

## Pre-Knowledge Topics

A level chemistry will use your knowledge from GCSE and build on this to help you understand new and more demanding ideas. Complete the following tasks to make sure your knowledge is up to date and you are ready to start studying:

### **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).

7
Li
lithium
3

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>

<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: 1s2, 2s2, 2p6 etc.

Q1. 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

Q2. Extension question, can you write out the electron arrangement of the following ions:

a) K<sup>+</sup>   b) O<sup>2-</sup>   c) Zn<sup>2+</sup>   d) V<sup>5+</sup>   e) Co<sup>2+</sup>

### **Chemistry Topic 2 – Oxidation and reduction**

At GCSE you learnt 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 learnt 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<sup>+</sup> and that group 7, the halogens, form -1 ions, i.e. Br<sup>-</sup>.

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<sub>2</sub>, 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.

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-5
0
+5

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>

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).

The charges in a molecule must cancel.

Examples: Sodium nitrate,  $\text{NaNO}_3$  sulfate ion,  $\text{SO}_4^{2-}$   
 $\text{Na} +1$        $3 \times \text{O}^{2-}$        $4 \times \text{O}^{2-}$  and 2- charges 'showing'  
 $+1$        $-6$        $-8$        $-2$

To cancel:               $\text{N} = +5$                                        $\text{S} = +6$

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

- a)  $\text{Mg}\underline{\text{C}}\text{O}_3$       b)  $\underline{\text{S}}\text{O}_3$       c)  $\text{Na}\underline{\text{C}}\text{O}_3$       d)  $\underline{\text{Mn}}\text{O}_2$       e)  $\underline{\text{Fe}}_2\text{O}_3$       f)  $\underline{\text{V}}_2\text{O}_5$   
 g)  $\underline{\text{K}}\text{MnO}_4$       h)  $\underline{\text{Cr}}_2\text{O}_7^{2-}$       i)  $\underline{\text{Cl}}_2\text{O}_4$

### Chemistry Topic 3 – Isotopes and mass

You will remember that isotopes are elements that have differing numbers of neutrons. Hydrogen has 3 isotopes;  $\text{H}_1^1$ ,  $\text{H}_1^2$ ,  $\text{H}_1^3$

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 will need to understand what a mass spectrometer is and how it works at A level. You can read about a mass spectrometer here:

<http://bit.ly/pixlchem3>

<http://www.kore.co.uk/tutorial.htm>

<http://bit.ly/pixlchem4>

<http://filestore.aqa.org.uk/resources/chemistry/AQA-7404-7405-TN-MASS-SPECTROMETRY.PDF>

Q1. What must happen to the atoms before they are accelerated in the mass spectrometer?

Q2. Explain why the different isotopes travel at different speeds in a mass spectrometer.

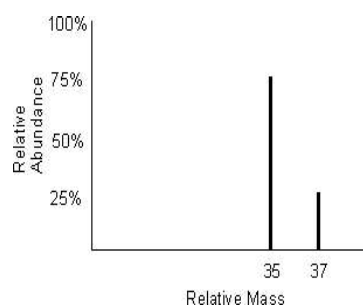
A mass spectrum for the element chlorine will give a spectrum like this:

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

Given a sample of naturally occurring chlorine,  $\frac{3}{4}$  of it

will be Cl-35 and  $\frac{1}{4}$  of it is Cl-37. We can calculate what the **mean** mass of the sample will be:

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



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.

GCSE

11 <b>B</b> boron 5	12 <b>C</b> carbon 6	14 <b>N</b> nitrogen 7	16 <b>O</b> oxygen 8	19 <b>F</b> fluorine 9
27 <b>Al</b> aluminium 13	28 <b>Si</b> silicon 14	31 <b>P</b> phosphorus 15	32 <b>S</b> sulfur 16	35.5 <b>Cl</b> chlorine 17

A Level

10.8 <b>B</b> boron 5	12.0 <b>C</b> carbon 6	14.0 <b>N</b> nitrogen 7	16.0 <b>O</b> oxygen 8	19.0 <b>F</b> fluorine 9
27.0 <b>Al</b> aluminium 13	28.1 <b>Si</b> silicon 14	31.0 <b>P</b> phosphorus 15	32.1 <b>S</b> sulphur 16	35.5 <b>Cl</b> chlorine 17

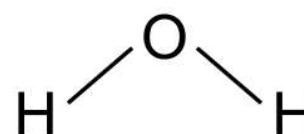
Given the percentage of each isotope you can calculate the mean mass which is the accurate atomic mass for that element.

