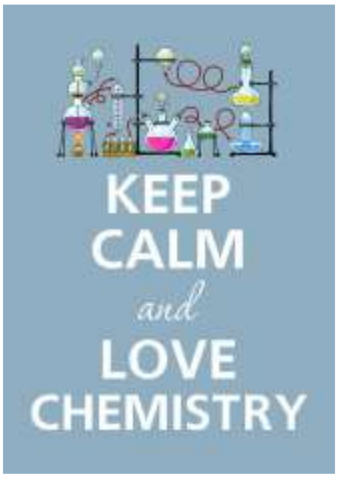
A Level Chemistry Transition Guide

You're studying AS or A-level Chemistry, congratulations!

Welcome to A-level Chemistry. This pack contains a programme of activities and resources to prepare you to start an A-level in Chemistry in September. It is aimed to be used over the Summer Holidays to ensure you are ready to start your course in September.

The transition from GCSEs to A-levels is challenging, and we as teachers expect mature and organised students, but most of all we want you to be passionate about our subject.



You might think of chemistry only in the context of lab tests, food additives or dangerous substances, but the field of chemistry involves everything around us.

"Everything you hear, see, smell, taste, and touch involves chemistry and chemicals (matter)," American Chemical Society

Chemistry is about matter, defined as anything that has mass and takes up space, and the changes that matter can undergo when it is subject to different environments and conditions.

At first, you may find the jump in demand from GCSE a little daunting, but if you follow the tips and advice in this guide, you'll soon adapt.

<u>Course information</u>:

- We will be following the AQA A-level Chemistry syllabus
- You will complete a baseline test in September to check your understanding of topics
- You will sit two exams at the end of Year 12, which you will need to pass in order to progress to Year 13. These exams do NOT contribute to your final A-level qualification.
- You will sit three exams at the end of Year 13, each contributing ≈33% towards your A-level qualification

<u>Chemistry lesson information and expectations</u>:

- You will attend 5 x 60 minute lessons each week
- Lessons and assessments will consist of both practical skill and theory content
- You must complete at least 12 assessed practical investigations over the course of the A-level course
- Homework must be completed and handed in on time
- Tests will take place at the end of each topic and each unit

Independent study will be completed each week

Specification at a glance

AS and A-level

3.1 Physical chemistry

3.1.1 Atomic structure
3.1.2 Amount of substance
3.1.3 Bonding
3.1.4 Energetics
3.1.5 Kinetics
3.1.6 Chemical equilibria, Le Chatelier's principle and K_c
3.1.7 Oxidation, reduction and redox equations

3.1.8 Thermodynamics (A-level only)
3.1.9 Rate equations (A-level only)
3.1.10 Equilibrium constant K_p for homogeneous systems (A-level only)
3.1.11 Electrode potentials and electrochemical cells (A-level only)
3.1.12 Acids and bases (A-level only)

3.2 Inorganic chemistry

3.2.1 Periodicity
3.2.2 Group 2, the alkaline earth metals
3.2.3 Group 7(17), the halogens

3.2.4 Properties of Period 3 elements and their oxides (A-level only)
3.2.5 Transition metals (A-level only)
3.2.6 Reactions of ions in aqueous solution (A-level only)

3.3 Organic chemistry

3.3.1 Introduction to organic chemistry
3.3.2 Alkanes
3.3.3 Halogenoalkanes
3.3.4 Alkenes
3.3.5 Alcohols
3.3.6 Organic analysis

3.3.7 Optical isomerism (A-level only)
3.3.8 Aldehydes and ketones (A-level only)
3.3.9 Carboxylic acids and derivatives (A-level only)
3.3.10 Aromatic chemistry (A-level only)
3.3.11 Amines (A-level only)
3.3.12 Polymers (A-level only)
3.3.13 Amino acids, proteins and DNA (A-level only)
3.3.14 Organic synthesis (A-level only)
3.3.15 Nuclear magnetic resonance spectroscopy (A-level only)
3.3.16 Chromatography (A-level only)

Book Recommendations

Periodic Tales: The Curious Lives of the Elements (Paperback) Hugh Aldersey-Williams
ISBN-10: 0141041455
http://bit.ly/pixlchembook1
This book covers the chemical elements, where they come from and how they are used. There are loads of fascinating insights into uses for chemicals you would have never even thought about.

