorine only. MgO is a compound of magnesium and oxygen called magnesium oxide.

Name the following compounds:

- The compound formed between calcium and oxygen
- The compound formed between sodium and sulphur
- The compound formed between iron and chlorine
- The compound with the formula MgS
- The compound with the formula AlN
- The compound with the formula KBr
- The compound with the formula AgCl

Extension:

*Name the following ionic compounds:*

- 1) NaBr \_\_\_\_\_
- 2) Sc(OH)<sub>3</sub> \_\_\_\_\_
- 3) V<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub> \_\_\_\_\_
- 4) NH<sub>4</sub>F \_\_\_\_\_
- 5) CaCO<sub>3</sub> \_\_\_\_\_
- 6) NiPO<sub>4</sub> \_\_\_\_\_
- 7) Li<sub>2</sub>SO<sub>3</sub> \_\_\_\_\_
- 8) Zn<sub>3</sub>P<sub>2</sub> \_\_\_\_\_

## Week 1 continued

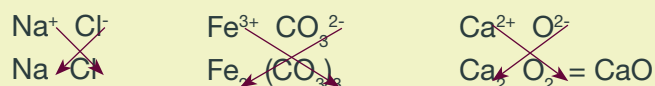
Working out chemical formulae

It is possible to work out the formula of a compound by using the 'swap and drop' method

1. Write down the ions in the compound (see previous page)

For	sodium chloride	iron(III) carbonate	calcium oxide
example:	$\text{Na}^+ \text{Cl}^-$	$\text{Fe}^{3+} \text{CO}_3^{2-}$	$\text{Ca}^{2+} \text{O}^{2-}$

2. Swap the ionic charge number and drop them to the baseline (for ions with more than one element use brackets)



Remember: numbers can cancel down to their lowest ratio.

Write the formulas for the following ionic compounds:

calcium bromide \_\_\_\_\_

sodium hydride \_\_\_\_\_

beryllium hydroxide \_\_\_\_\_

ammonium oxide \_\_\_\_\_

potassium hydroxide \_\_\_\_\_

strontium nitride \_\_\_\_\_

ammonium sulfate \_\_\_\_\_

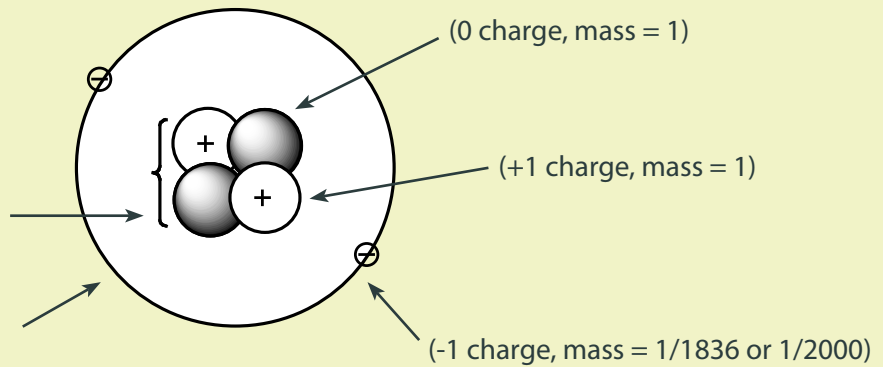
calcium sulfide \_\_\_\_\_

## Week 2 - Atomic structure and relative mass

There are over 100 known elements in the universe. Elements are made up of millions of tiny particles called atoms. Each element only contains one type of atom.

Use the following description to label the diagram of a helium atom ( ${}^4_2\text{He}$ ) & fill in the table.

An atom is made up of a central nucleus which is orbited by electrons which move around their electron shell. The nucleus contains a mixture of positively charged protons and neutral neutrons.

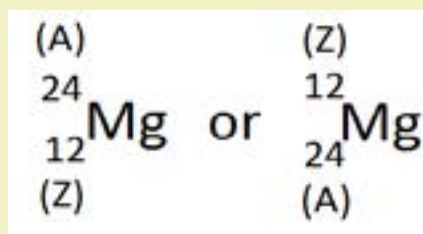


These particles cannot be weighed, so we use a relative scale (how their mass compares to each other)

Particle in atom	Relative Mass	Relative Charge
Proton		
Neutron		
Electron		

## Atomic number and mass number

Fill in the gaps & complete the table



Definitions

(A) Mass number = number of p \_\_\_\_\_ and n \_\_\_\_\_  
(or nucleon number)

(Z) Atomic number = number of \_\_\_\_\_ (or proton number)  
(equivalent to number of electrons in a neutral atom).

