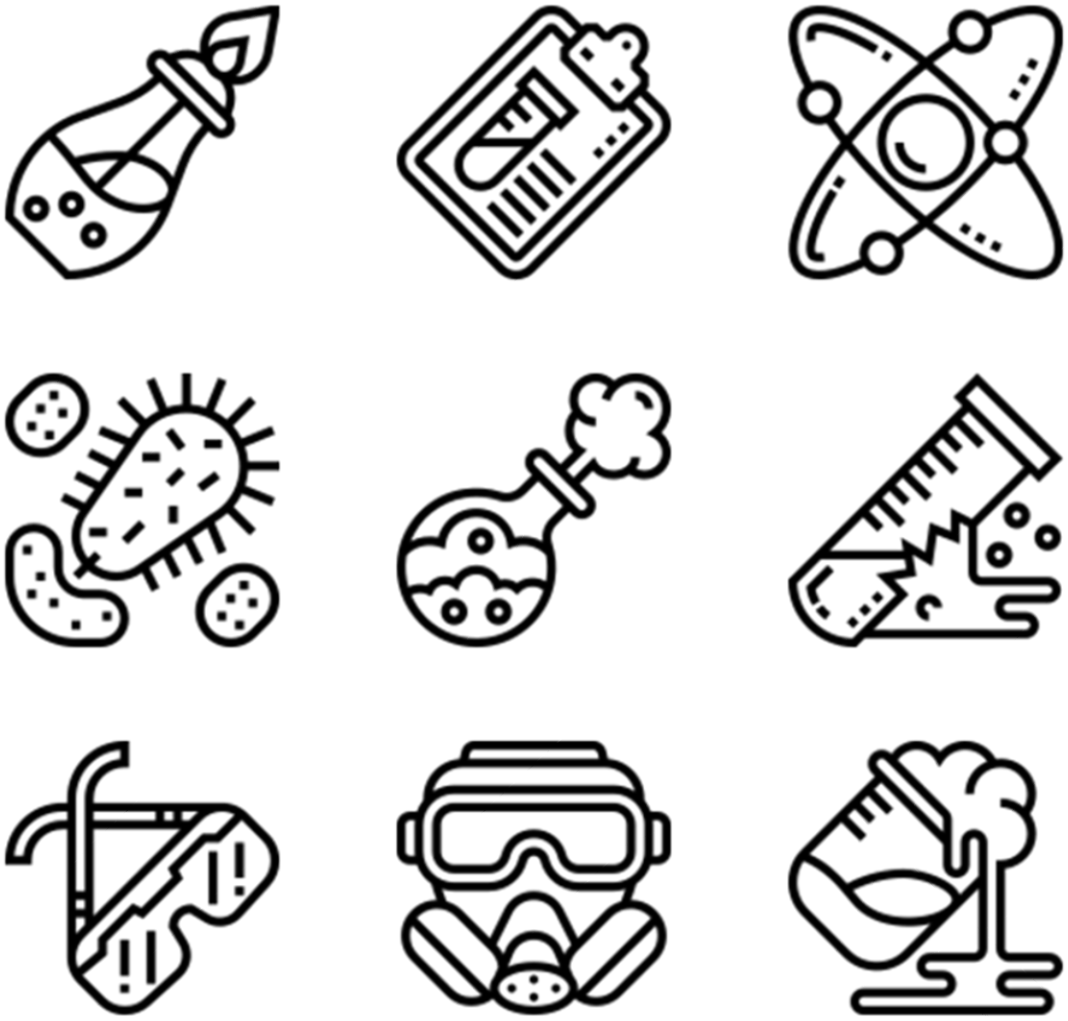
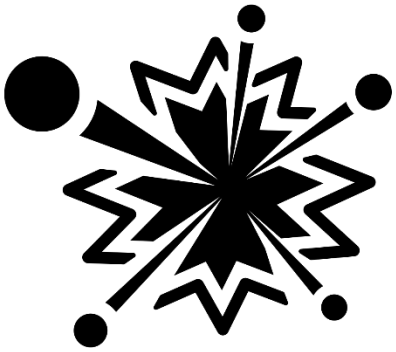
A Level Chemistry At DHFS



Y11 to Y12 introduction assignments

Assignment 1: The Elements of Life



There are **118 known elements** on Earth, each with their unique properties and characteristics. Some of these elements are responsible for life, others for useful materials and technologies that have revolutionised these lives.

Write an article about these fantastic elements.

Things to consider:

Where have the elements come from? How were they created?