The Science of Everyday Life: Why Teapots Dribble, Toast Burns and Light Bulbs Shine (Hardback) Marty Jopson
ISBN-10: 1782434186
http://bit.ly/pixlchembook2
The title says it all really, lots of interesting stuff about the things around you home!

Bad Science (Paperback) Ben Goldacre
ISBN-10: 000728487X
http://bit.ly/pixlchembook3
Here Ben Goldacre takes apart anyone who published bad / misleading or dodgy science – this book will make you think about everything the advertising industry tries to sell you by making it sound 'sciency'.

Calculations in AS/A Level Chemistry (Paperback) Jim Clark
ISBN-10: 0582411270
http://bit.ly/pixlchembook4
If you struggle with the calculations side of chemistry, this is the book for you. Covers all the possible calculations you are ever likely to come across. Brought to you by the same guy who wrote the excellent chemguide.co.uk website.

Salters' Advanced Chemistry: Chemical Storylines
Do not feel you need to buy the latest edition (unless you are doing Salters chemistry!) You can pick up an old edition for a few pounds on ebay, gives you a real insight into how chemistry is used to solve everyday problems from global pollution through feeding to world to making new medicines to treat disease.

Movie / Video Clip Recommendations

Rough science – the Open University – 34 episodes available
Real scientists are 'stranded' on an island and are given scientific problems to solve using only what they can find on the island.
Great fun if you like to see how science is used in solving problems.
There are six series in total
http://bit.ly/pixlchemvid1a
http://www.dailymotion.com/playlist/x2igjq_Rough-Science_rough-science-full-series/1#video=xxw6pr
or
http://bit.ly/pixlchemvid1b
https://www.youtube.com/watch?v=lUoDWAt259I

A thread of quicksilver – The Open University
A brilliant history of the most mysterious of elements – mercury. This program shows you how a single substance led to empires and war, as well as showing you come of the cooler properties of mercury.
http://bit.ly/pixlchemvid2
https://www.youtube.com/watch?v=t46lvTxHHTA

10 weird and wonderful chemical reactions
10 good demonstration reactions, can you work out the chemistry of …. any… of them?
http://bit.ly/pixlchemvid3
https://www.youtube.com/watch?v=0Bt6RPP2ANI

Chemistry in the Movies
Dantes Peak 1997: Volcano disaster movie.
Use the link to look at the Science of acids and how this links to the movie.
http://www.open.edu/openlearn/science-maths-technology/science/chemistry/dantes-peak
http://www.flickclip.com/flicks/dantespeak1.html
http://www.flickclip.com/flicks/dantespeak5.html

Fantastic 4 2005 &2015: Superhero movie
Michio Kaku explains the "real" science behind fantastic four http://nerdist.com/michio-kaku-explains-the-real-science-behind-fantastic-four/
http://www.flickclip.com/flicks/fantastic4.html

You are not expected to watch / read all recommendations but if you could pick a selection that particularly appeals.

Transition from GCSE to A Level

Moving from GCSE Science to A Level can be a daunting leap. You'll be expected to remember a lot more facts, equations, and definitions, and you will need to learn new maths skills and develop confidence in applying what you already know to unfamiliar situations.

This worksheet aims to give you a head start by helping you:

- to pre-learn some useful knowledge from the first chapters of your A Level course
- understand and practice of some of the maths skills you'll need.

Compulsory Task for non-Triple Science Candidates

You need to purchase and complete the 'Head Start to AS Chemistry' book

- Publisher: Coordination Group Publications Ltd (CGP) (2nd Mar. 2015)
- ISBN 978 1 78294 280 1

Having only studied the content for 2 GCSEs there are already gaps compared to those who have 3 science GCSEs. Completing this book will help to fill those gaps.

All of the questions should be fully answered with clear and structured workings on paper with content titles. *This is to be brought to your first Chemistry lesson*.

Retrieval questions

You need to be confident about the definitions of terms that describe measurements and results in A Level Chemistry.

Learn the answers to the questions below then cover the answers column with a piece of paper and write as many answers as you can. Check and repeat.

