NAME____

GCSE to AS Chemistry

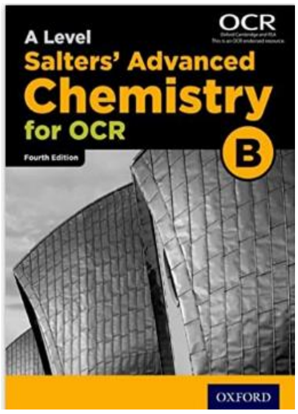
Bridging materials

Use your GCSE resources, the internet or a chemistry textbook to help answer these questions in preparation for your AS course in Chemistry.

Good textbooks you could use are:

The course text :

A Level Salters Advanced Chemistry for OCR B (4th ed)
University of York **ISBN** **978-0198332909**



OR

Advanced Chemistry for you **Lawrie Ryan (2015 edition)**
ISBN 978-1408527368

Useful websites include:

1] *Chemguide* **:** **www.chemguide.co.uk**

2] *DocBrown Chemistry* **:** **www.docbrown.info/page19/Salters_GCE_chem_A_Level_2015.htm**

3] *ChemRevise* **(N. Goaby) : www.chemrevise.org/ocr-revision-guides**

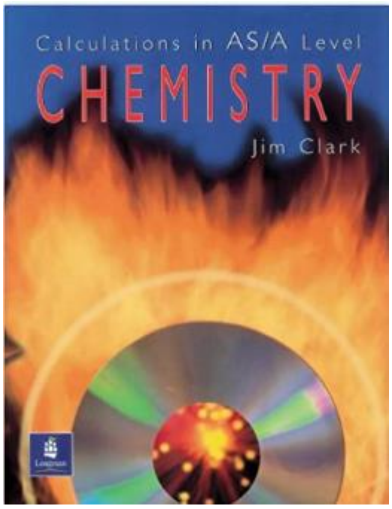
Hartismere bridging materials can be found on the school website.
Search for item number : **29071**

ESSENTIAL PURCHASE:

CGP Revision Guide New A-Level Chemistry :
OCR B Year 1 & 2 Complete Revision & Practice,
ISBN 978-1782943037

.The main course text will be available to students free of charge in September when starting the course.

You will also be provided with a copy of "Calculations in AS/A Level Chemistry**"**
By Jim Clark (the person behind the "Chemguide" website)



We have copies of other textbooks students may borrow to assist with their independent study.

The CGP Revision guide book is vital – Copies will be available to order through school in September

If you would like more questions feel free to browse the OCR website and look at past papers from the old specification.

Useful information and activities

Greek letters

Greek letters are used often in science. They can be used as symbols for numbers (such as π = 3.14…), as prefixes for units to make them smaller (eg μm = 0.000 000 001 m**) or as symbols for particular quantities (such as** λ **which is used for wavelength). The Greek alphabet is shown below.**

Α	α	**alpha**	Ν	ν	**nu**
Β	β	**beta**	Ξ	ξ	**ksi**
Γ	γ	**gamma**	Ο	ο	**omicron**
Δ	δ	**delta**	Π	π	**pi**
Ε	ε	**epsilon**	Ρ	ρ	**rho**
Ζ	ζ	**zeta**	Σ	ς or σ	**sigma**
Η	η	**eta**	Τ	τ	**tau**
Θ	θ	**theta**	Υ	υ	**upsilon**
Ι	ι	**iota**	Φ	φ	**phi**
Κ	κ	**kappa**	Χ	χ	**chi**
Λ	λ	**lambda**	Ψ	ψ	**psi**
Μ	μ	**mu**	Ω	ω	**omega**

Activity 1

A lot of English words are derived from Greek ones, but it's difficult to see as the **alphabet is so different.**

Many of the Greek letters are pronounced like the start of their name. For example, omega is pronounced "o", sigma is pronounced "s" and lambda is pronounced "l".

See if you can work out what the following Greek words mean by comparing the phonetic spelling with similar English words.

Πυθαγόρας	**Name of a mathematician**
Ωκεανος	**Atlantic, Pacific or** Arctic…
μόνος	**Single**
Τηλε	**Far or distant**
Τρωγλοδύτης	**Cave dweller**

SI units

Every measurement must have a size (eg 2.7) and a unit (eg metres or °C). Sometimes there are different units available for the same type of measurement, for example ounces, pounds, kilograms and tonnes are all used as units for mass.

To reduce confusion and to help with conversion between different units, there is a standard system of units called the SI units which are used for most scientific purposes.

These units have all been defined by experiment so that the size of, say, a metre in the UK is the same as a metre in China.

