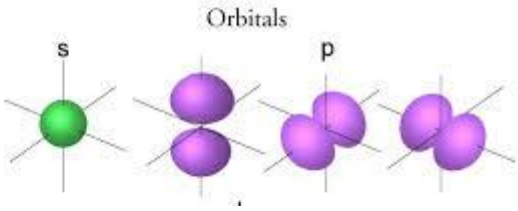
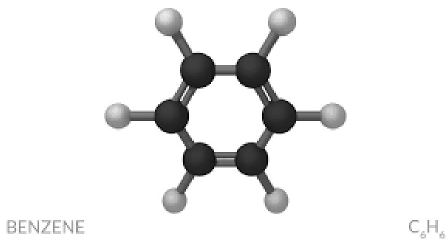
A Level Chemistry – Bridging Booklet





Name:

Due Date:

How the use this Bridging Booklet

Hello!

It is great that you are considering A Level Chemistry. It is a great course covering lots of fundamental knowledge and skills that are essential for University study in a number of areas. For example, A Level Chemistry provides essential knowledge if you are considering a career in Medicine and lots of other scientific areas. Plus the skills developed in A Level Chemistry are highly prized in other career areas such as accountancy and law. A Level Chemistry fits nicely alongside lots of other subjects such as Biology, Physics, Maths, Geography, Economics and Psychology.

There are a variety of tasks throughout the booklet, which cover some fundamentals of Chemistry that you need to feel confident with before starting the A Level Chemistry course. There are some video links to watch and some information to read. You can complete the tasks in the space provided.

Answers will also be shared so that you can check your work.

At the end of the booklet there are some links to some videos and other websites with information about the A Level Chemistry course. It would be a really good idea for you to start to explore the course and even start pre-learning some material so that you can make a really positive start to A Level Chemistry.

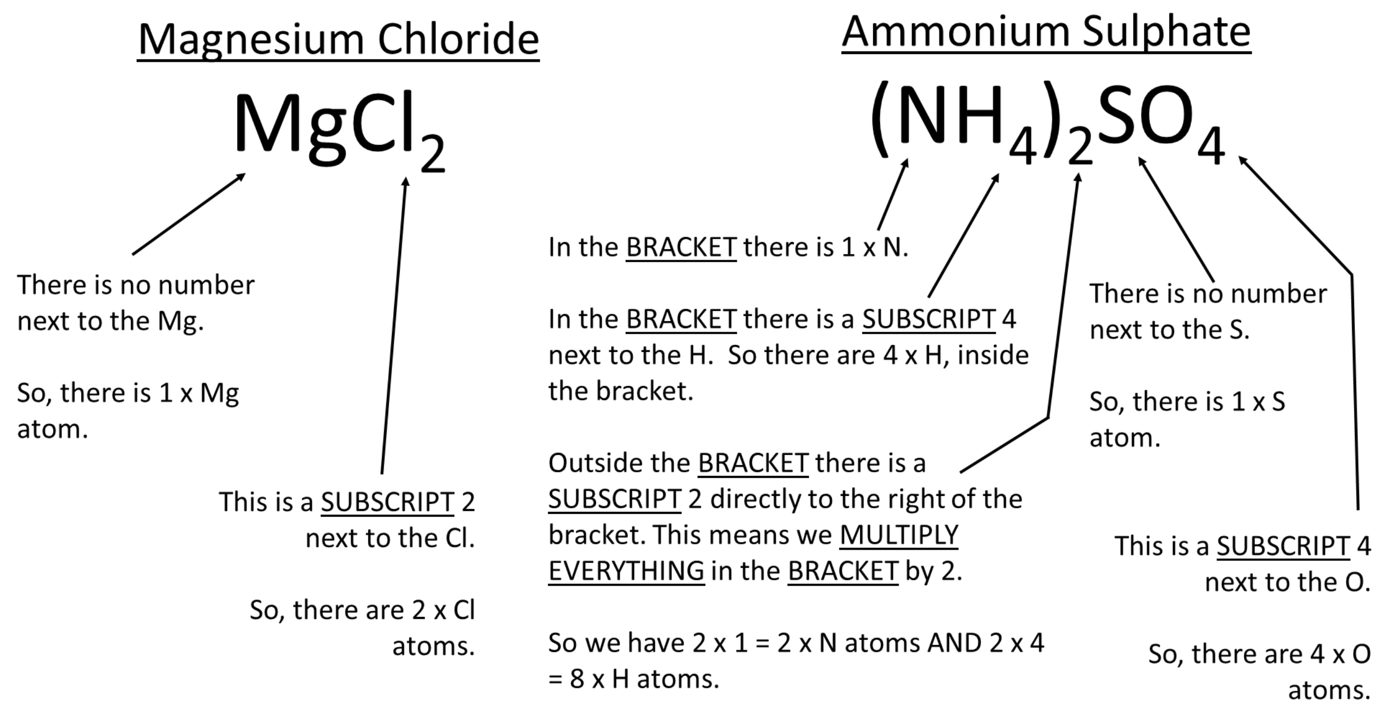
Enjoy!