Practical science key terms

When is a measurement valid?	when it measures what it is supposed to be measuring
When is a result accurate?	when it is close to the true value
What are precise results?	when repeat measurements are consistent/agree closely with each other
What is repeatability?	how precise repeated measurements are when they are taken by the *same* person, using the *same* equipment, under the *same* conditions
What is reproducibility?	how precise repeated measurements are when they are taken by *different* people, using *different* equipment
What is the uncertainty of a measurement?	the interval within which the true value is expected to lie

Define measurement error	the difference between a measured value and the true value
What type of error is caused by results varying around the true value in an unpredictable way?	random error
What is a systematic error?	a consistent difference between the measured values and true values
What does zero error mean?	a measuring instrument gives a false reading when the true value should be zero
Which variable is changed or selected by the investigator?	independent variable
What is a dependent variable?	a variable that is measured every time the independent variable is changed
Define a fair test	a test in which only the independent variable is allowed to affect the dependent variable
What are control variables?	variables that should be kept constant to avoid them affecting the dependent variable

Atomic structure

Learn the answers to the questions below then cover the answers column with a piece of paper and write as many answers as you can. Check and repeat.

What does an atom consist of?	a nucleus containing protons and neutrons, surrounded by electrons
What are the relative masses of a proton, neutron, and electron?	1, 1, and $\frac{1}{1840}$ respectively
What are the relative charges of a proton, neutron, and electron?	+1, 0, and -1 respectively
How do the number of protons and electrons differ in an atom?	they are the same because atoms have neutral charge
What force holds an atomic nucleus together?	strong nuclear force
What is the atomic number of an element?	the number of protons in the nucleus of a single atom of an element
What is the mass number of an element?	number of protons + number of neutrons
What is an isotope?	an atom with the same number of protons but different number of neutrons
What is an ion?	an atom, or group of atoms, with a charge

What is the function of a mass spectrometer?	it accurately determines the mass and abundance of separate atoms or molecules, to help us identify them
What is a mass spectrum?	the output from a mass spectrometer that shows the different isotopes that make up an element
What is the total number of electrons that each electron shell (main energy level) can contain?	$2n^2$ electrons, where n is the number of the shell
How many electrons can the first three electron shells hold each?	2 electrons (first shell), 8 electrons (second shell), 18 electrons (third shell)
What are the first four electron sub-shells (orbitals) called?	s, p, d, and f (in order)
How many electrons can each orbital hold?	a maximum of 2 electrons
Define the term ionisation energy, and give its unit	the energy it takes to remove a mole of electrons from a mole of atoms in the gaseous state, unit = kJ mol^{-1}
What is the equation for relative atomic mass (A_r)?	relative atomic mass = $\frac{\text{average mass of 1 atom}}{\frac{1}{12}^{\text{th}} \text{ mass of 1 atom of } ^{12}\text{C}}$
What is the equation for relative molecular mass (M_r)?	relative molecular mass = $\frac{\text{average mass of 1 molecule}}{\frac{1}{12}^{\text{th}} \text{ mass of 1 atom of } ^{12}\text{C}}$

Maths skills

1 Core mathematical skills

A practical chemist must be proficient in standard form, significant figures, decimal places, SI units, and unit conversion.

1.1 Standard form

In science, very large and very small numbers are usually written in standard form. Standard form is writing a number in the format A × 10^x where A is a number from 1 to 10 and x is the number of places you move the decimal place.

For example, to express a large number such as 50 000 mol dm^{-3} in standard form, A = 5 and x = 4 as there are four numbers after the initial 5.

Therefore, it would be written as 5×10^4 mol dm^{-3}.

To give a small number such as 0.000 02 Nm^2 in standard form, A = 2 and there are five numbers before it so x = −5.

So it is written as 2×10^{-5} Nm^2.

Practice questions

1 Change the following values to standard form.

a boiling point of sodium chloride: 1413 °C

b largest nanoparticles: 0.0 001×10^{-3} m

c number of atoms in 1 mol of water: 1806×10^{21}

2 Change the following values to ordinary numbers.

a 5.5×10^{-6} **b** 2.9×10^2 **c** 1.115×10^4 **d** 1.412×10^{-3} **e** 7.2×10^1

1.2 Significant figures and decimal places

In chemistry, you are often asked to express numbers to either three or four significant figures. The word significant means to 'have meaning'. A number that is expressed in significant figures will only have digits that are important to the number's precision.