The seven SI base units are:

Physical quantity	Usual quantity symbol	Unit	Abbreviation
mass	m	kilogram	kg
length	l or x	metre	m
time	t	second	s
electric current	I	ampere	A
temperature	T	kelvin	K
amount of substance	N	mole	mol
luminous intensity	(not used at A-level)	candela	cd

All other units can be derived from the SI base units.

For example, area is measured in square metres (written as m^2) and speed is measured in metres per second (written as ms^{-1}).

It is not always appropriate to use a full unit. For example, measuring the width of a hair or the distance from Manchester to London in metres would cause the numbers to be difficult to work with.

Prefixes are used to multiply each of the units. You will be familiar with centi (meaning 1/100), kilo (1000) and milli (1/1000) from centimetres, kilometres and millimetres.

There is a wide range of prefixes. The majority of quantities in scientific contexts will be quoted using the prefixes that are multiples of 1000. For example, a distance of 33 000 m would be quoted as 33 km.

The most common prefixes you will encounter are:

Prefix	Symbol	Multiplication factor		
Tera	T	10^{12}	1 000 000 000 000	
Giga	G	10^{9}	1 000 000 000	
Mega	M	10^{6}	1 000 000	
kilo	k	10^{3}	1000	
deci	d	10^{-1}	0.1	1/10
centi	c	10^{-2}	0.01	1/100
milli	m	10^{-3}	0.001	1/1000
micro	µ	10^{-6}	0.000 001	1/1 000 000
nano	n	10^{-9}	0.000 000 001	1/1 000 000 000
pico	p	10^{-12}	0.000 000 000 001	1/1 000 000 000 000
femto	f	10^{-15}	0.000 000 000 000 001	1/1 000 000 000 000 000

Activity 2

Which SI unit and prefix would you use for the following quantities?

1. **The mass of water in a test tube.**

2. **The time taken for a solution to change colour.**

3. **The radius of a gold atom.**

4. **The volume of water in a burette.**

5. **The amount of substance in a beaker of sugar.**

6. **The temperature of the blue flame from a Bunsen burner.**

Sometimes, there are units that are used that are not combinations of SI units and prefixes.

These are often multiples of units that are helpful to use. For example, one litre is 0.001 m^3.

Activity 3

Rewrite the following in SI units.

1. **5 minutes**

2. **2 days**

3. **5.5 tonnes**

Activity 4

Rewrite the following quantities.

1. **0.00122 metres in millimetres**

2. **104 micrograms in grams**

3. **1.1202 kilometres in metres**

4. **70 decilitres in millilitres**

5. **70 decilitres in litres**

6. **10 cm^3 in litres**

Important vocabulary for practical work

Activity 5 Join the boxes to link the word to its definition.

Accurate	**A statement suggesting what may happen in the future.**
Data	**An experiment that gives the same results when a different person carries it out, or a different technique or set of equipment is used.**
Precise	**A measurement that is close to the true value.**
Prediction	**An experiment that gives the same results when the same experimenter uses the same method and equipment.**
Range	**Physical, chemical or biological quantities or characteristics.**
Repeatable	**A variable that is kept constant during an experiment.**
Reproducible	**A variable that is measured as the outcome of an experiment.**
Resolution	**This is the smallest change in the quantity being measured (input) of a measuring instrument that gives a perceptible change in the reading.**
Uncertainty	**The interval within the true value can be expected to lie.**
Variable	**The spread of data, showing the maximum and minimum values of the data.**
Control variable	**Measurements where repeated measurements show very little spread.**
Dependent variable	**Information, in any form, that has been collected.**

Precise language

It is essential at AS and A-level to use precise language when you write reports and when you answer examination questions. You must always demonstrate that you understand a topic by using the correct and appropriate terms.

For example, you should take care when discussing bonding to refer to the correct particles and interactions between them.

Also, when discussing the interaction between particles in an ionic solid, you would demonstrate a lack of understanding if you referred to the particles as atoms or molecules instead of ions or the interaction between these ions as intermolecular forces rather than electrostatic forces. In this case, use of the incorrect terms would result in the loss of all the marks available for that part of a question.

Take care also to use the word 'chloride' and not 'chlorine' when referring to the ions in a compound such as sodium chloride. The word 'chlorine' should only be **used for atoms or molecules of the element.**

The periodic table

The periodic table of elements is shown on the back page of this booklet. The A-level course will build on what you've learned in your GCSE studies.