So the number of neutrons = mass number – proton number = A-Z

Which way round are they?

It varies, but remember: the mass number (A) will always be bigger than the atomic number (Z)

## Week 2 continued

### Exercise

Refer to the Periodic Table on the data sheet. Complete the following table.

Hint: ions of an element have the same number of protons & neutrons as atoms, but more or less electrons depending on the charge. Positive ions have lost electrons and negative ions have gained electrons.

Particle name	Mass number A	Atomic number Z	Number of protons	Number of neutrons	Number of electrons
fluorine atom					
helium atom					
phosphorus atom					
sodium ion Na <sup>+</sup>					
chromium (II) ion Cr <sup>2+</sup>					
fluoride ion F <sup>-</sup>					
oxygen ion O <sup>2-</sup>					
scandium (II) ion Sc <sup>2+</sup>					
phosphide ion P <sup>3-</sup>					

### Isotopes

Some elements can exist in different forms called isotopes they have the same chemical reactions, but slightly different physical properties such as density. Some isotopes (U and Pu) are unstable and can fall apart (nuclear decay), they are often used in nuclear power station or bombs! Use the datasheet to help

Symbol	Element name	Number of protons	Number of electrons	Number of neutrons
<sup>1</sup> H				
<sup>2</sup> H				
<sup>3</sup> H				
<sup>238</sup> U				
<sup>235</sup> U				
<sup>244</sup> Pu				
<sup>239</sup> Pu				

you fill in the table.

Use your data from the table, to come up with a definition of an isotope:

*Isotopes are...*

Ext: Why does the mass number of an isotope differ from the Relative atomic mass of an element?

## Calculating the Relative atomic mass of an element

Relative atomic mass (RAM or Ar) Definition:

The weighted mean mass of an atom of an element relative to 1/12th of carbon-12

This wordy definition can be broken down into:

1/12th of carbon-12 – you would think that it would be compared to a Hydrogen atom as this has an Ar = 1 atomic mass unit (only 1 proton), however hydrogen is a gas and so is difficult to weigh, Carbon is the simplest atom which is solid at room temp and 1/12th of carbon also = 1 atomic mass unit, so carbon is used.

weighted mean mass of an atom – this basically means the Ar is an average of mass of an elements isotopes, however it will not be a 50/50 mixture of isotopes, so this average is 'weighted' to take into account the percentage of each isotope.

For this reason we use the following calculation to work out the Ar:

$$\begin{array}{r} \text{Relative} \\ \text{atomic mass} \\ (\text{Ar}) = \end{array} \begin{array}{l} \textit{Isotope 1} \\ \textit{Isotope 2} \\ \textit{Isotope 3 etc...} \end{array} \frac{(\text{mass number} \times \% \text{ abundance}) + (\text{mass number} \times \% \text{ abundance}) + \dots}{100}$$

Calculations (Don't forget to use BIDMAS!)

1. The antimony in a bullet was analysed by a forensic scientist to help solve a crime. The antimony was found to have the following percentage composition by mass:  $^{121}\text{Sb}$ , 57.21%;  $^{123}\text{Sb}$ , 42.79%. Calculate a value for the relative atomic mass of the antimony. Give your answer to 4 significant figures.

2. A sample of indium contains 4.23% of  $^{113}\text{In}$  and 95.77%  $^{115}\text{In}$ . Calculate the relative atomic mass of the indium sample. Give your answer to one decimal place.

3. The sample of sulphur had the following percentage composition by mass:  $^{32}\text{S}$ , 94.93%;  $^{33}\text{S}$ , 0.76%;  $^{34}\text{S}$ , 4.29%;  $^{36}\text{S}$ , 0.02%. Calculate the relative atomic mass of the sample of sulphur. Give your answer to four significant figures.

Extension: Chlorine has an Ar of 35.5. It has 2 isotopes,  $^{35}\text{Cl}$  has an abundance of 75%. What is the mass of the other isotope?