It is important to record your data and your answers to calculations to a reasonable number of significant figures. Too many and your answer is claiming an accuracy that it does not have, too few and you are not showing the precision and care required in scientific analysis.

For example, 6.9301 becomes 6.93 if written to three significant figures.

Likewise, 0.000 434 56 is 0.000 435 to three significant figures.

Notice that the zeros before the figure are *not* significant – they just show you how large the number is by the position of the decimal point. Here, a 5 follows the last significant digit, so just as with decimals, it must be rounded up.

Any zeros between the other significant figures are significant. For example, 0.003 018 is 0.003 02 to three significant figures.

Sometimes numbers are expressed to a number of decimal places. The decimal point is a place holder and the number of digits afterwards is the number of decimal places.

For example, the mathematical number pi is 3 to zero decimal places, 3.1 to one decimal place, 3.14 to two decimal places, and 3.142 to three decimal places.

Practice questions

3 Give the following values in the stated number of significant figures (s.f.).

a 36.937 (3 s.f.) **b** 258 (2 s.f.) **c** 0.043 19 (2 s.f.) **d** 7 999 032 (1 s.f.)

4 Use the equation:

number of molecules = number of moles × 6.02 × 10^{23} molecules per mole

to calculate the number of molecules in 0.5 moles of oxygen. Write your answer in standard form to 3 s.f.

5 Give the following values in the stated number of decimal places (d.p.).

a 4.763 (1 d.p.) **b** 0.543 (2 d.p.) **c** 1.005 (2 d.p.) **d** 1.9996 (3 d.p.)

1.3 Converting units

Units are defined so that, for example, every scientist who measures a mass in kilograms uses the same size for the kilogram and gets the same value for the mass. Scientific measurement depends on standard units – most are *Système International* (SI) units.

If you convert between units and round numbers properly it allows quoted measurements to be understood within the scale of the observations.

Multiplication factor	Prefix	Symbol
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n

Unit conversions are common. For instance, you could be converting an enthalpy change of 488 889 J mol^{-1} into kJ mol^{-1}. A kilo is 10^3 so you need to divide by this number or move the decimal point three places to the left.

488 889 ÷ 10^3 kJ mol^{-1} = 488.889 kJ mol^{-1}

Converting from mJ mol^{-1} to kJ mol^{-1}, you need to go from 10^3 to 10^{-3}, or move the decimal point six places to the left.

333 mJ mol^{-1} is 0.000 333 kJ mol^{-1}

If you want to convert from 333 mJ mol^{-1} to nJ mol^{-1}, you would have to go from 10^{-9} to 10^{-3}, or move the decimal point six places to the right.

333 mJ mol^{-1} is 333 000 000 nJ mol^{-1}

Practice question

6 Calculate the following unit conversions.

a 300 µm to m

b 5 MJ to mJ

c 10 GW to kW

2 Balancing chemical equations

2.1 Conservation of mass

When new substances are made during chemical reactions, atoms are not created or destroyed – they just become rearranged in new ways. So, there is always the same number of each type of atom before and after the reaction, and the total mass before the reaction is the same as the total mass after the reaction. This is known as the conservation of mass.

You need to be able to use the principle of conservation of mass to write formulae, and balanced chemical equations and half equations.

2.2 Balancing an equation

The equation below shows the correct formulae but it is not balanced.

$H_2 + O_2 \rightarrow H_2O$

While there are two hydrogen atoms on both sides of the equation, there is only one oxygen atom on the right-hand side of the equation against two oxygen atoms on the left-hand side. Therefore, a two must be placed before the H_2O.

$H_2 + O_2 \rightarrow 2H_2O$

Now the oxygen atoms are balanced but the hydrogen atoms are no longer balanced. A two must be placed in front of the H_2.

$2H_2 + O_2 \rightarrow 2H_2O$

The number of hydrogen and oxygen atoms is the same on both sides, so the equation is balanced.