Understanding Chemical Formulae

Rules

1. **Each CAPITAL letter represents an atom of a DIFFERENT element.**
2. **A SUBSCRIPT NUMBER (little, lower number to the right) tells you how many atoms there are of the element that come JUST BEFORE the number.**
3. **If there are BRACKETS followed by a SUBSCRIPT NUMBER, it means ALL of the atoms INSIDE the BRACKETS get MULTIPLIED BY the SUBSCRIPT NUMBER JUST TO the RIGHT of the BRACKETS.**

Examples



Questions

State how many of each type of atom/ion there are in each of these chemical formulae.

1. **Li_2O**

2. **$MgBr_2$**

3. **KNO_3**

4. **$Al(OH)_3$**

5. **$Ca(CO_3)_2$**

Balancing Chemical Equations

Watch this video: https://www.youtube.com/watch?v=QlN3qSXP2eA

A guide and worked example – A trial and error approach

1. **Chemical equations are thought of as being in TWO HALVES, split by the chemical reaction arrow; the left-hand side (LHS) are the REACTANTS and right-hand side (RHS) are the PRODUCTS.**

   Word Equation: Magnesium + Oxygen ---------> Magnesium Oxide

   Balanced Chemical Equation: 2 Mg + O_2 ---------> 2 MgO

   LHS — REACTANTS; RHS — PRODUCTS

2. **When balancing equations the AIM is to get the SAME number of ALL atoms on BOTH sides of the chemical equation.**

3. **When trying to balance a chemical equation, firstly COUNT the number of atoms on both sides of the equation. You might want to use a TABLE to keep an easy record of the numbers of atoms. By COUNTING the number of atoms, you are finding out if the equation is ALREADY BALANCED.**

	Mg + O_2 →	MgO	Balanced?
Mg	1	1	✓
O	2	1	✗

This isn't balanced. There is 1 magnesium atom on the left and one on the right, but there are two oxygen atoms on the left and only on the right. We know that mass cannot be created or destroyed (due to the law of conservation of mass) so something isn't right here as we have made an oxygen disappear.

4. **To BALANCE an equation we can INSERT BIG NUMBERS DIRECTLY IN FRONT of the formula of each REACTANT/PRODUCT in the chemical reaction; this has the effect of MULTIPLYING ALL of the atoms in the REACTANT/PRODUCT by that BIG NUMBER. NOTE: We DO NOT and CANNOT put a SUBSCRIPT NUMBER (little, lower number to the right) as this changes the chemistry. IT IS FORBIDDEN!!!**

	Mg + O_2 →	**2** MgO	Balanced?
Mg	1	2	✗
O	2	2	✓

We have added a 2 in front of the MgO to say that there are now 2 molecules of MgO. Which has balanced the oxygen. Unfortunately, this means that there are now two atoms of magnesium on the right and only one on the left. Let's try again…

	2 Mg + O_2 → **2** MgO		Balanced?
Mg	2	2	✓
O	2	2	✓

We now add a 2 in front of the Magnesium and count up our atoms on each side. We now have a **<u>BALANCED CHEMICAL EQUATION!!!</u>**

5. **Overall, we take a trial and error approach, placing <u>BIG NUMBERS DIRECTLY IN FRONT</u> of each reactant and product, and then <u>COUNTING THE NUMBERS OF ATOMS</u> on <u>BOTH SIDES</u> of the equation <u>UNTIL THE CHEMICAL EQUATION IS BALANCED</u>.**

