

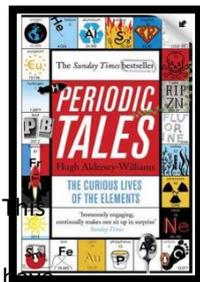
Science Department

A'LEVEL CHEMISTRY
Transition Material

“Aiming to deliver consistently high quality and
engaging lessons to inspire the scientists of the
future”

Book Recommendations

Periodic Tales: The Curious Lives of the Elements (Paperback) Hugh Aldersey-Williams

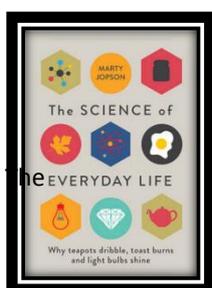


ISBN-10: 0141041455

<http://bit.ly/pixlchembook1>

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 never even thought about.

The Science of Everyday Life: Why Teapots Dribble, Toast Burns and Light Bulbs Shine (Hardback) Marty Jopson

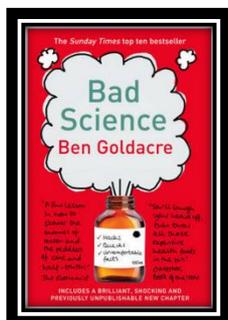


ISBN-10: 1782434186

<http://bit.ly/pixlchembook2>

title says it all really, lots of interesting stuff about the things around you home!

Bad Science (Paperback) Ben Goldacre

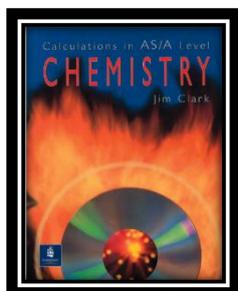


ISBN-10: 000728487X

<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.

Videos to watch online

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=IUoDWAt259I>

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>

Research activities

Use your online searching abilities to see if you can find out as much about the topic as you can. Remember if you are a prospective A level chemist, you should aim to push **your** knowledge.

You can make a 1-page summary for each one you research using Cornell notes:

<http://coe.jmu.edu/learningtoolbox/cornellnotes.html>

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?

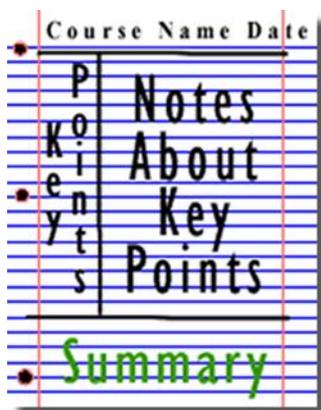


Figure 1: <http://coe.jmu.edu/learningtoolbox/images/noteb4.gif>

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).

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:

$1s^2, 2s^2, 2p^6$ 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!

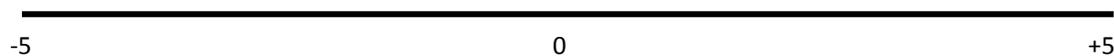
You know that the metals in group 1 react to form ions that are +1, i.e. Na^+ and that group 7, the halogens, form -1 ions, i.e. Br^- .

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 O₂ 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>

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)

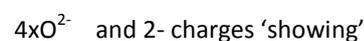
The charges in a molecule must cancel.

Examples: Sodium nitrate, NaNO₃



To cancel: N = +5

sulfate ion, SO₄²⁻



S = +6

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

- a) MgCO₃ b) SO₃ c) NaClO₃ d) MnO₂ e) Fe₂O₃ f) V₂O₅
g) KMnO₄ h) Cr₂O₇²⁻ i) Cl₂O₄

Chemistry topic 3 – Isotopes and mass

You will remember that an isotopes are elements that have differing numbers of neutrons. Hydrogen has 3 isotopes; H₁¹ H₁² H₁³

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:



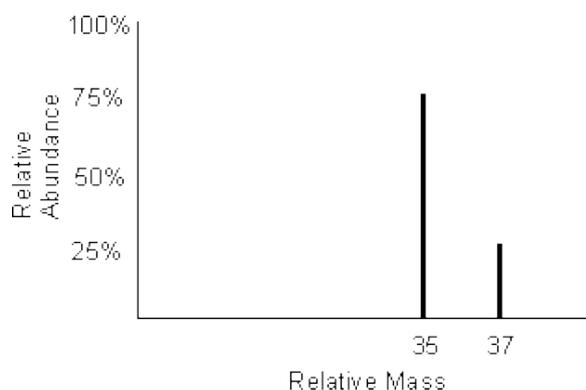
<http://bit.ly/pixlchem3>
<http://www.kore.co.uk/tutorial.htm>
<http://bit.ly/pixlchem4>



Q3.1 What must happen to the atoms before they are accelerated in the mass spectrometer?