Practice question

1 Balance the following equations.

a $C + O_2 \rightarrow CO$

b $N_2 + H_2 \rightarrow NH_3$

c $C_2H_4 + O_2 \rightarrow H_2O + CO_2$

2.3 Balancing an equation with fractions

To balance the equation below:

$C_2H_6 + O_2 \rightarrow CO_2 + H_2O$

- Place a two before the CO_2 to balance the carbon atoms.
- Place a three in front of the H_2O to balance the hydrogen atoms.

  $C_2H_6 + O_2 \rightarrow 2CO_2 + 3H_2O$

There are now four oxygen atoms in the carbon dioxide molecules plus three oxygen atoms in the water molecules, giving a total of seven oxygen atoms on the product side.

- To balance the equation, place three and a half in front of the O_2.

  $C_2H_6 + 3\frac{1}{2}O_2 \rightarrow 2CO_2 + 3H_2O$

- Finally, multiply the equation by 2 to get whole numbers.

$$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$$

Practice question

2 Balance the equations below.

a $C_6H_{14} + O_2 \rightarrow CO_2 + H_2O$

b $NH_2CH_2COOH + O_2 \rightarrow CO_2 + H_2O + N_2$

2.4 Balancing an equation with brackets

$Ca(OH)_2 + HCl \rightarrow CaCl_2 + H_2O$

Here the brackets around the hydroxide (OH^-) group show that the $Ca(OH)_2$ unit contains one calcium atom, two oxygen atoms, and two hydrogen atoms.

To balance the equation, place a two before the HCl and another before the H_2O.

$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$

Practice question

3 Balance the equations below.

a $Mg(OH)_2 + HNO_3 \rightarrow Mg(NO_3)_2 + H_2O$

b $Fe(NO_3)_2 + Na_3PO_4 \rightarrow Fe_3(PO_4)_2 + NaNO_3$

3 Rearranging equations and calculating concentrations

3.1 Rearranging equations

In chemistry, you sometimes need to rearrange an equation to find the desired values.

For example, you may know the amount of a substance (*n*) and the mass of it you have (*m*), and need to find its molar mass (*M*).

The amount of substance (*n*) is equal to the mass you have (*m*) divided by the molar mass (*M*):

$$n = \frac{m}{M}$$

You need to rearrange the equation to make the molar mass (*M*) the subject.

Multiply both sides by the molar mass (*M*):

$$M \times n = m$$

Then divide both sides by the amount of substance (*n*):

$$m = \frac{m}{N}$$

Practice questions

4 Rearrange the equation $c = \frac{n}{V}$ to make:

a *n* the subject of the equation

b *V* the subject of the equation.

5 Rearrange the equation $PV = nRT$ to make:

a *n* the subject of the equation

b *T* the subject of the equation.

3.2 Calculating concentration

The concentration of a solution (a solute dissolved in a solvent) is a way of saying how much solute, in moles, is dissolved in 1 dm^3 or 1 litre of solution.

Concentration is usually measured using units of mol dm^{-3}. (It can also be measured in g dm^3.)

The concentration of the amount of substance dissolved in a given volume of a solution is given by the equation:

$$c = \frac{n}{V}$$

where n is the amount of substance in moles, c is the concentration, and V is the volume in dm^3.

The equation can be rearranged to calculate:

- the amount of substance n, in moles, from a known volume and concentration of solution
- the volume V of a solution from a known amount of substance, in moles, and the concentration of the solution.

Practice questions

6 Calculate the concentration, in mol dm^{-3}, of a solution formed when 0.2 moles of a solute is dissolved in 50 cm^3 of solution.

7 Calculate the concentration, in mol dm^{-3}, of a solution formed when 0.05 moles of a solute is dissolved in 2.0 dm^3 of solution.

8 Calculate the number of moles of NaOH in an aqueous solution of 36 cm^3 of 0.1 mol dm^{-3}.

4 Molar calculations

4.1 Calculating masses and gas volumes

The balanced equation for a reaction shows how many moles of each reactant and product are involved in a chemical reaction.

If the amount, in moles, of one of the reactants or products is known, the number of moles of any other reactants or products can be calculated.