<u>Questions</u>

Balance these equations. (Make notes on scrap paper, if you want to draw out a table for each one)

1) Na_3PO_4 + KOH → NaOH + K_3PO_4

2) MgF_2 + Li_2CO_3 → $MgCO_3$ + LiF

3) P_4 + O_2 → P_2O_3

4) $RbNO_3$ + BeF_2 → $Be(NO_3)_2$ + RbF

5) $AgNO_3$ + Cu → $Cu(NO_3)_2$ + Ag

6) CF_4 + Br_2 → CBr_4 + F_2

7) HCN + $CuSO_4$ → H_2SO_4 + $Cu(CN)_2$

8) GaF_3 + Cs → CsF + Ga

9) BaS + PtF_2 → BaF_2 + PtS

10) N_2 + H_2 → NH_3

11) NaF + Br_2 → NaBr + F_2

12) $Pb(OH)_2$ + HCl → H_2O + $PbCl_2$

13) $AlBr_3$ + K_2SO_4 → KBr + $Al_2(SO_4)_3$

14) CH_4 + O_2 → CO_2 + H_2O

15) Na_3PO_4 + $CaCl_2$ → NaCl + $Ca_3(PO_4)_2$

16) K + Cl_2 → KCl

17) Al + HCl → H_2 + $AlCl_3$

18) N_2 + F_2 → NF_3

19) SO_2 + Li_2Se → SSe_2 + Li_2O

20) NH_3 + H_2SO_4 → $(NH_4)_2SO_4$

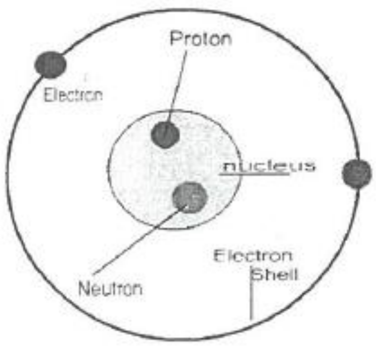
Atomic structure

As you all know the atom is the fundamental unit of all elements. It is not the smallest thing that can exist. Scientists keep on coming up with smaller and smaller things. But we shall consider the atom as the building block of all elements.

Bromine contains bromine atoms. Iron contains iron atoms. Sodium contains sodium atoms etc.

However, not all bromine atoms are the same and not all carbon atoms are the same but more of that later. (isotopes)

Atoms contain electrons and protons and neutrons



The electrons stay in shells surrounding the nucleus and the protons and neutrons stay in the nucleus. Chemistry is basically to do with what happens to the electrons in an atom. Here is a table that you need to remember

Particles	Symbol	Charge	Location
Protons	p	Positive charge	Found in the nucleus
Neutrons	N	Neutral (no) charge	Found in the nucleus
Electrons	e^-	Negative charge	Found orbiting the nucleus

The periodic table gives us all the information that we need to work out the structure of an atom ie. the number of electrons, protons and neutrons in any atom----and where the electrons are.

Look up carbon and put the symbol and the little numbers next to it

Carbon

The smallest number is the number of protons in the atom. Since all atoms have an overall neutral charge the number of electrons must be the same. The big number is the atomic mass and is the number of all the bits in the nucleus. That is the number of protons and neutrons added together.

Now this is known you should be able to work out the number of protons , neutrons and electrons in the carbon atom

________ n

________ p

________ e

Repeat this for the following atoms.

Use the periodic table at the back of the booklet to work out the number of protons neutrons and electrons in the following atoms

1. *helium*
2. *Calcium*
3. *Lithium*
4. *Oxygen*
5. *sulphur*

1________ n	2________ n	3________ n	4________ n	5________ n
________p	________p	________p	________p	________p
________e	________e	________e	________e	________e

Now you should be confident on working out the number of protons neutrons and electrons in atoms but where do they go?

Electrons are arranged in shells and this simple Bohr model that we are using helps us understand a lot of chemistry. The shells can take certain amounts of electrons before they are full. They always fill up from the closest shell to the nucleus.