## Week 3 - Basic chemical calculations & balancing equations

Relative formula mass, molecular mass and Molar mass

Not all chemicals weigh the same as each other. We can use the mass number of each element present to work out the relative mass of a compound, its (Mr).

For an ionic compound (compound of metal and non-metal) this is known as its Relative formula mass.

For a covalent compound (compound of non-metal only) this is known as its Relative molecular mass.

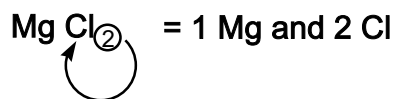
And it is also known as the Molar mass of compound when measured in grams per mole ( $\text{g mol}^{-1}$ )

Question: Find the Molar mass (Mr) of magnesium chloride,  $\text{MgCl}_2$

Step 1 - use the formula to work out the ratio of Mg atoms to Cl atoms

Step 2 - Find the mass numbers of Mg & Cl on the Periodic Table.

Step 3 - For each element, multiply the mass number by number of atoms. Then add them all together.



$$\text{Mg} = 24.3 \quad \text{Cl} = 35.5$$

$$1 \text{ Mg} + 2 \times \text{Cl} = 24.3 + (2 \times 35.5) = 95.3 \text{ g mol}^{-1}$$

Remember: If there are brackets, times everything inside the bracket by the number outside

eg.  $\text{Mg}(\text{OH})_2 = 1 \times \text{Mg}, 2 \times \text{O}$  and  $2 \times \text{H}$

### Percentage (%) Mass

To calculate the percentage of an element in a compound we need to know the Relative atomic mass (Ar) of the element and the Relative formula mass (Mr) of the compound. We then use the following formula:

$$\text{percentage mass of an element in a compound} = \frac{\text{Ar} \times \text{number of atoms (of that element)} \times 100}{\text{Mr (of whole compound)}}$$

eg. What is the percentage mass of oxygen in carbon dioxide.

1. Find the Ar and Mr's
2. Find the % mass of oxygen

Ar of oxygen = 16, Mr of carbon dioxide ( $\text{CO}_2$ ) =  $12 + (16 \times 2) = 44$ .

$$= \frac{\text{Ar of O} \times \text{number of O atoms} \times 100}{\text{Mr of CO}_2}$$

$$= \frac{\text{O}_2 \times 100}{\text{CO}_2} = \frac{16 \times 2}{44} \times 100 = 72.7\%$$

Calculate the %age masses for the elements in the following compounds (show your working out).

1. carbon in cocaine,  $\text{C}_{17}\text{H}_{21}\text{NO}_4$

2. hydrogen in adrenaline,  $\text{C}_9\text{H}_{13}\text{NO}_3$



## Week 3 continued

3. oxygen in antifreeze, HOCH<sub>2</sub>CH<sub>2</sub>OH

4. nitrogen in viagra, C<sub>28</sub>H<sub>38</sub>N<sub>6</sub>O<sub>11</sub>S

## Symbol equations

Balancing and interpreting chemical symbol equations is essential if you want to progress in Chemistry. State symbols tell you physical state of each substance involved (fill in the blanks):

Answers:            solution                    gas                    solid                    liquid

(s) = \_\_\_\_\_ (l) = \_\_\_\_\_ (g) = \_\_\_\_\_ (aq) = \_\_\_\_\_

Atoms are not destroyed, so whatever atoms are in your reactants, must also be in your products, the only difference is they have been rearranged!!!!

Reactants	→	Products
Number & type of atoms	=	Number & type of atoms (different arrangement)

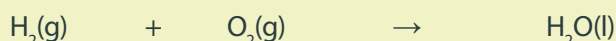
Substances have their own unique formula which cannot be changed eg. Water is H<sub>2</sub>O, however you can change the number of water molecules present by putting a number in front

ie. 2 H<sub>2</sub>O = 2 H<sub>2</sub>O molecules = 4 H & 2 O atoms.

Balancing an equation (forming water)

hydrogen + oxygen → water

The formulae of the chemicals are below (they cannot be changed).