The number of moles (n), the mass of the substance (m), and the molar mass (M) are linked by:

$$n = \frac{m}{M}$$

Note: The molar mass of a substance is the mass per mole of the substance. For $CaCO_3$, for example, the atomic mass of calcium is 40.1, carbon is 12, and oxygen is 16. So the molar mass of $CaCO_3$ is:

40.1 + 12 + (16 × 3) = 100.1. The units are g mol^{-1}.

Look at this worked example. A student heated 2.50 g of calcium carbonate, which decomposed as shown in the equation:

$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

The molar mass of calcium carbonate is 100.1 g mol^{-1}.

a Calculate the amount, in moles, of calcium carbonate that decomposes.

$$n = \frac{m}{M} = 2.50/100.1 = 0.025 \text{ mol}$$

b Calculate the amount, in moles, of carbon dioxide that forms.

From the balanced equation, the number of moles of calcium carbonate = number of moles of carbon dioxide = 0.025 mol

9 In a reaction, 0.486 g of magnesium was added to oxygen to produce magnesium oxide.

$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$

a Calculate the amount, in moles, of magnesium that reacted.

b Calculate the amount, in moles, of magnesium oxide made.

c Calculate the mass, in grams, of magnesium oxide made.

10 Oscar heated 4.25 g of sodium nitrate. The equation for the decomposition of sodium nitrate is:

$2NaNO_3(s) \rightarrow 2NaNO_2(s) + O_2(g)$

a Calculate the amount, in moles, of sodium nitrate that reacted.

b Calculate the amount, in moles, of oxygen made.

11 0.500 kg of magnesium carbonate decomposes on heating to form magnesium oxide and carbon dioxide. Give your answers to 3 significant figures.

$MgCO_3(s) \rightarrow MgO(s) + CO_2(g)$

a Calculate the amount, in moles, of magnesium carbonate used.

b Calculate the amount, in moles, of carbon dioxide produced.

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Answers given at end of document

Making the Jump to AS / A level

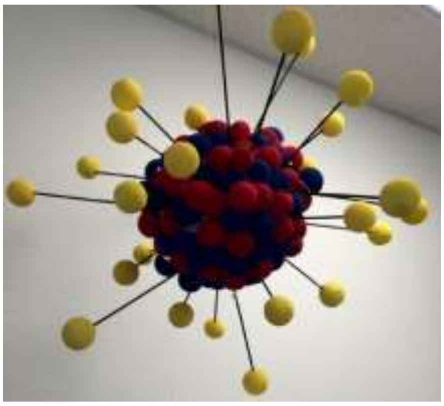
Please complete the AQA specific transition document 'lesson activity: GCSE to A level progression' - which can be found on our HGSS website under transition documents and on the AQA website (see link below). Mark schemes are provided.

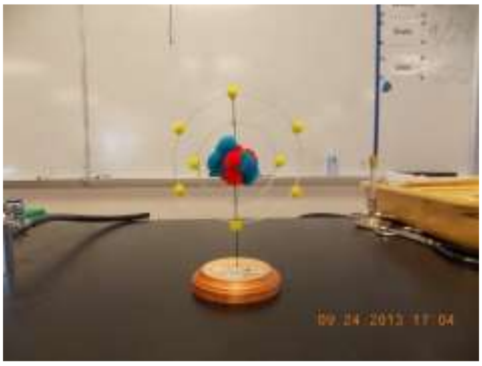
https://www.aqa.org.uk/subjects/science/as-and-a-level/chemistry-7404-7405/teaching-resources

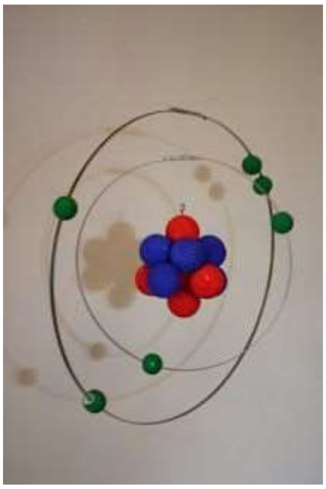
Extension

Build a model of an atom using whatever you like. Some useful materials might include polystyrene balls, straws, cocktail sticks, plasticine, coat hanger, wire, buttons, tiddly-winks, small fury pom-poms from art shop, sweets etc. What every you fancy. Take a picture and send to me, Dr Sarah Cockbill, cockbills@holmer.org.uk