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________e	________e	________e	________e	________e

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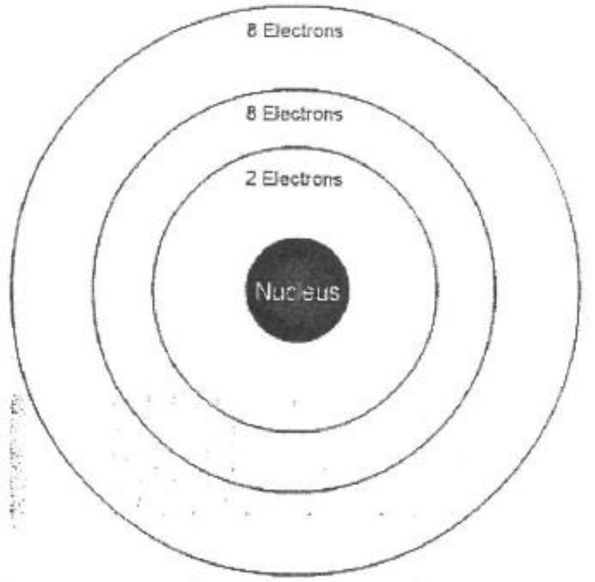


Shell diagram of a neutral atom. The positively charged nucleus is surroundedby clouds of negatively charged electrons, arranged in successive shells. The first (inner) shell holds a maximum of 2 electrons; the second and third shells can hold 8 outer electrons each.

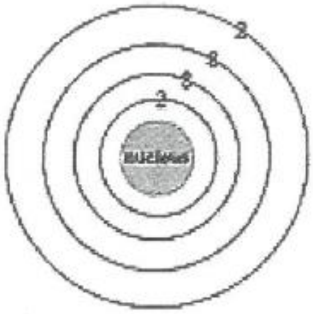
(www.chem.ox.ac.uk/vrchemistry/chapter6/Page2.htm)

So in the oxygen atom the first two electrons fill up the first shell which leaves 6 left and these go into the second shell. They are usually grouped in two s. If we don't draw the atom we can put down in a shorthand way the **electronic configuration------** 2,6.

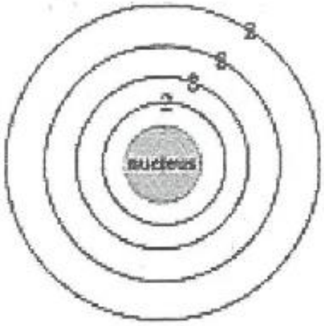
Fill in the following shells for the elements given

Na

Ca



F



That's straightforward then.

Now what about those isotopes mentioned earlier.

Work out the number of protons neutrons and electrons in chlorine.

Not so easy as you can't have halves of neutrons- they come in ones only.

So where does the 35.5 come from.

Actually there are number of different types of atoms for each element and the mass number that you see in the periodic table is the average of all the different types of atoms for that element. In chlorine for example there are 25% of chlorine-37 and 75% of chlorine-35 which gives an average of 35.5.

Each element has isotopes. Carbon has a number which you have probably heard of already.

Carbon-12, carbon-11 and carbon-14 (that's the one to do with carbon dating)

Don't forget though that all atoms of an element have the same number of electrons and protons in their atoms. The number of protons tells you which element the atom is.

One last point here Hydrogen doesn't have any neutrons. It has one proton and one electron and if it loses its electron to become the hydrogen ion it is just a proton!

HOW ATOMS COMBINE

Elements usually combine with other elements to produce compounds.

We like to think that they do this in one of two ways but in truth it isn't always that straight forward. But what you need to know at this point is that elements combine in one of two ways called **ionic bonding** and **covalent bonding.**

Ionic Bonding

Atoms are quite stable when they have a full outer shell. They will combine with other atoms to get a full outer shell either by donating electrons or accepting them from other atoms.