Activity 6

On the periodic table on the following page:

- **Draw a line showing the metals and non-metals.**
- **Colour the transition metals blue.**
- **Colour the halogens yellow.**
- **Colour the alkali metals red.**
- **Colour the noble gases green.**
- **Draw a blue arrow showing the direction of periods.**
- **Draw a red arrow showing the direction of groups.**
- **Draw a blue ring around the symbols for all gases.**
- **Draw a red ring around the symbols for all liquids.**

Key

relative atomic mass **symbol** name atomic (proton) number

1	2											3	4	5	6	7	0
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
							1.0 **H** hydrogen 1										4.0 **He** helium 2
6.9 **Li** lithium 3	9.0 **Be** beryllium 4											10.8 **B** boron 5	12.0 **C** carbon 6	14.0 **N** nitrogen 7	16.0 **O** oxygen 8	19.0 **F** fluorine 9	20.2 **Ne** neon 10
23.0 **Na** sodium 11	24.3 **Mg** magnesium 12											27.0 **Al** aluminium 13	28.1 **Si** silicon 14	31.0 **P** phosphorus 15	32.1 **S** sulfur 16	35.5 **Cl** chlorine 17	39.9 **Ar** argon 18
39.1 **K** potassium 19	40.1 **Ca** calcium 20	45.0 **Sc** scandium 21	47.9 **Ti** titanium 22	50.9 **V** vanadium 23	52.0 **Cr** chromium 24	54.9 **Mn** manganese 25	55.8 **Fe** iron 26	58.9 **Co** cobalt 27	58.7 **Ni** nickel 28	63.5 **Cu** copper 29	65.4 **Zn** zinc 30	69.7 **Ga** gallium 31	72.6 **Ge** germanium 32	74.9 **As** arsenic 33	79.0 **Se** selenium 34	79.9 **Br** bromine 35	83.8 **Kr** krypton 36
85.5 **Rb** rubidium 37	87.6 **Sr** strontium 38	88.9 **Y** yttrium 39	91.2 **Zr** zirconium 40	92.9 **Nb** niobium 41	96.0 **Mo** molybdenum 42	[98] **Tc** technetium 43	101.1 **Ru** ruthenium 44	102.9 **Rh** rhodium 45	106.4 **Pd** palladium 46	107.9 **Ag** silver 47	112.4 **Cd** cadmium 48	114.8 **In** indium 49	118.7 **Sn** tin 50	121.8 **Sb** antimony 51	127.6 **Te** tellurium 52	126.9 **I** iodine 53	131.3 **Xe** xenon 54
132.9 **Cs** caesium 55	137.3 **Ba** barium 56	138.9 **La** * lanthanum 57	178.5 **Hf** hafnium 72	180.9 **Ta** tantalum 73	183.8 **W** tungsten 74	186.2 **Re** rhenium 75	190.2 **Os** osmium 76	192.2 **Ir** iridium 77	195.1 **Pt** platinum 78	197.0 **Au** gold 79	200.6 **Hg** mercury 80	204.4 **Tl** thallium 81	207.2 **Pb** lead 82	209.0 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
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	58	59	60	61	62	63	64	65	66	67	68	69	70	71
* 58 – 71 Lanthanides	140.1 **Ce** cerium 58	140.9 **Pr** praseodymium 59	144.2 **Nd** neodymium 60	[145] **Pm** promethium 61	150.4 **Sm** samarium 62	152.0 **Eu** europium 63	157.3 **Gd** gadolinium 64	158.9 **Tb** terbium 65	162.5 **Dy** dysprosium 66	164.9 **Ho** holmium 67	167.3 **Er** erbium 68	168.9 **Tm** thulium 69	173.1 **Yb** ytterbium 70	175.0 **Lu** lutetium 71
† 90 – 103 Actinides	232.0 **Th** thorium 90	231.0 **Pa** protactinium 91	238.0 **U** uranium 92	[237] **Np** neptunium 93	[244] **Pu** plutonium 94	[243] **Am** americium 95	[247] **Cm** curium 96	[247] **Bk** berkelium 97	[251] **Cf** californium 98	[252] **Es** einsteinium 99	[257] **Fm** fermium 100	[258] **Md** mendelevium 101	[259] **No** nobelium 102	[262] **Lr** lawrencium 103

Activity 7

Use the periodic table to find the following:

1. The atomic number of: osmium, sodium, lead, chlorine.

2. The relative atomic mass of: helium, barium, europium, oxygen.

3. The number of protons in: mercury, iodine, calcium.

4. The symbol for: gold, lead, copper, iron.

5. The name of: Sr, Na, Ag, Hg.

6. THInK can be written using a combination of the symbols for Thorium, Indium and Potassium (ThInK). Which combinations of element symbols could be used to make the following words?