What is an element?

What is the chemical formula for a human being?

How did the work of JJ Thomson, Rutherford, Geiger & Marsden, Niels Bohr, Werner Heisenberg, Erwin Schrodinger, Dobereiner, Newlands, Mendeleev allow us to understand and organise our elements into a periodic table?

Which elements are man-made? How do you make an element in the lab?

What's so special about the lanthanides and actinides?

Have we found all the elements?

Could there be elements past Oganesson, Og (atomic number 118)?

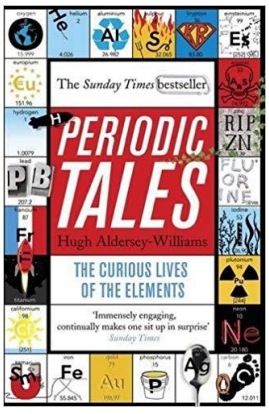
Why make more elements?

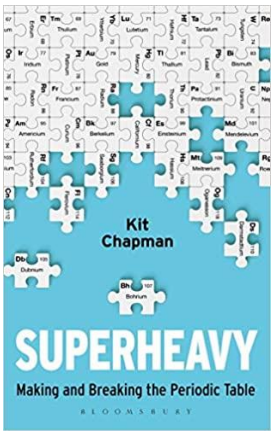
What is your favourite element and why?

Recommended reads (available in the LRC)

Periodic tales: The curious lives of the elements

Hugh Aldersey-Williams

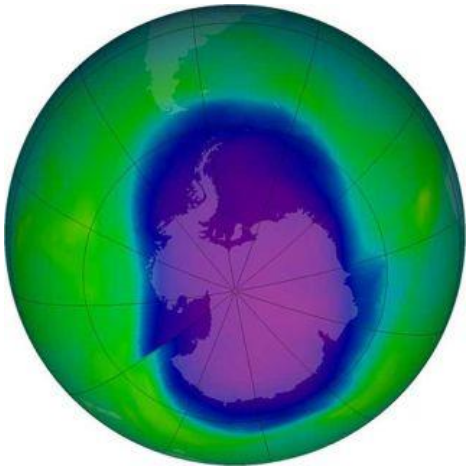




Superheavy: making and breaking the periodic table

Kit Chapman

Assignment 2: The Ozone Story



Chemistry in the atmosphere is vital for our survival - in particular, the **ozone layer** in our stratosphere provides us with protection. Since the 1930's, an **ozone hole** has been forming which has put humans at greater risk of health problems and hence a great concern to scientists.

Create an A3 information poster on the story of our ozone layer fit for display at school

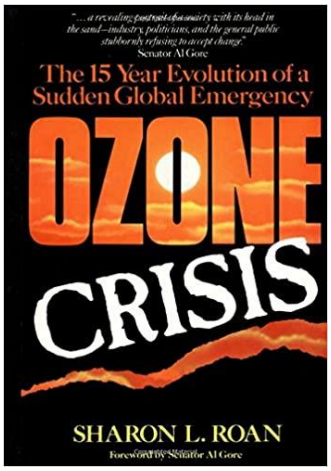
Things to consider:

- What is the ozone layer?
- Why is the ozone layer important?
- Why has a hole in the ozone layer formed?
- What chemical reactions take place in the ozone?
- What happened in the 1930's that created this issue?
- What are radicals and how are they involved?
- How have the government helped with the problem?
- How have chemists helped with the problem?
- Is ozone always useful?
- What does Coco Chanel have to do with it?
- How does sun cream work? What does this have to do with ozone?
- Is the ozone hole still getting bigger? What's happening to it now?

Recommended read (available on Amazon)

Ozone Crisis: The 15-year Evolution of a Sudden Global Emergency

Sharon Roan



Assignment 3: Making Medicines

Medicines can save lives. They can also improve the quality of life for those with prolonged diseases and illnesses. Chemists make this happen through the design and synthesis of thousands of medicines every year.

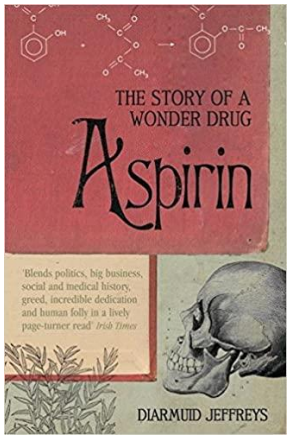
Aspirin is a globally used pain killer and costs about 13p per tablet.

Write an article about the story of aspirin and medicines.