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

- Antimony has 2 isotopes: Sb-121 57.25% and Sb-123 42.75%
- Gallium has 2 isotopes: Ga-69 60.2% and Ga-71 39.8%
- Silver has 2 isotopes: Ag-107 51.35% and Ag-109 48.65%
- Thallium has 2 isotopes: Tl-203 29.5% and Tl-205 70.5%
- 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>

<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>

Q1. Draw a dot and cross diagram to show the bonding in a molecule of aluminium chloride (AlCl<sub>3</sub>)

Q2. Draw a dot and cross diagram to show the bonding in a molecule of ammonia (NH<sub>3</sub>)

Q3. What is the shape and the bond angles in a molecule of methane (CH<sub>4</sub>)?

#### **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 chemicals- don't worry about that, the key idea is to get balancing right.

<http://bit.ly/pixlchem7>

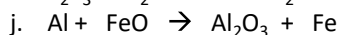
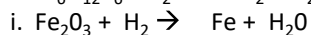
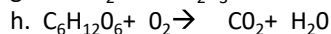
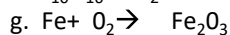
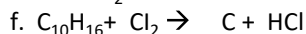
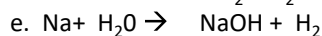
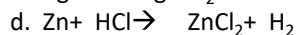
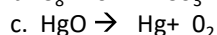
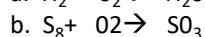
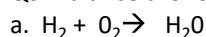
<http://www.chemteam.info/Equations/Balance-Equation.html>

This website has a download; it is safe to do so:

<http://bit.ly/pixlchem8>

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

Q5. Balance the following equations



### **Chemistry Topic 6 – Measuring chemicals – the mole**

From this point on you need to be using an A level periodic table, not a GCSE one. You can view one here:

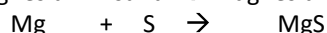
<http://bit.ly/pixlpertab>

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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



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 ( $6.02 \times 10^{23}$ !!!!). 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>

Q1. Answer the following questions on moles.

How many moles of phosphorus pentoxide ( $\text{P}_4\text{O}_{10}$ ) are in 85.2g?

How many moles of potassium are in 73.56g of potassium chlorate (V) ( $\text{KClO}_3$ )?

How many moles of water are in 249.6g of hydrated copper sulfate(VI) ( $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ )? For this one, you need to be aware the dot followed by  $5\text{H}_2\text{O}$  means that the molecule comes with 5 water molecules so these have to be counted in as part of the molecules mass.

What is the mass of 0.125 moles of tin sulfate ( $\text{SnSO}_4$ )?

If I have 2.4g of magnesium, how many g of oxygen ( $\text{O}_2$ ) will I need to react completely with the magnesium?  $2\text{Mg} + \text{O}_2 \rightarrow \text{MgO}$

### **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  $1\text{dm}^3$  of water.

The  $\text{dm}^3$  is a cubic decimetre, it is actually 1 litre but from this point on as an A level chemist you will use the  $\text{dm}^3$  as your volume measurement.

<http://bit.ly/pixlchem10>

[http://www.docbrown.info/page04/4\\_73calcs11msc.htm](http://www.docbrown.info/page04/4_73calcs11msc.htm)

Q1.

a. What is the concentration (in  $\text{mol dm}^{-3}$ ) of 9.53g of magnesium chloride ( $\text{MgCl}_2$ ) dissolved in  $100\text{cm}^3$  of water?

b. What is the concentration (in  $\text{mol dm}^{-3}$ ) of 13.248g of lead nitrate ( $\text{Pb}(\text{NO}_3)_2$ ) dissolved in  $2\text{dm}^3$  of water?

c. If I add  $100\text{cm}^3$  of  $1.00\text{ mol dm}^{-3}$  HCl to  $1.9\text{dm}^3$  of water, what is the molarity of the new solution?

d. What mass of silver is present in  $100\text{cm}^3$  of  $1\text{mol dm}^{-3}$  silver nitrate ( $\text{AgNO}_3$ )?

e. The Dead Sea, between Jordan and Israel, contains  $0.0526\text{ mol dm}^{-3}$  of Bromide ions ( $\text{Br}^-$ ). What mass of bromine is in  $1\text{dm}^3$  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.