AMERICA, FUN, PIRATE, LIFESPAN, FRACTION, EROSION, DYNAMO

Activity 8: research activity

Research either:

The history of the periodic table

OR

The history of models of atomic structure.

Present your findings as a simple timeline. You should include the work of at least four people. For each, explain what evidence or experiments they used and how this changed the understanding of chemistry.

Relative atomic mass (A_r)

If there are several isotopes of an element, the relative atomic mass will take into account the proportion of atoms in a sample of each isotope.

For example, chlorine gas is made up of 75% of chlorine-35 $^{35}{}_{17}Cl$ and 25% of chlorine-37 $^{37}_{17}Cl$.

The relative atomic mass of chlorine is therefore the mean atomic mass of the atoms in a sample, and is calculated by:

$$A_r = \left(\frac{75.0}{100} \times 35\right) + \left(\frac{25.0}{100} \times 37\right) = 26.25 + 9.25 = 35.5$$

Activity 9

1. **What is the relative atomic mass of Bromine, if the two isotopes, ^{79}Br and ^{81}Br, exist in equal amounts?**

2. **Neon has three isotopes. ^{20}Ne accounts for 90.9%, ^{21}Ne accounts for 0.3% and the last 8.8% of a sample is ^{22}Ne. What is the relative atomic mass of neon?**

3. **Magnesium has the following isotope abundances: ^{24}Mg: 79.0%; ^{25}Mg: 10.0% and $_{26}$ Mg: 11.0%. What is the relative atomic mass of magnesium?**

Harder:

4. Boron has two isotopes, ^{10}B and ^{11}B. The relative atomic mass of boron is 10.8. What are the percentage abundances of the two isotopes?

5. Copper's isotopes are **^{63}Cu and ^{65}Cu. If the relative atomic mass of copper is 63.5, what are the relative abundances of these isotopes?**

Relative formula mass (M_r)

Carbon dioxide, CO_2 has 1 carbon atom (A_r = 12.0) and two oxygen atoms (A_r = 16.0). The relative formula mass is therefore

$M_r = (12.0 \times 1) + (16.0 \times 2) = 44.0$

Magnesium hydroxide $Mg(OH)_2$ has one magnesium ion (A_r = 24.3) and two hydroxide ions, each with one oxygen (A_r = 16.0) and one hydrogen (A_r = 1.0).

The relative formula mass is therefore:

$(24.3 \times 1) + (2 \times (16.0 + 1.0)) = 58.3$

Activity 10

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 $(NH_4)_2SO_4$

Common ions

Positive ions (cations)		Negative ions (anions)	
Name	**Symbol**	**Name**	**Symbol**
Hydrogen	H^+	Hydroxide	OH^-
Sodium	Na^+	Chloride	Cl^-
Lithium	Li^+	Bromide	Br^-
Silver	Ag^+	Oxide	O^{2-}
Magnesium	Mg^{2+}	Hydrogencarbonate	HCO_3^-
Calcium	Ca^{2+}	Nitrate	NO_3^-
Zinc	Zn^{2+}	Sulfate	SO_4^{2-}
Aluminium	Al^{3+}	Carbonate	CO_3^{2-}
Ammonium	NH_4^+	Phosphate	PO_4^{3-}

Some elements have more than one charge. For example, iron can form ions with a charge of +2 or +3. Compounds containing these are named Iron(II) and Iron(III) respectively.

Other common elements with more than one charge include:

Chromium(II) and chromium(III)

Copper(I) and copper(II)

Lead(II) and lead(IV)

Activity 11

On the periodic table on the following page, colour elements that form one atom ions (eg Na^+ or O^{2-}) according to the following key:

Charge	Colour
+1	red
+2	yellow
+3	green
-1	blue
-2	brown

Key

relative atomic mass
symbol
name
atomic (proton) number

1 (1)	2 (2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	3 (13)	4 (14)	5 (15)	6 (16)	7 (17)	0 (18)
							1.0 **H** hydrogen 1										4.0 **He** helium 2
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Ionic compounds must have an overall neutral charge. The ratio of cations to anions must mean that there is as many positives as negatives.

For example:

NaCl	
Na^+	**Cl^-**
+1	**-1**

MgO	
Mg^{2+}	**O^{2-}**
+2	**–2**

$MgCl_2$	
	Cl^-
Mg^{2+}	**Cl^-**
+2	**–2**

Activity 12

Work out what the formulas for the following ionic compounds should be:

1. **Magnesium bromide**

2. **Barium oxide**

3. **Zinc chloride**

4. **Ammonium chloride**

5. **Ammonium carbonate**

6. **Aluminium bromide**

7. **Iron(II) sulfate**

8. **Iron(III) sulfate**

Diatomic molecules

A number of atoms exist in pairs as diatomic (two atom) molecules.