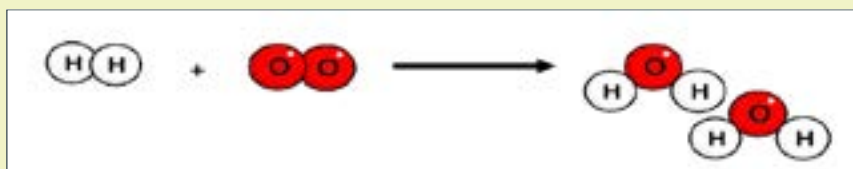
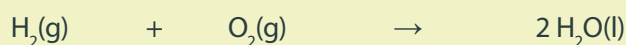


2 hydrogen atoms

2 oxygen atoms

2 hydrogen & 1 oxygen atoms

In this equation, hydrogen is balanced, oxygen is not balanced. Oxygen can be balanced by doubling the number of water molecules by placing a '2' in front of H<sub>2</sub>O.

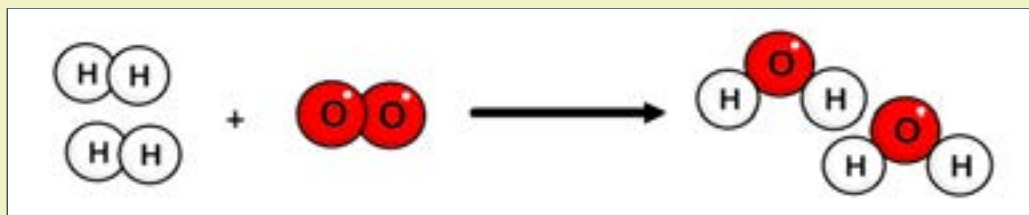
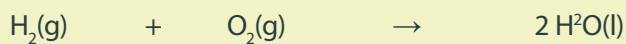


2 hydrogen atoms

2 oxygen atoms

4 hydrogen & 2 oxygen atoms

However, this unbalances hydrogen, it can be re-balanced by doubling the number of H<sub>2</sub> molecules by placing a '2' in front of H<sub>2</sub>. The equation is now balanced:



4 hydrogen atoms

2 oxygen atoms

4 hydrogen & 2 oxygen atoms

Note: when balancing an equation you are allowed to use fractions, as the equation is actually referring to moles of a substance (this will be explained in detail to you) rather than molecules.

How far can you get? Balance as many of the following equations in half an hour:

#### Reactions of acids:

1.  $\text{HCl} + \text{CaO} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O}$
2.  $\text{H}_2\text{SO}_4 + \text{NH}_3 \rightarrow (\text{NH}_4)_2\text{SO}_4$
3.  $\text{H}_2\text{SO}_4 + \text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O}$
4.  $\text{HNO}_3 + \text{CaCO}_3 \rightarrow \text{Ca}(\text{NO}_3)_2 + \text{CO}_2 + \text{H}_2\text{O}$
5.  $\text{H}_2\text{SO}_4 + \text{Na}_2\text{CO}_3 \rightarrow \text{Na}_2\text{SO}_4 + \text{CO}_2 + \text{H}_2\text{O}$
6.  $\text{H}_2\text{SO}_4 + \text{NaHCO}_3 \rightarrow \text{Na}_2\text{SO}_4 + \text{CO}_2 + \text{H}_2\text{O}$
7.  $\text{H}_3\text{PO}_4 + \text{Na}_2\text{CO}_3 \rightarrow \text{Na}_3\text{PO}_4 + \text{CO}_2 + \text{H}_2\text{O}$
8.  $\text{H}_3\text{PO}_4 + \text{MgCO}_3 \rightarrow \text{Mg}_2(\text{PO}_4)_3 + \text{CO}_2 + \text{H}_2\text{O}$

#### Combustion equations:

1.  $\text{CH}_4 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
2.  $\text{C}_2\text{H}_4 + \text{O}_2 \rightarrow \text{CO} + \text{H}_2\text{O}$
3.  $\text{C}_3\text{H}_8 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$

## Week 4 – Covalent bonding and basic organic chemistry

### Covalent bonding

Elements bond to become more stable. They usually do this by gaining a full outer shell of electrons. Covalent bonding is one way in which atoms can achieve a full outer shell – generally it occurs between non-metals.

- A covalent bond is when a pair of electrons is shared between two atoms. This produces a molecule.

Covalent bonding can occur between atoms of the same element (see hydrogen below) or atoms of different elements, for example in carbon dioxide ( $\text{CO}_2$  – see later)

### Drawing molecules with covalent bonding

When drawing molecules you need only show the atom's outer electrons. As you know this is easy to remember as the number is generally the same as the elements group number.