Research Questions:

- How do we make aspirin? Where do we get the ingredients from?
- What does aspirin contain? What is its chemical structure?
- How does aspirin work as a painkiller in the body?
- Why can't we use salicylic acid instead?
- Why is it so cheap?
- What is the problem with taking oral medicines?
- Why is molecular shape important in medicine design?
- What stages does a medicine go through before it is allowed to be used by patients?
- Research some other medicines that you may already have heard of (eg. penicillin) and identify its structure & how it works in the body.

Recommended reads (available on Amazon & Waterstones)

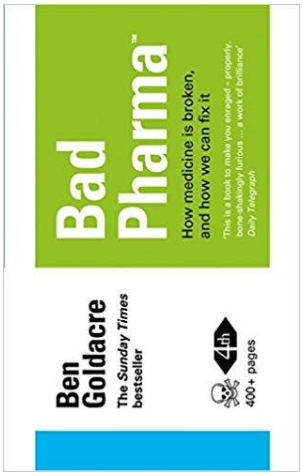


Aspirin: The Extraordinary Story of a Wonder Drug

Diarmuid Jeffreys

Bad Pharma

Ben Goldacre



Assignment 4: Chlorine

Chlorine has saved many lives but has also claimed them due to its toxic nature. Chemists argue there is a fine line between the risks and benefits of using and handling chlorine.

Create an information poster on the element chlorine

Research Questions:

1. What is chlorine?
2. Where do we get chlorine from? What's the chemistry involved?
3. Why is chlorine toxic? How does it kill?
4. How was chlorine used in chemical warfare?
5. If chlorine's toxic then why am I safe in a swimming pool?
6. Chlorine kills bacteria. How?
7. If you work with chlorine, how can you be safe when handling it? How does the chlorine industry take safety precautions?
8. Do you think the benefits of using chlorine outweigh the risks?

Recommended podcast

Chemistry in its element – Chemistry World

https://www.rsc.org/periodic-table/podcast/17/Chlorine

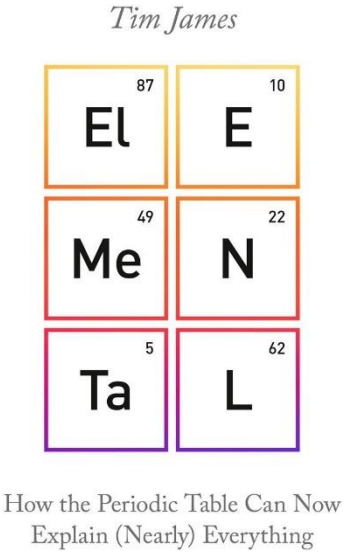
(This is brilliant for your 'elements of life' assignment too!)

Assignment 5: Research activity

Present a poster for display that answers these **big chemistry questions** that our younger students ask teachers all the time!

1. Can a human spontaneously combust?
2. What is the strongest acid ever made? What can it do?
3. What makes an explosive explode?
4. What's the deadliest poison?
5. Why does Helium make your voice change?
6. What's the most flammable chemical ever made?
7. Why are carrots orange?

Recommended read (Amazon)



Elemental: How the periodic table can now explain (nearly) everything

Tim James

Recommended magazine subscription (available in the LRC)

Chemistry World (Royal Society of Chemistry)

https://www.chemistryworld.com/

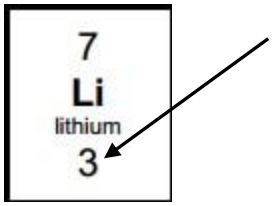
Assignment 6: Pre-Knowledge Topics

Chemistry topic 1 – Electronic structure, how electrons are arranged around the nucleus

A periodic table can give you the proton / atomic number of an element, this also tells you how many electrons are in the ***atom***.

You will have used the rule of electrons shell filling, where:

The first shell holds up to 2 electrons, the second up to 8, the third up to 8 and the fourth up to 18 (or you may have been told 8).



Atomic number =3, electrons = 3, arrangement 2 in the first shell and 1 in the second or:

Li = 2,1

At **A level** you will learn that the electron structure is more complex than this, and can be used to explain a lot of the chemical properties of elements.

The 'shells' can be broken down into 'orbitals', which are given letters: 's' orbitals, 'p' orbitals and 'd' orbitals.

You can read about orbitals here: http://bit.ly/pixlchem1

Or scan this barcode with your phone →

http://www.chemguide.co.uk/atoms/properties/atomorbs.html#top

Now that you are familiar with s, p and d orbitals try these problems, write your answer in the format:

$1s^2$, $2s^2$, $2p^6$ etc.