The common ones that you should remember are:

Hydrogen H_2, Oxygen O_2, Fluorine F_2, Chlorine Cl_2, Bromine Br_2, Nitrogen N_2 and Iodine I_2

Common compounds

There are several common compounds from your GCSE studies that have names that do not help to work out their formulas. For example, water is H_2O.

Activity 13: Research activity

What are the formulas of the following compounds?

1. **Methane**

2. **Ammonia**

3. **Hydrochloric acid**

4. **Sulfuric acid**

5. **Sodium hydroxide**

6. **Potassium manganate(VII)**

7. **Hydrogen peroxide**

Balancing equations

Chemical reactions never create or destroy atoms. They are only rearranged or joined in different ways.

When hydrogen and oxygen react to make water: hydrogen + oxygen ➔ water

$H_2 + O_2 \rightarrow H_2O$

There are two hydrogen atoms on both sides of this equation, but two oxygen atoms on the left and only one on the right. This is not balanced.

This can be balanced by writing:

$2H_2 + O_2 \rightarrow 2H_2O$

The reactants and products in this reaction are known and you can't change them. The compounds can't be changed and neither can the subscripts because **that would change the compounds. So, to balance the equation, a number must be added in front of the compound or element in the equation. This is a coefficient. Coefficients show how many atoms or molecules there are.**

Activity 14

Write balanced symbol equations for the following reactions. You'll need to use the **information on the previous pages to work out the formulas of the compounds. Remember some of the elements may be diatomic molecules.**

1. **Aluminium + oxygen ➔ aluminium oxide**

2. **Methane + oxygen ➔ carbon dioxide + water**

3. **Aluminium + bromine ➔ aluminium bromide**

4. **Calcium carbonate + hydrochloric acid ➔ calcium chloride + water + carbon dioxide**

5. Aluminium sulfate + calcium hydroxide ➔ aluminium hydroxide + calcium sulfate

Harder:

6. Silver nitrate + potassium phosphate ➔ silver phosphate + potassium nitrate

More challenging:

7.

Potassium manganate(VII) + hydrochloric acid ➔ potassium chloride + manganese(II) chloride + water + chlorine

Moles

A mole is the amount of a substance that contains 6.02×10^{23} particles.

The mass of 1 mole of any substance is the relative formula mass (M_r) in grams.

Examples:

One mole of carbon contains 6.02×10^{23} particles and has a mass of 12.0 g

Two moles of copper contains 12.04×10^{23} particles, and has a mass of 127 g 1 mole of water contains 6.02×10^{23} particles and has a mass of 18 g

The amount in moles of a substance can be found by using the formula:

$$\text{Amount in moles of a substance} = \frac{\text{mass of substance}}{\text{relative formula mass}}$$

Activity 15

Fill in the table.

Substance	Mass of substance	Amount/moles	Number of particles
Helium			18.12×10^{23}
Chlorine	14.2		
Methane		4	
Sulfuric acid	4.905		

Empirical formula

If you measure the mass of each reactant used in a reaction, you can work out the ratio of atoms of each reactant in the product. This is known as the empirical formula. This may give you the actual chemical formula, as the actual formula may be a multiple of this. For example, hydrogen peroxide is H_2O_2 but would have the empirical formula HO.

Use the following to find an empirical formula:

1. **Write down reacting masses**
2. **Find the amount in moles of each element**
3. **Find the ratio of moles of each element**

Example:

A compound contains 2.232 g of ion, 1.284 g of sulfur and 1.920 g of oxygen. What is the empirical formula?

Element	Iron	Sulfur	Oxygen
mass/relative atomic mass	2.232/55.8	1.284/32.1	1.920/16.0
Amount in moles	0.040	0.040	0.120
Divide by smallest value	0.040/0.040	0.040/0.040	0.120/0.040
Ratio	1	1	3

So the empirical formula is $FeSO_3$.

If the question gives the percentage of each element instead of the mass, replace mass with the percentage of an element present and follow the same process.

Activity 16

Work out the following empirical formulas:

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?