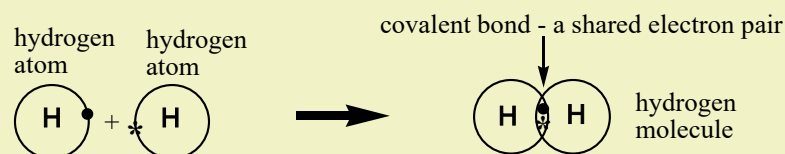
- We can use dot/cross diagrams – dots & crosses represent the electrons from the different atoms.

Tip: Whatever number of electrons an atom needs to get a full outer shell should be put into the overlap region by that atom, eg In a  $\text{H}_2$  molecule each H atom needs 1 electron to get a full shell, so each atom puts 1 electron into the overlap region (see below).

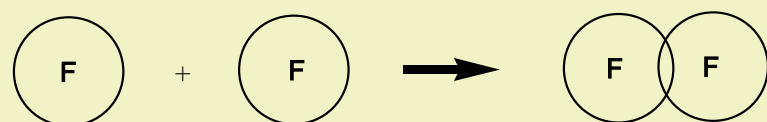
Remember: it is possible to get double and triple covalent bonds as well as single bonds.

Complete the diagrams:

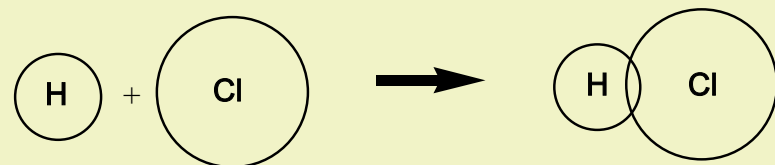
Hydrogen atom + Hydrogen atom → hydrogen molecule ( $\text{H}_2$ )



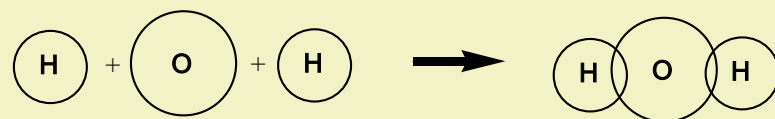
fluorine (Group 7) + fluorine (Group 7)



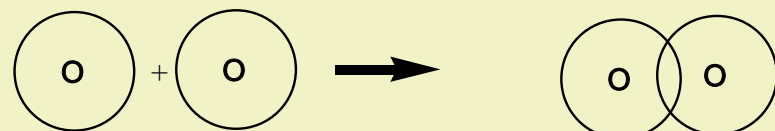
Hydrogen atom + chlorine atom (Group 7)



2 Hydrogen atoms + oxygen atom (Group 6)



2 oxygen atoms (Group 6)



## Week 4 continued

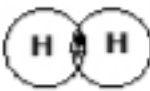
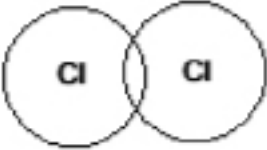




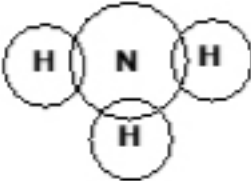
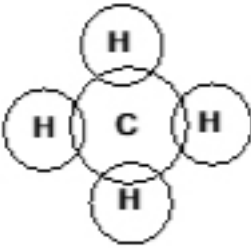
### More covalent molecules

Generally we do not show the atoms before they are bonded, we just show the final molecules.

We can use other representations of covalent molecules, ie. Displayed formula or electron models.

- In displayed formula, no electrons are shown, but each covalent bond is represented by a single line.
- The electron model is exactly the same as the outer shell model except the rings are not drawn.