Q1.1 Write out the electron configuration of:

a) Ca b) Al c) S d) Cl e) Ar f) Fe g) V h) Ni i) Cu j) Zn k) As

Q1.2 Extension question, can you write out the electron arrangement of the following ***ions***:

a) K^+ b) O^{2-} c) Zn^{2+} d) V^{5+} e) Co^{2+}

Chemistry topic 2 – Oxidation and reduction

At GCSE you know that oxidation is adding oxygen to an atom or molecule and that reduction is removing oxygen, or that oxidation is removing hydrogen and reduction is adding hydrogen. You may have also learned that oxidation is removing electrons and reduction is adding electrons.

At A level we use the idea of ***oxidation number*** a lot!

You know that the metals in group 1 react to form ions that are +1, i.e. Na^+ and that group 7, the halogens, form -1 ions, i.e. Br -.

We say that sodium, when it has reacted has an oxidation number of +1 and that bromide has an oxidation number of -1.

All atoms that are involved in a reaction can be given an oxidation number.

An element, Na or O_2 is always given an oxidation state of zero (0), any element that has reacted has an oxidation state of + or -.

As removing electrons is **reduction**, if, in a reaction the element becomes **more** negative it has been reduced, if it becomes more positive it has been oxidised.

You can read about the rules for assigning oxidation numbers here:

http://www.dummies.com/how-to/content/rules-for-assigning-oxidation-numbers-to-elements.html

Or scan this barcode with your phone →

Elements that you expect to have a specific oxidation state actually have different states, so for example you would expect chlorine to be -1, it can have many oxidation states: NaClO, in this compound it has an oxidation state of +1

There are a few simple rules to remember:

- Metals have a + oxidation state when they react.
- Oxygen is 'king' it always has an oxidation state of -2
- Hydrogen has an oxidation state of +1 (except metal hydrides where it is -1)
- The charges in a molecule must cancel to equal 0
- The sign always comes before the number (eg +1 not -1)

Example:

Sodium nitrate, $NaNO_3$

Na = +1

O = -2 x 3 = -6

N = +5 (in order to cancel the charges on Na and O to equal 0)

Q2.1 Work out the oxidation state of the **underlined** atom in the following:

a) $Mg\underline{C}O_3$ b) $\underline{S}O_3$ c) $Na\underline{Cl}O_3$

d) $\underline{Mn}O_2$ e) $\underline{Fe}_2O_3$ f) $\underline{V}_2O_5$

g) $K\underline{Mn}O_4$ h) $\underline{Cr}_2O_7^{2-}$ i) $\underline{Cl}_2O_4$

Chemistry topic 3 – Isotopes and mass

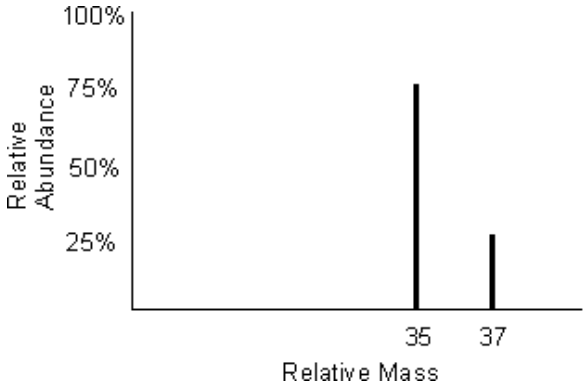
You will remember that an isotopes are elements that have differing numbers of neutrons. Hydrogen has 3 isotopes; H_1^1 H_1^2 H_1^3

Isotopes occur naturally, so in a sample of an element you will have a mixture of these isotopes. We can accurately measure the amount of an isotope using a **mass spectrometer**.

You can read about a mass spectrometer here:

https://www.chemguide.co.uk/analysis/masspecmenu.html

A mass spectrum for the element chlorine will give a spectrum like this:



75% of the sample consist of chlorine-35, and 25% of the sample is chlorine-37.

Given a sample of naturally occurring chlorine ¾ of it will be Cl-35 and ¼ of it is Cl-37. We can calculate what the **mean** mass of the sample will be:

Mean mass = $\frac{75}{100} \times 35 + \frac{25}{100} \times 37 = 35.5$

If you look at a periodic table this is why chlorine has an atomic mass of 35.5.