The Periodic Table of the Elements

Key

relative atomic mass
symbol
name
atomic (proton) number

1	2											3	4	5	6	7	0
							1.0 **H** hydrogen 1										(18)
(1)	(2)											(13)	(14)	(15)	(16)	(17)	4.0 **He** helium 2
6.9 **Li** lithium 3	9.0 **Be** beryllium 4											10.8 **B** boron 5	12.0 **C** carbon 6	14.0 **N** nitrogen 7	16.0 **O** oxygen 8	19.0 **F** fluorine 9	20.2 **Ne** neon 10
23.0 **Na** sodium 11	24.3 **Mg** magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	27.0 **Al** aluminium 13	28.1 **Si** silicon 14	31.0 **P** phosphorus 15	32.1 **S** sulfur 16	35.5 **Cl** chlorine 17	39.9 **Ar** argon 18
39.1 **K** potassium 19	40.1 **Ca** calcium 20	45.0 **Sc** scandium 21	47.9 **Ti** titanium 22	50.9 **V** vanadium 23	52.0 **Cr** chromium 24	54.9 **Mn** manganese 25	55.8 **Fe** iron 26	58.9 **Co** cobalt 27	58.7 **Ni** nickel 28	63.5 **Cu** copper 29	65.4 **Zn** zinc 30	69.7 **Ga** gallium 31	72.6 **Ge** germanium 32	74.9 **As** arsenic 33	79.0 **Se** selenium 34	79.9 **Br** bromine 35	83.8 **Kr** krypton 36
85.5 **Rb** rubidium 37	87.6 **Sr** strontium 38	88.9 **Y** yttrium 39	91.2 **Zr** zirconium 40	92.9 **Nb** niobium 41	96.0 **Mo** molybdenum 42	[98] **Tc** technetium 43	101.1 **Ru** ruthenium 44	102.9 **Rh** rhodium 45	106.4 **Pd** palladium 46	107.9 **Ag** silver 47	112.4 **Cd** cadmium 48	114.8 **In** indium 49	118.7 **Sn** tin 50	121.8 **Sb** antimony 51	127.6 **Te** tellurium 52	126.9 **I** iodine 53	131.3 **Xe** xenon 54
132.9 **Cs** caesium 55	137.3 **Ba** barium 56	138.9 **La** * lanthanum 57	178.5 **Hf** hafnium 72	180.9 **Ta** tantalum 73	183.8 **W** tungsten 74	186.2 **Re** rhenium 75	190.2 **Os** osmium 76	192.2 **Ir** iridium 77	195.1 **Pt** platinum 78	197.0 **Au** gold 79	200.6 **Hg** mercury 80	204.4 **Tl** thallium 81	207.2 **Pb** lead 82	209.0 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac** † actinium 89	[267] **Rf** rutherfordium 104	[268] **Db** dubnium 105	[271] **Sg** seaborgium 106	[272] **Bh** bohrium 107	[270] **Hs** hassium 108	[276] **Mt** meitnerium 109	[281] **Ds** darmstadtium 110	[280] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

* 58 – 71 Lanthanides	140.1 **Ce** cerium 58	140.9 **Pr** praseodymium 59	144.2 **Nd** neodymium 60	[145] **Pm** promethium 61	150.4 **Sm** samarium 62	152.0 **Eu** europium 63	157.3 **Gd** gadolinium 64	158.9 **Tb** terbium 65	162.5 **Dy** dysprosium 66	164.9 **Ho** holmium 67	167.3 **Er** erbium 68	168.9 **Tm** thulium 69	173.1 **Yb** ytterbium 70	175.0 **Lu** lutetium 71
† 90 – 103 Actinides	232.0 **Th** thorium 90	231.0 **Pa** protactinium 91	238.0 **U** uranium 92	[237] **Np** neptunium 93	[244] **Pu** plutonium 94	[243] **Am** americium 95	[247] **Cm** curium 96	[247] **Bk** berkelium 97	[251] **Cf** californium 98	[252] **Es** einsteinium 99	[257] **Fm** fermium 100	[258] **Md** mendelevium 101	[259] **No** nobelium 102	[262] **Lr** lawrencium 103

Activity 17 : Equations that you've done !

Feel free to research/remind yourself. Try these questions to refresh your equations

Group 7

Q1] This is a halogen displacement reaction :

$$Cl_{2\ (aq)} + 2LiBr_{(aq)} \rightarrow Br_{2\ (aq)} + 2LiCl_{(aq)}$$

a) Why is lithium bromide used "in solution" for this reaction, as it would normally be a solid at room temperature and pressure.

____

____

b) What would you SEE happening at this reaction takes place ?

____

____

c) Suggest why chlorine is used in solution for this reaction, as chlorine is a gas ?

____

____

d) What is the role ("job") of lithium ions in this reaction ?

____

____

e) Write an **ionic equation** for this reaction by removing the "spectator ions".

f) Which is the more powerful reducing agent in this reaction Cl atoms or Br^- ions ?
How do you know ? *(a reducing agent reduces the thing that it is reacting with by giving it electrons !)*

____

____

g) Describe what you would observe if you added silver nitrate solution to the products of this reaction ?