Complete the table:

molecule	Outer shell	Displayed formula	Electron model
Hydrogen, $H_2$		$H-H$	$H \uparrow \downarrow H$
Chlorine, $Cl_2$			
Water, $H_2O$			
Oxygen, $O_2$			
Nitrogen, $N_2$			
Ammonia, $NH_3$		$H-N-H$ $ $ $H$	
Methane, $CH_4$			

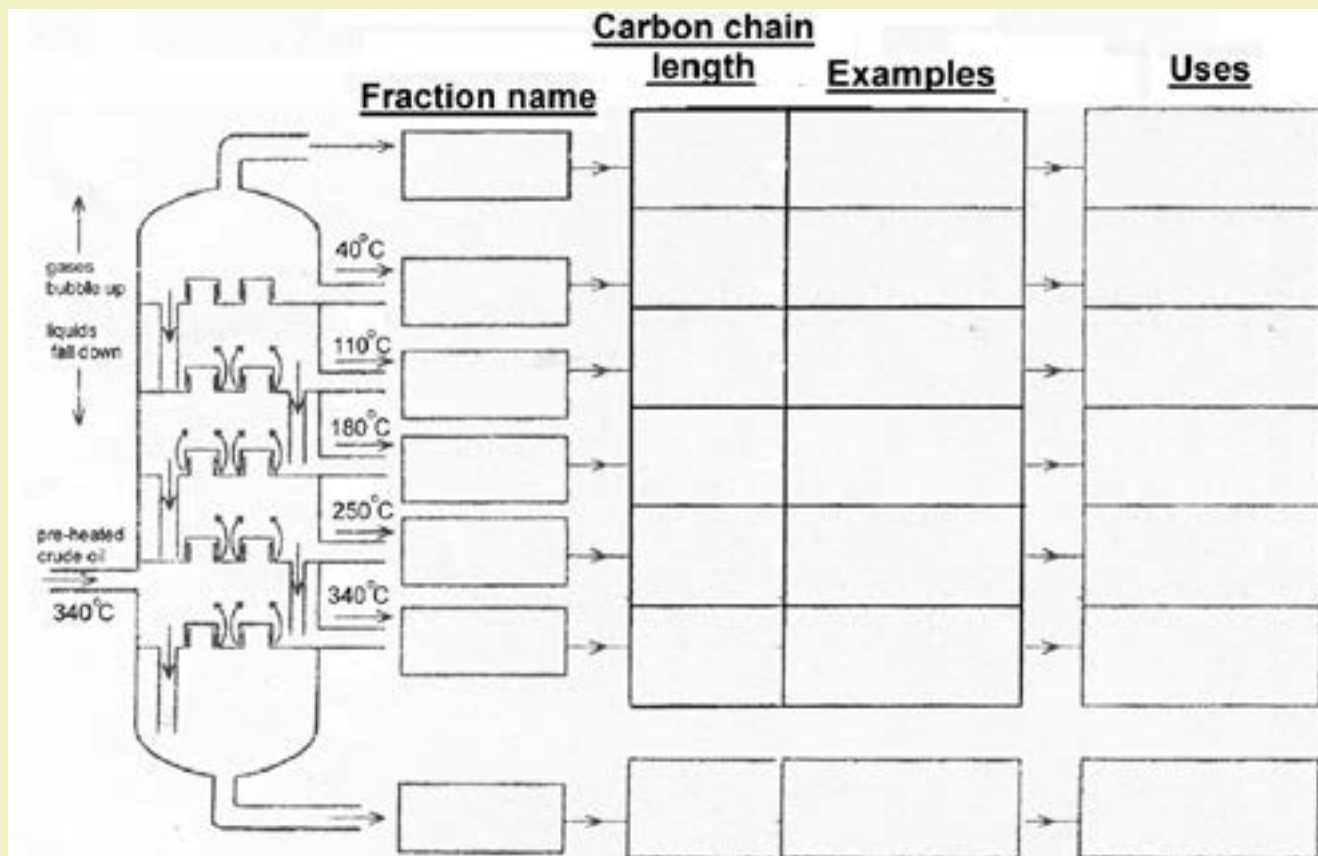


## Week 4 continued

### Organic chemistry

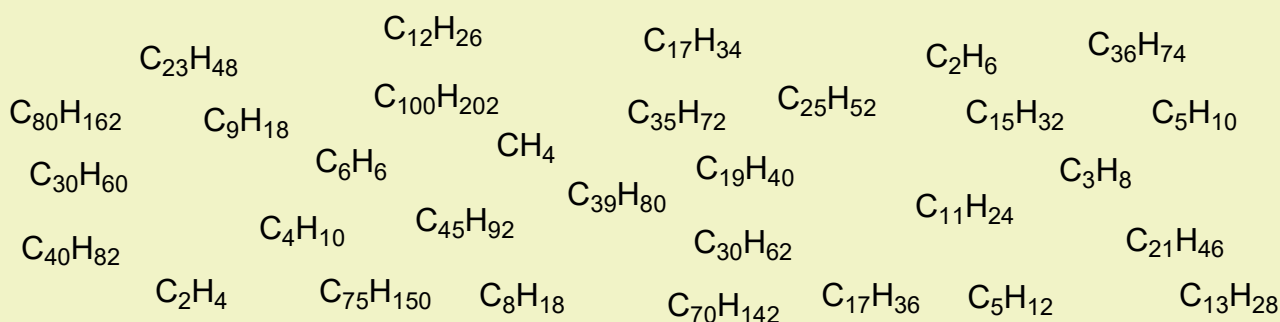
Organic chemistry is study of the chemicals produced from oil. These chemicals are called hydrocarbons, obviously as they contain carbon and hydrogen atoms only. The main source of hydrocarbons is crude oil.

Oil is separated by the process known as fractional distillation. In industry this is done in a large fractionating tower (up to 50 foot high).



Name of fraction	Boiling points	Number of carbons in hydrocarbon	Uses
Petroleum gases	below 25 °C	C <sub>1</sub> - C <sub>4</sub>	Camping gas, Calor gas
Petrol	30 - 50 °C	C <sub>4</sub> - C <sub>10</sub>	Fuel for cars
Naptha	60 - 120 °C	C <sub>7</sub> - C <sub>14</sub>	Chemicals for industry
Paraffin	130 - 190 °C	C <sub>11</sub> - C <sub>15</sub>	Aircraft fuel
Diesel	200 - 260 °C	C <sub>15</sub> - C <sub>19</sub>	Fuel for lorries
Fuel oil	270 - 370 °C	C <sub>20</sub> - C <sub>40</sub>	Fuel for ships & power stations
Bitumen	above 400 °C	C <sub>40</sub> and above	Tarmac, waxes & greases

Put the following hydrocarbons in the correct fraction on your diagram (cross them off as you go):



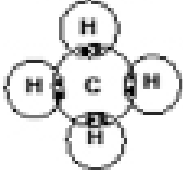