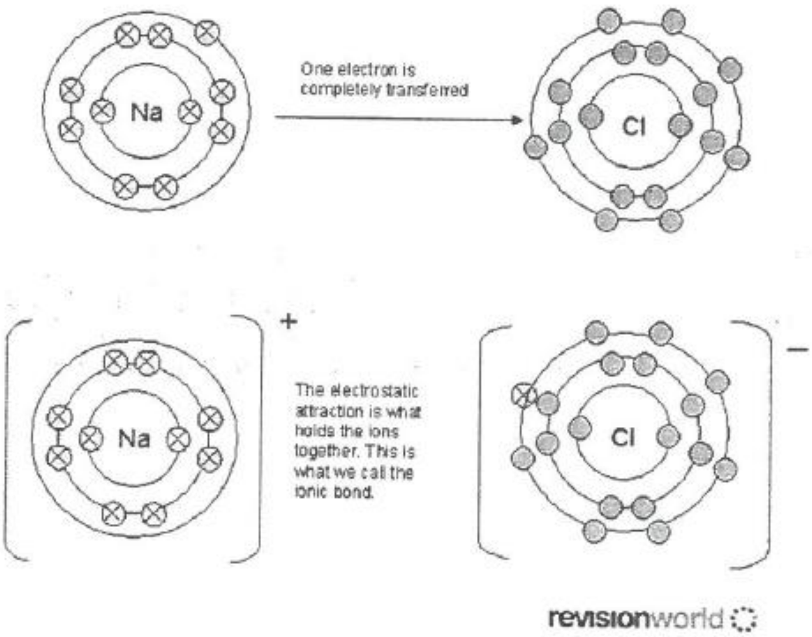
Atoms need the same number of electrons in their nucleus as they have protons in their nucleus which makes them neutral.

Think about Lithium. It has one electron in its outer shell. If it looses this electron it will have a full outer shell which means it is stable. It also means that there are more protons in its nucleus than there are electrons. Now the atom is positive but it isn't called an atom anymore. It is now a positive ion.

(The atom wondering down the road said "Oh dear, I've lost an electron. Yes I'm positive).

Think about fluorine. It has seven electrons in its outer shell. If it gains an electron it will have a full outer shell which means it is stable. It also means that there are less protons in its nucleus than there are electrons. Now the atom is negative but it isn't called an atom anymore. It is now a negative ion.

The following diagram shows what happens when sodium and chlorine combine.



(http://www.revisionworld.com)

Notice that the sodium and chlorine ions are now in brackets and each one has a charge.

Some atoms want to give away or accept more than one electron. In this case the ions have either 2+ or 2-.

You now need to do a few of these diagrams.

Lithium will combine with fluorine to form lithium fluoride. Draw a similar diagram to the above to show how this happens in the box below.

sodium combines with oxygen to form sodium oxide. Draw a similar diagram to the above to show how this happens in the box below. Don't forget that the oxygen needs two electrons to get a full outer shell and so needs two sodiums to do this.

Calcium combines with oxygen to form calcium oxide. Draw a similar diagram to the above to show how this happens in the box below. Don't forget that the oxygen needs two electrons to get a full outer shell and calcium wants to give away two electrons.

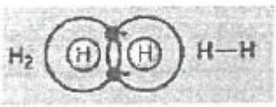
Covalent bonding

Atoms in the middle of the periodic table can't give away all the electrons in the outer shell and so they have to get a full outer shell by some other method. Oxygen needs two more electrons to complete its outer shell and it exists uncombined with other elements, so how does it do this?

(Just a point here.... atoms don't think. They don't have desires and career plans. Whether they give electrons away or take them is just to do with energies and what is most stable. Well as far as I know!)

Let's take hydrogen as a starting point. A hydrogen atom has one proton and an electron. Draw the diagram of the hydrogen atom in the box below

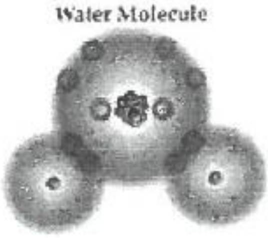
Notice that the hydrogen has got half a shell full of electrons and yet hydrogen can exist on its own. It needs another electron. Hydrogen will share its electron with another hydrogen atom so that they both have a full outer shell. Hydrogen bonds to another hydrogen by covalent bonding. This is why hydrogen gas is H_2.



The line between the hydrogens represents a single covalent bond. A double line- a double bond and three lines a triple bond.

Here is a diagram showing water H_2O which also has covalent bonding.

Notice the shape.



It is not a linear molecule, in other words it is not straight.

Now you need to draw some covalent molecules. Include all the electrons even though the inner electrons do not have anything to do with the bonding.