____

Metal + Acid

[General equation] Metal + acid ➔ metal salt + hydrogen

The salt depends on the acid used.
HCl forms **chloride** salts
H_2SO_4 forms **sulphate** salts
HNO_3 forms **nitrate** salts

Q2] Select the correct formulae of the following metal salts formed in reactions with acids, by looking at the charges and getting the total + charge to equal the total - charge, from the four choices for each question

a] Potassium sulphate

KSO_4 K_2SO_4 $K(SO_4)_2$ K_3SO_4

b] Zinc Nitrate

$ZnNO_3$ Zn_2NO_3 $Zn(NO_3)_2$ $Zn(NO_3)_3$

c] Iron III chloride

$FeCl$ Fe_3Cl $FeCl_2$ $FeCl_3$

Q3] Complete these metal – acid equations :
Li forms 1+ ions
Mg forms 2+ ions
Al forms 3+ ions

a)

_____ Li $_{(s)}$ + _____ HCl $_{(aq)}$ ➔ _____ LiCl $_{(aq)}$ + _____$H_{2(g)}$

b)

_____ Li $_{(s)}$ + _____ HNO_3 $_{(aq)}$ ➔ _____ __________ $_{(aq)}$ + _____$H_{2(g)}$

c)

_____ Li $_{(s)}$ + _____ H_2SO_4 $_{(aq)}$ ➔ _____ __________ $_{(aq)}$ + ____ ______$_{(g)}$

d)

_____ Mg $_{(s)}$ + _____ HCl $_{(aq)}$ ➔ _____ $MgCl_2$ $_{(aq)}$ + _____$H_{2(g)}$

e)

_____ Mg $_{(s)}$ + _____ HNO_3 $_{(aq)}$ ➔ _____ __________ $_{(aq)}$ + _____$H_{2(g)}$

f)

_____ Mg $_{(s)}$ + _____ H_2SO_4 $_{(aq)}$ ➔ _____ __________ $_{(aq)}$ + ____ ______$_{(g)}$

g)

_____ Al $_{(s)}$ + _____ HCl $_{(aq)}$ ➔ _____ $AlCl_3$ $_{(aq)}$ + _____$H_{2(g)}$

h)

_____ Al $_{(s)}$ + _____ HNO_3 $_{(aq)}$ ➔ _____ __________ $_{(aq)}$ + _____$H_{2(g)}$

i)

_____ Al $_{(s)}$ + _____ H_2SO_4 $_{(aq)}$ ➔ _____ __________ $_{(aq)}$ + ____ ______$_{(g)}$

Q4] You can also represent these reactions as **ionic equations** – which show more detail on what actually happened.

eg/ *[full equation]* $2Rb_{(s)} + 2HCl_{(aq)} \rightarrow 2RbCl_{(aq)} + H_{2(g)}$

decisions:
- the acid part of the HCl (the thing that makes HCl an acid) are the H^+ ions.
- here Cl is Cl^- ions on the left and Cl^- ions on the right. In other words, no change ! Spectator ions …
….remove them.
- have to leave the H_2 in at the end to show what happened to the H+ ions.

Answer:

[ionic equation] $2Rb + 2H^+ \rightarrow 2Rb^+ + H_2$

write ionic equations for the following metal – acid reactions:

a) *[Full]* $2Cs + 2HNO_3 \rightarrow 2CsNO_3 + H_2$

b) *[Full]* $Cu + 2HNO_3 \rightarrow Cu(NO_3)_2 + H_2$

c) *[Full]* $2Fe + 6HNO_3 \rightarrow 2Fe(NO_3)_3 + 3H_2$

d) *[Full]* $2Cs + H_2SO_4 \rightarrow Cs_2SO_4 + H_2$

e) *[Full]* $2Cs + 2HCl \rightarrow 2CsCl + H_2$

Acid reactions

- anything that reacts with an acid (and neutralises it) is known as a "**base**".

- bases include : metal elements (eg/ Cu), metal oxide compounds (eg/ CuO), metal hydroxide compounds (eg/ $Cu(OH)_2$) and metal carbonate compounds (eg/ $CuCO_3$).

- some metal hydroxides are soluble in water. These are known as "**alkalis**".
  (eg/ LiOH, NaOH, KOH)

- they're all neutralisation reactions.

- in each reaction, the acid does the same thing !
  It gives away H^+ ions that turn into either H_2 gas *(reaction with metal only)* or H_2O.