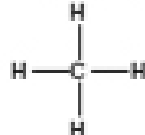
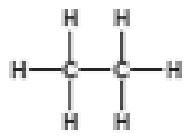
## Week 4 continued

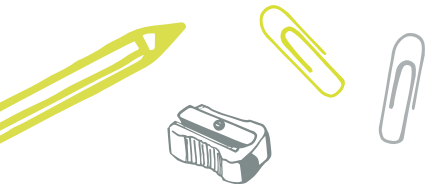
### Hydrocarbons: Alkanes

The two types of hydrocarbons you have come across so far are alkanes and alkenes. These are not the only two!

- Alkanes contain only single covalent bonds and for this reason we say they are saturated hydrocarbons.
- The general formula for alkanes is  $C_nH_{2n+2}$  where  $n$  is the number of carbons. Using this formula gives you the molecular formula of any alkane.
- When naming an alkane its name always ends in -ane (suffix)

Complete the table:

No. of carbons	prefix	Molecular formula	Dot/cross diagram	Displayed formula	Name
1	meth-	$CH_4$			methane
2	eth-				
3	prop-				
4	but-	$C_4H_{10}$			
5	Pent-				



## Week 4 continued

### Hydrocarbons: Alkenes

- Alkenes contain a double covalent bond as well as single bonds and for this reason we say they are unsaturated hydrocarbons.
- When naming an alkene its name always ends in -ene (suffix)

Complete the table:

No. of carbons	prefix	Molecular formula	Dot/cross diagram	Displayed formula	Name
2	Eth-	$C_2H_4$			
3		$C_3H_6$			
4		$C_4H_8$			
6		$C_6H_{12}$			

What is the general formula for alkenes? \_\_\_\_\_

**Well done, you have revised most of the work on basic inorganic and organic chemistry you did at GCSE and you are now ready to start AS – level chemistry at Bede Sixth Form.**