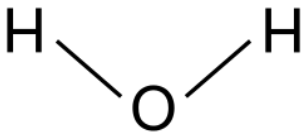
An A level periodic table has the masses of elements recorded much more accurately than at GCSE. Most elements have isotopes and these have been recorded using mass spectrometers.

Given the percentage of each isotope you can calculate the mean mass which is the accurate atomic mass for that element.

Q3.3 Use the percentages of each isotope to calculate the accurate atomic mass of the following elements.

a) Antimony has 2 isotopes: Sb-121 57.25% and Sb-123 42.75%
b) Gallium has 2 isotopes: Ga-69 60.2% and Ga-71 39.8%
c) Silver has 2 isotopes: Ag-107 51.35% and Ag-109 48.65%
d) Thallium has 2 isotopes: Tl-203 29.5% and Tl-205 70.5%
e) Strontium has **4** isotopes: Sr-84 0.56%, Sr-86 9.86%, Sr-87 7.02% and Sr-88 82.56%

Chemistry topic 4 – The shapes of molecules and bonding.



Have you ever wondered why your teacher drew a water molecule like this?

The lines represent a covalent bond, but why draw them at an unusual angle?

If you are unsure about covalent bonding, read about it here: http://bit.ly/pixlchem5

Or scan these barcodes with your phone →

http://www.chemguide.co.uk/atoms/bonding/covalent.html#top

At A level you are also expected to know how molecules have certain shapes and why they are the shape they are.

You can read about shapes of molecules here: http://bit.ly/pixlchem6

http://www.chemguide.co.uk/atoms/bonding/shapes.html#top

Q4.1 Draw a dot and cross diagram to show the bonding in a molecule of aluminium chloride ($AlCl_3$)

Q4.2 Draw a dot and cross diagram to show the bonding in a molecule of ammonia (NH_3)

Q4.3 What is the shape and the bond angles in a molecule of methane (CH_4)?

Q4.3 What other shapes exist in molecules? Draw their general shapes, labelling their bond angle and name.

Chemistry topic 5 – Chemical equations

Balancing chemical equations is the stepping stone to using equations to calculate masses in chemistry.

There are loads of websites that give ways of balancing equations and lots of exercises in balancing.

Some of the equations to balance may involve strange chemical, don't worry about that, the key idea is to get balancing right.

http://bit.ly/pixlchem7

http://www.chemteam.info/Equations/Balance-Equation.html

Or scan this barcode with your phone →

This website has a download:

http://bit.ly/pixlchem8

https://phet.colorado.edu/en/simulation/balancing-chemical-equations

Q5.1 Re-write and balance the following equations

a. $H_2 + O_2 \rightarrow H_2O$

b. $S_8 + O_2 \rightarrow SO_3$

c. $HgO \rightarrow Hg + O_2$

d. $Zn + HCl \rightarrow ZnCl_2 + H_2$

e. $Na + H_2O \rightarrow NaOH + H_2$

f. $C_{10}H_{16} + Cl_2 \rightarrow C + HCl$

g. $Fe + O_2 \rightarrow Fe_2O_3$

h. $C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O$

i. $Fe_2O_3 + H_2 \rightarrow Fe + H_2O$

j. $Al + FeO \rightarrow Al_2O_3 + Fe$

Chemistry topic 6 – Measuring chemicals – the mole

Now that we have our chemical equations balanced, we need to be able to use them in order to work out masses of chemicals we need or we can produce.

The ***mole*** is the chemists equivalent of a dozen, atoms are so small that we cannot count them out individually, we weigh out chemicals.

For example: magnesium + sulfur → magnesium sulfide

$$Mg + S \rightarrow MgS$$

We can see that one atom of magnesium will react with one atom of sulfur, if we had to weigh out the atoms we need to know how heavy each atom is.

From the periodic table: Mg = 24.3 and S = 32.1

If I weigh out exactly 24.3g of magnesium this will be 1 mole of magnesium, if we counted how many atoms were present in this mass it would be a huge number (6.02×10^{23}!!!!), if I weigh out 32.1g of sulfur then I would have 1 mole of sulfur atoms.

So 24.3g of Mg will react precisely with 32.1g of sulfur, and will make 56.4g of magnesium sulfide.

Here is a comprehensive page on measuring moles, there are a number of descriptions, videos and practice problems.