O_2 Oxygen

N_2 Nitrogen

HCl hydrogen chloride

CH_4 Methane

C_2H_4 ethene

You should now have a good understanding of how atoms join to form compounds by either ionic or covalent bonding .

Which type of bonding would you expect in the following compounds? You will need to look at your periodic table.

1. *potassium oxide*
2. *propane*
3. *lithium chloride*
4. *chlorine*
5. *barium oxide*

Naming compounds and writing their formulae.

This is a really important section and you need to know it well.

For two element compounds all you need is the periodic table

+1	+2	+3	+or-4	-3	-2	-1	0

H							He
Li	Be	B	C	N	O	F	Ne
Na	Mg	Al	Si	P	S	Cl	Ar

You need to look at the number above the groups. Groups go down. (Periods go across). The total +'s and –'s for a compound need to be zero.

So the compound of lithium and fluorine is Li (+1) and F (-1) . One lithium cancels out the fluorine and so the formula is LiF. This is called lithium fluoride. Notice the metal name stays the same but the non-metal part gets an –ide.

Next Beryllium and oxygen. Be (+2) and O (-2). One beryllium cancels out the oxygen and so the formula is BeO. Beryllium oxide. Oxygen produces oxides when combined with other elements.

Again Sodium and oxygen . Na (+1) and O (-2). In this case we need two lots of Na and so the formula is Na_2O. Sodium oxide.

Try these.Give the formulae and the names of the compounds they form.

elements	*formula*	*name*
Hydrogen and chlorine		
Lithium and oxygen		
Magnesium and chlorine		
Hydrogen and carbon		
Aluminium and chlorine		
Aluminium and oxygen		

Often there are groups of elements that go together to form an ion. Here are the more common groups of elements ions.

OH^- hydroxide

SO_4^{2-} sulphate

NO_3^- nitrate

CO_3^{2-} carbonate

MnO_4^{2-} manganate

(notice ion names – when an element is combined with oxygen to form an ion it ends with –ate)

And one positive ion – **NH_4^+ ammonium.**

These groups should be treated exactly the same as a single element when combining them with other elements to form a compound.

Magnesium hydroxide is made up of Mg^{2+} and OH^- . One Mg^{2+} needs two hydroxides to balance the charges and so the compound's formula is

$Mg(OH)_2$

Note the use of the brackets to ensure that there are two lots of OH required. $MgOH_2$ would be wrong as it would look like there was two hydrogens and one oxygen. Make sure that brackets are used to indicate numbers of the groups that are being used.

Sodium nitrate is made up of Na^+ and NO_3^- . One Na^+ needs one nitrate to balance the charges and so the compound's formula is

$NaNO_3$

Notice that brackets are not needed here.

Try the following

Elements /groups	*name*	*formula*
Sodium and hydroxide		
Lithium and sulphate		
Magnesium and carbonate		
Potassium and manganate		
Calcium and nitrate		

Ammonium and nitrate		
Aluminium and nitrate		
Aluminium and sulphate		

You also need to know the names of some acids. These ones need to be remembered.

- H_2SO_4 sulphuric acid
- $HCl_{(aq)}$ hydrochloric acid
- HNO_3 nitric acid
- H_2CO_3 carbonic acid
- CH_3CO_2H ethanoic acid (acetic acid).

Equations to know

During your study of chemistry at GCSE you will have come across a number of important chemical equations that you will need for A level. If you understand the generic equations you will be able to apply these to all sorts of situations. Listed below are the ones you should already know

Acid + reactive metal → salt + hydrogen

Acid + alkali → salt + water

Acid + carbonate → salt + water +carbon dioxide

Carbon compound + oxygen → carbon dioxide + water

The carbon compound could be a hydrocarbon or a carbohydrate.

Don't forget to balance equations. This is when you make sure that the number of atoms in the reactants is the same as the number of atoms in the products. Like this......

$$2CO_{(g)} + O_{2(g)} \rightarrow 2CO_{2(g)}$$

Write the following equations using the information above. You will need to remember to make sure that the formulae are correct using the rules given earlier on. You also need to make sure that the equations are balanced and that state symbols are given.