Here are some examples to inspire you:







Research Activities

- Task 1: The chemistry of fireworks - What are the component parts of fireworks? What chemical compounds cause fireworks to explode? What chemical compounds are responsible for the colour of fireworks?
- Task 2: Why is copper sulfate blue? - Copper compounds like many of the transition metal compounds have got vivid and distinctive colours – but why?
- Task 3: Aspirin - What was the history of the discovery of aspirin, how do we manufacture aspirin in a modern chemical process?
- Task 4: The hole in the ozone layer - Why did we get a hole in the ozone layer? What chemicals were responsible for it? Why were we producing so many of these chemicals? What is the chemistry behind the ozone destruction?
- Task 5: ITO and the future of touch screen devices - ITO – indium tin oxide is the main component of touch screen in phones and tablets. The element indium is a rare element and we are rapidly running out of it. Chemists are desperately trying to find a more readily available replacement for it. What advances have chemists made in finding a replacement for it?

Follow the above links and begin to explore the wider world of Chemistry - You could make a 1-page summary for each one you research using Cornell notes:
http://coe.jmu.edu/learningtoolbox/cornellnotes.html

Pupil Background Information

Name	
GCSE results	
Why you chose to study Chemistry at A-level?	
What are you most looking forward to about studying A-level Chemistry?	
What are you most apprehensive about studying A-level Chemistry?	
What areas of Chemistry interest you the most?	

Please bring the completed background info sheet below to your first lesson

Answers to maths skills practice questions

1 Core mathematics

Practice questions

1 **a** 1.413×10^3 °C **b** 1.0×10^{-7} m
c 1.806×10^{21} atoms

2 **a** 0.000 0055 **b** 290
c 11150 **d** 0.001 412
e 72

3 **a** 36.9 **b** 260
c 0.043 **d** 8 000 000

4 Number of molecules = 0.5 moles × $6.022 \times 10^{23} = 3.011 \times 10^{23} = 3.01 \times 10^{23}$

5 **a** 4.8 **b** 0.54
c 1.01 **d** 2.000

6 **a** 0.0003 m **b** 5×10^9 mJ
c 1×10^7 kW

2 Balancing chemical equations

Practice questions

1 **a** $2C + O_2 \rightarrow 2CO$ **b** $N_2 + 3H_2 \rightarrow 2NH_3$
c $C_2H_4 + 3O_2 \rightarrow 2H_2O + 2CO_2$

2 **a** $C_6H_{14} + 9\frac{1}{2}O_2 \rightarrow 6CO_2 + 7H_2O$ **or** $2C_6H_{14} + 19O_2 \rightarrow 12CO_2 + 14H_2O$
b $2NH_2CH_2COOH + 4\frac{1}{2}O_2 \rightarrow 4CO_2 + 5H_2O + N_2$
or $4NH_2CH_2COOH + 9O_2 \rightarrow 8CO_2 + 10H_2O + 2N_2$

3 **a** $Mg(OH)_2 + 2HNO_3 \rightarrow Mg(NO_3)_2 + 2H_2O$
b $3Fe(NO_3)_2 + 2Na_3PO_4 \rightarrow Fe_3(PO_4)_2 + 6NaNO_3$

3 Rearranging equations and calculating concentrations

Practice questions

1 **a** $n = cv$ **b** $v = \frac{n}{c}$

2 **a** $n = \frac{PV}{RT}$ **b** $T = \frac{PV}{nR}$

3 $\frac{0.2}{0.050} = 4.0$ mol dm^{-3}

4 $\frac{0.05}{2} = 0.025$ mol dm^{-3}

5 $\frac{36}{1000} \times 0.1 = 3.6 \times 10^{-3}$ mol

4 Molar calculations

Practice questions

1 **a** $\frac{0.486}{24.3} = 0.02$ mol **b** 0.02 mol
c $0.02 \times 40.3 = 0.806$ g

2 **a** $\frac{4.25}{85} = 0.05$ mol **b** $\frac{0.05}{2} = 0.025$ mol

3 **a** $\frac{500}{84.3} = 5.93$ mol **b** 5.93 mol