You will find the first 6 tutorials of most use here, and problem sets 1 to 3.

http://bit.ly/pixlchem9

http://www.chemteam.info/Mole/Mole.html

Or scan this barcode with your phone →

Q6.1 Answer the following questions on moles.

a) How many moles of phosphorus pentoxide (P_4O_{10}) are in 85.2g?

b) How many moles of potassium in 73.56g of potassium chlorate (V) ($KClO_3$)?

c) How many moles of water are in 249.6g of hydrated copper sulfate(VI) ($CuSO_4.5H_2O$)? For this one, you need to be aware the dot followed by $5H_2O$ means that the molecule comes with 5 water molecules so these have to be counted in as part of the molecules mass.

d) What is the mass of 0.125 moles of tin sulfate ($SnSO_4$)?

e) If I have 2.4g of magnesium, how many g of oxygen(O_2) will I need to react completely with the magnesium? $2Mg + O_2 \rightarrow MgO$

Chemistry topic 7 – Solutions and concentrations

In chemistry a lot of the reactions we carry out involve mixing solutions rather than solids, gases or liquids.

You will have used bottles of acids in science that have labels saying 'Hydrochloric acid 1M', this is a solution of hydrochloric acid where 1 mole of HCl, hydrogen chloride (a gas) has been dissolved in 1dm^3 of water.

The dm^3 is a cubic decimetre, it is actually 1 litre, but from this point on as an A level chemist you will use the dm^3 as your volume measurement. http://bit.ly/pixlchem10

http://www.docbrown.info/page04/4_73calcs11msc.htm

Q7.1 Answer the following questions:

a) What is the concentration (in mol dm^{-3}) of 9.53g of magnesium chloride ($MgCl_2$) dissolved in 100cm^3 of water?

b) What is the concentration (in mol dm^{-3}) of 13.248g of lead nitrate ($Pb(NO_3)_2$) dissolved in 2dm^3 of water?

c) If I add 100cm^3 of 1.00 mol dm^3 HCl to 1.9dm^3 of water, what is the molarity of the new solution?

d) What mass of silver is present in 100cm^3 of 1moldm^{-3} silver nitrate ($AgNO_3$)?

e) The Dead Sea, between Jordan and Israel, contains 0.0526 moldm^{-3} of Bromide ions (Br^-), what mass of bromine is in 1dm^3 of Dead Sea water?

Chemistry topic 8 – Titrations

One key skill in A level chemistry is the ability to carry out accurate titrations, you may well have carried out a titration at GCSE, at A level you will have to carry them out very precisely **and** be able to describe in detail how to carry out a titration - there will be questions on the exam paper about how to carry out practical procedures.

Remember for any titration calculation you need to have a balanced symbol equation; this will tell you the ratio in which the chemicals react.

E.g. a titration of an unknown sample of sulfuric acid with sodium hydroxide.

A 25.00cm^3 sample of the unknown sulfuric acid was titrated with 0.100$moldm^{-3}$ sodium hydroxide and required exactly 27.40cm^3 for neutralisation. What is the concentration of the sulfuric acid?

Step 1: the equation $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

Step 2; the ratios 2 : 1

Step 3: how many moles of sodium hydroxide 27.40cm^3 =0.0274dm^3

number of moles = c x v = 0.100 x 0.0274 = 0.00274 moles

Step 4: Using the ratio, how many moles of sulfuric acid for every 2 NaOH there are 1 H_2SO_4 so, we must have 0.00274/2 =0.00137 moles of H_2SO_4

Step 5: Calculate concentration.

concentration = moles/volume in dm^3 = 0.00137/0.025 = ***0.0548 moldm^{-3}***

Here are some additional problems, which are harder, ignore the questions about colour changes of indicators.

http://bit.ly/pixlchem12

http://www.docbrown.info/page06/Mtestsnotes/ExtraVolCalcs1.htm

Q8.1 Complete this titration calculation

A solution of barium nitrate will react with a solution of sodium sulfate to produce a precipitate of barium sulfate.

$Ba(NO_3)_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2NaNO_3(aq)$

What volume of 0.25$moldm^{-3}$sodium sulfate solution would be needed to precipitate all of the barium from 12.5cm^3 of 0.15 $moldm^{-3}$ barium nitrate?

Chemistry topic 9 – Organic Chemistry

Organic chemistry is the study of molecules primarily containing C, H, N and O. These can arrange in a variety of ways giving many different uses and applications. They do this by forming **functional groups.**

Research the following functional groups and identify their general structure, physical properties, their chemical reactions and their application/uses.

1. Alkanes
2. Alkenes
3. Cycloalkanes
4. Alcohols
5. Carboxylic acids
6. Esters
7. Ethers
8. Haloalkanes
9. Benzene