1. Magnesium + hydrochloric acid
2. Zinc + sulphuric acid
3. Sodium hydroxide + nitric acid
4. Potassium hydroxide + sulphuric acid
5. Citric acid + magnesium
6. Hydrochloric acid + calcium carbonate
7. Sulphuric acid + copper carbonate
8. Burning methane in oxygen (complete combustion)
9. Burning ethanol in oxygen (complete combustion)
10. The complete combustion of glucose (where else does this equation crop up)

1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Moles and chemical calculations

This is a very important section. You need to become competent with these calculations as soon as possible.

The mole

A dozen means twelve of something

A gross means one hundred and forty four of something

A brace means two of something

A score is twenty of something

A mole is 6.02×10^{23} of atoms, ions, molecules, electrons etc.

Although the number is important in chemistry it is really only used to work out masses and concentrations at A level.

You need to follow this section very carefully and complete all the questions.

Relative atomic mass A_r

The mass number for any atom is the large number that you will find next to every element in the periodic table. The small number as we have already seen is the proton number or atomic number. Write down the mass numbers for the following elements. You will need a periodic table

element	Atomic mass	element	Atomic mass
Ca		U	
P		Be	
N		B	
O		I	
K		Ra	

Relative molecular mass M_r

Relative molecular mass is simply all the relative atomic masses in a molecule added together. However there are a few thing that may catch you out.

Brackets- anything inside a bracket is multiplied by the little number outside the bracket

Water of crystallisation- Some compounds have . x H_2O such as Cu $SO_4.5H_2O$. When you work out the relative molecular mass of the compound you must remember to add on the correct number of water molecules, in the example above 5 lots of 18 which is 90.

Complete the following

compound	M_r	compound	M_r
$NaCl$		NH_4NO_3	
$CuCO_3$		$(NH_4)_2SO_4$	
$Cu(Cl)_2$		$CuSO_4.5H_2O$	
$Ca(NO_3)_2$		$Al_2(SO4)_3$	

Moles of compounds

Now you have worked out the relative atomic and molecular masses it is very easy to state the mass of a mole of a specific substance.

A mole of a substance is simply the atomic or molecular mass expressed in grams.

A mole of calcium carbonate has a mass of 100g. A mole of carbon atoms has a mass of 12g. Half a mole of calcium carbonate has a mass of 50g and a tenth of a mole of carbon has a mass of 1.2g

The mass therefore is the *number of moles x the atomic or molecular mass*

Work out the gaps in the following table

item	Atomic or molecular mass	Number of moles	Mass in grams
C		2	
Ca		0.1	
H_2		0.125	
N_2			2.8
H_2O			9
$CaCO_3$			2
C_2H_6			0.6
$C_2H_4O_2$		2.5	
NaCl		0.16	
$CuSO_4$		1.4×10^{-3}	

Solutions and their concentrations

Concentrations are expressed as so many moles in a dm^3 of solution and the correct unit is mol dm^{-3} . A dm^3 is the same as a litre.

1mole of a substance dissolved in $1dm^3$ of solution gives a concentration of 1 mol dm^{-3}.

0.5 mol of a substance dissolved in $0.5dm^3$ of solution gives a concentration of 1 mol dm^{-3}.

2 mol of a substance dissolved in $0.5dm^3$ of solution gives a concentration of 4 mol dm^{-3}.

Fill in the spaces in the table below.

No. of mols	Vol. of solution dm^3	Concentration mol dm^{-3}
1	1	
	1	0.5
1		2
0.5	1	
0.1	1	
0.2	0.5	
0.25		1
0.15	0.2	
	2	0.56

0.125		2.5

Now you can work out the mass of solute to use in a specific volume in order to obtain a solution of specific concentration.

1mole of a substance dissolved in $1dm^3$ of solution gives a concentration of 1 mol $dm^{-3.}$ (as above)

If we needed to make $1dm^3$ of NaCl solution at a concentration of 1 mol $dm^{-3.}$ then we would need to dissolve 1 mol of NaCl in $1dm^3$ of solution. That is 23+35.5 = 58.5g.