You can read about how to carry out a titration here, the next page in the series (page 5) describes how to work out the concentration of the unknown.

<http://bit.ly/pixlchem11>

[http://www.bbc.co.uk/schools/gcsebitesize/science/triple\\_aqa/further\\_analysis/analysing\\_substances/revision/4/](http://www.bbc.co.uk/schools/gcsebitesize/science/triple_aqa/further_analysis/analysing_substances/revision/4/)

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<sup>3</sup> sample of the unknown sulfuric acid was titrated with 0.100mol dm<sup>-3</sup> sodium hydroxide and required exactly 27.40cm<sup>3</sup> for neutralisation. What is the concentration of the sulfuric acid?

**Step 1:** the equation  $2\text{NaOH} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$

**Step 2:** the ratios 2 : 1

**Step 3:** how many moles of sodium hydroxide  $27.40\text{cm}^3 = 0.0274\text{dm}^3$   
number of moles =  $c \times v = 0.100 \times 0.0274 = 0.00274$  moles

**step 4:** using the ratio, how many moles of sulfuric acid

for every 2 NaOH there are 1 H<sub>2</sub>SO<sub>4</sub> so, we must have  $0.00274/2 = 0.00137$  moles of H<sub>2</sub>SO<sub>4</sub>

**Step 5:** calculate concentration. concentration = moles/volume ← in dm<sup>3</sup> =  $0.00137/0.025 = 0.0548 \text{ mol dm}^{-3}$

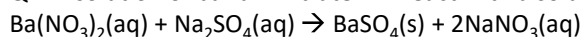
Here are some additional problems which are harder, ignore the questions about colour changes of indicators.

<http://bit.ly/pixlchem12>

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

Use the steps on the last page to help you.

Q1. A solution of barium nitrate will react with a solution of sodium sulfate to produce a precipitate of barium sulfate.



What volume of 0.25mol dm<sup>-3</sup> sodium sulfate solution would be needed to precipitate all of the barium from 12.5cm<sup>3</sup> of 0.15 mol dm<sup>-3</sup> barium nitrate?

### **Chemistry Topic 9 – Organic chemistry – functional groups**

At GCSE you would have come across **hydrocarbons** such as alkanes (ethane etc) and alkenes (ethene etc). You may have come across molecules such as alcohols and carboxylic acids. At A level you will learn about a wide range of molecules that have had atoms added to the carbon chain. These are called functional groups, they give the molecule certain physical and chemical properties that can make them incredibly useful to us.

Here you are going to meet a selection of the functional groups, learn a little about their properties and how we give them logical names.

You will find a menu for organic compounds here:

<http://bit.ly/pixlchem13>

<http://www.chemguide.co.uk/orgpropsmenu.html#top>

And how to name organic compounds here:

<http://bit.ly/pixlchem14>

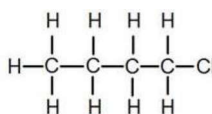
<http://www.chemguide.co.uk/basicorg/conventions/names.html#top>

Using the two links see if you can answer the following questions:

Q1. Halogenoalkanes

a. What is the name of this halogenoalkane?

b. How could you make it from butan-1-ol?



Q2. Alcohols

a. How could you make ethanol from ethene?

b. How does ethanol react with sodium and in what ways is this a) similar to the reaction with water, b) different to the reaction with water?

Q3. Aldehydes and ketones

a. Draw the structures of a) propanal, b) propanone

b. How are these two functional groups different?

### **Chemistry Topic 10 – Acids, bases, pH**

At GCSE you will know that an acid can dissolve in water to produce  $H^+$  ions, at A level you will need a greater understanding of what an acid or a base is.

Read the following page and answer the questions

<http://bit.ly/pixlchem15>

<http://www.chemguide.co.uk/physical/acidbaseeqia/theories.html#top>

Q1. What is your new definition of what an acid is?

Q2. How does ammonia ( $NH_3$ ) act as a base?

<http://bit.ly/pixlchem16>

<http://www.chemguide.co.uk/physical/acidbaseeqia/acids.html#top>

Q3 Ethanoic acid (vinegar) is a weak acid, what does this mean?

Q4 What is the pH of a solution of  $0.01 \text{ mol dm}^{-3}$  of the strong acid, hydrochloric acid?