- once again, the type of acid determines the type of salt formed :
  - HCl forms **chloride** salts
  - H_2SO_4 forms **sulphate** salts
  - HNO_3 forms **nitrate** salts

Here are the <u>general equations</u> for these reactions:

Metal oxide + acid ➔ metal salt + water

(eg/ $Na_2O + 2HCl \rightarrow 2NaCl + H_2O$………… *$H_2O$ because 2xH from acid and O from base)*

Metal hydroxide + acid ➔ metal salt + water

(eg/ $NaOH + HCl \rightarrow NaCl + H_2O$ ……… *H_2O because H from acid and OH from base*)

Metal carbonate + acid ➔ metal salt + water + carbon dioxide

(eg/ $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$)

Metal oxide + acid

Q5] Complete these equations (some just require balancing):

a)

$$\_\_\_\_\_ \ Li_2O_{(s)} + \_\_\_\_\_ \ HCl_{(aq)} \rightarrow \_\_\_\_\_ \ LiCl_{(aq)} + \_\_\_\_\_ \ H_2O_{(l)}$$

b)

$$\_\_\_\_\_ \ Li_2O + \_\_\_\_\_ \ HNO_{3\,(aq)} \rightarrow \_\_\_\_\_ \ \_\_\_\_\_\_\_\_\_\__{(aq)} + \_\_\_\_\_ \ H_2O_{(l)}$$

c)

_____ $Li_2O_{(s)}$ + _____ $H_2SO_{4\ (aq)}$ → _____ __________ $_{(aq)}$ + ____ _______$_{(l)}$

d)

_____ $MgO_{(s)}$ + _____ $HCl_{(aq)}$ → _____ $MgCl_{2\ (aq)}$ + _____ $H_2O_{(l)}$

e)

_____ $MgO_{(s)}$ + _____ $HNO_{3\ (aq)}$ → _____ __________ $_{(aq)}$ + ____ $H_2O_{(l)}$

f)

_____ $MgO_{(s)}$ + _____ $H_2SO_{4\ (aq)}$ → _____ ________ $_{(aq)}$ + ____ _______$_{(l)}$

g)

_____ $Al_2O_{3\ (s)}$ + _____ $HCl_{(aq)}$ → _____ $AlCl_{3\ (aq)}$ + _____ $H_2O_{(l)}$

h)

_____ $Al_2O_{3\ (s)}$ + _____ $HNO_{3\ (aq)}$ → _____ ___________ $_{(aq)}$ + _____ $H_2O_{(l)}$

i)

_____ $Al_2O_{3\ (s)}$ + ____ $H_2SO_{4\ (aq)}$ → _____ __________ $_{(aq)}$ + ____ _______$_{(l)}$

Q6] Write **ionic equations** for Q5a, 5d and 5g in the space below.

Metal hydroxide + acid reactions

Q7] Complete these equations (some just require balancing):

a)

_____ $NaOH_{(aq)}$ + _____ $HCl_{(aq)}$ ➔ _____ $NaCl_{(aq)}$ + _____$H_2O_{(l)}$

b)

_____ NaOH + _____ HNO_3 ➔ _____ __________ + _____ H_2O

c)

_____ NaOH + _____ H_2SO_4 ➔ _____ __________ + ____ ______

Note : Calcium hydroxide is only sparingly soluble in water. The solution is known as limewater.

d)

_____ $Ca(OH)_2$ (aq) + _____ HCl (aq) ➔ _____ _________(aq) + _____ $H_2O_{(l)}$

e)

____ $Ca(OH)_2$ (aq) + ____ H_2SO_4 (aq) ➔ _____ ________ (aq) + ____ _______(l)

Q8] Write **ionic equations** for Q7a and 7b in the space below

Metal carbonate + acid reactions

Q9] Complete these equations (some just require balancing):

a)

___ $Li_2CO_{3\ (s)}$ + ___ $HCl_{(aq)}$ ➔ ___ $LiCl_{(aq)}$ + ___$H_2O_{(l)}$ + ___$CO_{2\ (g)}$

b)

___ Li_2CO_3 + ___ HNO_3 ➔ ___ _______ + ___ H_2O + ___CO_2

c)

___ Li_2CO_3 + ___ H_2SO_4 ➔ ___ ________ + _________ + _______

d)

_____ $CaCO_3$ + ___ HCl ➔ ___ $CaCl_2$ + ____H_2O + ___CO_2

e)

___ $CaCO_3$ + ___ H_2SO_4 ➔ ___ _________ + ____H_2O + ___CO_2

f)

_____ $Al_2(CO_3)_3$ + _____ HCl ➔ ___________ + __________+ _______

Q10] Write **ionic equations** for Q9a and 9d below

Remember, the acid donates its H^+, the negative ion part (the non-metal bit) of the base accepts the acids H^+.