If we needed to make $0.5dm^3$ of NaOH solution at a concentration of 0.5 mol $dm^{-3.}$ then we would need to dissolve 0.25 mol of NaOH in 0.5 dm^3 of solution. That is 23+16+1 =40/4 or 40 x 0.25. Either way we get 10g. So 10g of NaOH dissolved in $0.5dm^3$ of solution gives a concentration of 0.5 mol $dm^{-3.}$

Answer the following questions.

1. How much potassium hydroxide do you need to dissolve in 1000 cm^3 in order to obtain a concentration of 2 mol dm^{-3} (1000 cm^3 is the same as $1dm^3$)?
2. How much potassium hydroxide do you need to dissolve in 500 cm^3 in order to obtain a concentration of 0.1 mol dm^{-3} ?
3. How much potassium hydroxide do you need to dissolve in 250 cm^3 in order to obtain a concentration of 0.2 mol dm^{-3} ?
4. How much anhydrous copper sulphate do you need to dissolve in 2000 cm^3 in order to obtain a concentration of 0.25 mol dm^{-3} ?

5. 10g of NaOH dissolved in $100cm^3$ of solution gives what concentration?

6. 5g of NaOH dissolved in $500cm^3$ of solution gives what concentration?

7. 10g of $CuSO_4$ dissolved in $100cm^3$ of solution gives what concentration?

8. 0.167g of $KMn0_4$ dissolved in 1.5 dm^3 of solution gives what concentration?

9. 0.1g of $KMn0_4$ dissolved in 0.1 dm^3 of solution gives what concentration?

10. 0.25g of KOH dissolved in $250cm^3$ of solution gives what concentration?

Organic Chemistry

Organic chemistry is a huge area of chemistry that covers the study of molecules that are based on chains and rings of carbon atoms. Organic chemistry is the chemistry of our bodies and all living things, it is the chemistry of the reactions that keep us alive, it is the chemistry of medicine and pharmacy and it is also the chemistry of fuels, plastics and other consumer products.

As a reminder of some organic chemistry that was covered at GCSE, please watch this video: https://www.youtube.com/watch?v=ZeUNWY7YDAo

If you took separate sciences you will have studied all of this, if you took combined sciences some information in this video will be new.

Once you've watched the video, please fill in the following tables…

Alkanes

Alkanes			General Formula =
Number of carbons in the Chain	Name of Alkane	Formula of Alkane	Structure of Alkane
1			
2			
3			
4			

<u>**Alkenes**</u>

Alkenes			**General Formula =**
Number of carbons in the Chain	**Name of Alkene**	**Formula of Alkene**	**Structure of Alkene**
2			
3			
4			

Alcohols

Alcohol			Functional group =
Number of carbons in the Chain	**Name of Alcohol**	**Formula of Alcohol**	**Structure of Alcohol**
1			
2			
3			
4			

Carboxylic acids

Carboxylic acids			Functional group =
Number of carbons in the Chain	**Name of Carboxylic acid**	**Formula of Carboxylic acid**	**Structure of Carboxylic acid**
1			
2			
3			
4			

Exploring the A Level Chemistry Course

At Whickham we study the OCR (A) A Level Chemistry course. You can find information about the course here:

https://www.ocr.org.uk/qualifications/as-and-a-level/chemistry-a-h032-h432-from-2015/specification-at-a-glance/

https://www.ocr.org.uk/Images/171720-specification-accredited-a-level-gce-chemistry-a-h432.pdf

There are some excellent online resources for the course. It would be a really good idea for you to start to explore the course and even start pre-learning some material so that you can make a really positive start to A Level Chemistry.

Take a look at these:

- Allery Chemistry YouTube (Videos covering A Level Chemistry course content):
https://www.youtube.com/channel/UCPtWS4fCi25YHw5SPGdPz0g/playlists?view=50&sort=dd&shelf_id=3

- SnapRevise YouTube (Videos covering A Level Chemistry course content):

https://www.youtube.com/watch?v=qZ3INba16v0&list=PLkocNW0BSuEEc4SOEXeDXrwUiKZjhAJ2q

- Physics and Maths tutor (Website includes notes, flashcards and questions by topic for A Level Chemistry)

https://www.physicsandmathstutor.com/chemistry-revision/a-level-ocr-a/

- Maths Made Easy (Website with lots of resources and questions/answers for A Level Chemistry)

https://mathsmadeeasy.co.uk/a-level-chemistry-revision/