**Do not forget to bring this work with to your first lesson!**



# The Periodic Table of the Elements

(1)	(2)													(3)	(4)	(5)	(6)	(7)	(8)
1 H hydrogen 1.0	2													13	14	15	16	17	18
<b>Key</b> atomic number Symbol name relative atomic mass																			
3 Li lithium 6.9	4 Be beryllium 9.0	5 B boron 10.8	6 C carbon 12.0	7 N nitrogen 14.0	8 O oxygen 16.0	9 F fluorine 19.0	10 Ne neon 20.2	11 Na sodium 23.0	12 Mg magnesium 24.3	13 Al aluminium 27.0	14 Si silicon 28.1	15 P phosphorus 31.0	16 S sulphur 32.1	17 Cl chlorine 35.5	18 Ar argon 36.9				
19 K potassium 39.1	20 Ca calcium 40.1	21 Sc scandium 45.0	22 Ti titanium 47.9	23 V vanadium 50.9	24 Cr chromium 52.0	25 Mn manganese 54.9	26 Fe iron 55.8	27 Co cobalt 58.9	28 Ni nickel 58.7	29 Cu copper 63.5	30 Zn zinc 65.4	31 Ga gallium 69.7	32 Ge germanium 72.6	33 As arsenic 74.9	34 Se selenium 79.0	35 Br bromine 79.9	36 Kr krypton 83.8		
37 Rb rubidium 85.5	38 Sr strontium 87.6	39 Y yttrium 88.9	40 Zr zirconium 91.2	41 Nb niobium 92.9	42 Mo molybdenum 95.9	43 Tc technetium	44 Ru ruthenium 101.1	45 Rh rhodium 102.9	46 Pd palladium 106.4	47 Ag silver 107.9	48 Cd cadmium 112.4	49 In indium 114.8	50 Sn tin 118.7	51 Sb antimony 121.8	52 Te tellurium 127.6	53 I iodine 126.9	54 Xe xenon 131.3		
55 Cs caesium 132.9	56 Ba barium 137.3	57-71 lanthanoids	72 Hf hafnium 178.5	73 Ta tantalum 180.9	74 W tungsten 183.8	75 Re rhenium 186.2	76 Os osmium 190.2	77 Ir iridium 192.2	78 Pt platinum 195.1	79 Au gold 197.0	80 Hg mercury 200.6	81 Tl thallium 204.4	82 Pb lead 207.2	83 Bi bismuth 209.0	84 Po polonium	85 At astatine	86 Rn radon		
87 Fr francium	88 Ra radium	89-103 actinoids	104 Rf rutherfordium	105 Db dubnium	106 Sg seaborgium	107 Bh bohrium	108 Hs hassium	109 Mt meitnerium	110 Ds darmstadtium	111 Rg roentgenium	112 Cn copernicium	113 Nh nihonium	114 Fl flerovium	115 Lv livermorium	116 Ts tennessine	117 Og oganesson	118 Uu ununoctium		

57 La lanthanum 138.9	58 Ce cerium 140.1	59 Pr praseodymium 140.9	60 Nd neodymium 144.2	61 Pm promethium 144.9	62 Sm samarium 150.4	63 Eu europium 152.0	64 Gd gadolinium 157.2	65 Tb terbium 158.9	66 Dy dysprosium 162.5	67 Ho holmium 164.9	68 Er erbium 167.3	69 Tm thulium 168.9	70 Yb ytterbium 173.0	71 Lu lutetium 175.0
89 Ac actinium 227.0	90 Th thorium 232.0	91 Pa protactinium	92 U uranium 238.1	93 Np neptunium	94 Pu plutonium	95 Am americium	96 Cm curium	97 Bk berkelium	98 Cf californium	99 Es einsteinium	100 Fm fermium	101 Md mendelevium	102 No nobelium	103 Lr lawrencium





### ***Helpful resources:***

- DOC brown Chemistry revision notes  
[http://www.docbrown.info/page19/OCR\\_GCE\\_chem\\_A\\_Level\\_2015.htm](http://www.docbrown.info/page19/OCR_GCE_chem_A_Level_2015.htm)
- Chem Guide Chemistry revision notes:  
<https://www.chemguide.co.uk/atommenu.html#top>
- Richard Allery Youtube Chemistry videos:  
<https://www.youtube.com/channel/UCPtWS4fCi25YHw5SPGdPz0g>
- Crash Course Youtube Chemistry videos:  
<https://www.youtube.com/watch?v=FSyAehMdpyl&list=PLnyeng9CrBLclHa5UkUs4UNR3SD-FEC6dc>