Q3.2 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.

<http://www.avogadro.co.uk/definitions/ar.htm>

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

A level

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

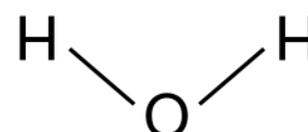
Given the percentage of each isotope you can calculate the mean mass which is the accurate atomic mass for that element.

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

- 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>



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)?

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>



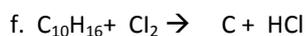
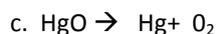
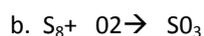
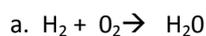
This website has a download; it is safe to do so:

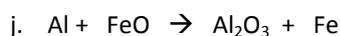
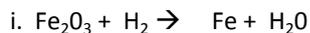
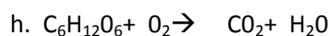
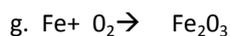


<http://bit.ly/pixlchem8>

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

Q5.1 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>



https://secondaryscience4all.files.wordpress.com/2014/08/filestore_aqa_org_uk_subjects_aqa-2420-w-trb-ptds_pdf.png

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 \rightarrow 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 (6.02×10^{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>



Q6.1 Answer the following questions on moles.

- How many moles of phosphorus pentoxide (P_4O_{10}) are in 85.2g?
- How many moles of potassium in 73.56g of potassium chlorate (V) (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.

- 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? $2\text{Mg} + \text{O}_2 \rightarrow \text{MgO}$

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 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

- 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 ($\text{Pb}(\text{NO}_3)_2$) 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 1mol dm^{-3} silver nitrate (AgNO_3)?
e) The Dead Sea, between Jordan and Israel, contains $0.0526\text{ mol dm}^{-3}$ 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.

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/revisio_n/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 25.00cm³ sample of the unknown sulfuric acid was titrated with 0.100mol dm⁻³ sodium hydroxide and required exactly 27.40cm³ 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 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 H₂SO₄ so, we must have 0.00274/2 = 0.00137 moles of H₂SO₄

Step 5: Calculate concentration. concentration = moles/volume ← in dm³ = 0.00137/0.025 = **0.0548 mol dm⁻³**

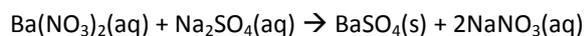
Here are some additional problems, which are harder, ignore the questions about colour changes of indicators.

<http://bit.ly/pixlchem12>

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

Use the steps on the last page to help you

Q8.1 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⁻³ sodium sulfate solution would be needed to precipitate all of the barium from 12.5cm³ of 0.15 mol dm⁻³ 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>

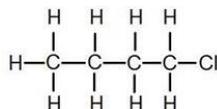
<http://www.chemguide.co.uk/basicorg/conventions/names.html#top>



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

Q9.1 Halogenoalkanes

What is the name of this halogenoalkane?



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

Q9.2 Alcohols

How could you make ethanol from ethene?

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

Q9.3 Aldehydes and ketones

Draw the structures of a) propanal b) propanone

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>



Q10.1 What is your new definition of what an acid is?

Q10.2 How does ammonia (NH_3) act as a base?

<http://bit.ly/pixlchem16>

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

Q10.3 Ethanoic acid (vinegar) is a weak acid, what does this mean?

Q10.4 What is the pH of a solution of 0.01 mol dm^{-3} of the strong acid, hydrochloric acid?

Pre-Knowledge Topics Answers to problems

Q1.1a) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$

b) $1s^2 2s^2 2p^6 3s^2 3p^1$

c) $1s^2 2s^2 2p^6 3s^2 3p^4$

d) $1s^2 2s^2 2p^6 3s^2 3p^5$

e) $1s^2 2s^2 2p^6 3s^2 3p^6$

f) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$

g) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3 4s^2$

- h) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^8 4s^2$ i) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$ j) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$
 k) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^3$

- Q1.2a) $1s^2 2s^2 2p^6 3s^2 3p^6$ b) $1s^2 2s^2 2p^6 3s^2 3p^6$ c) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$
 d) $1s^2 2s^2 2p^6 3s^2 3p^6$ e) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7$

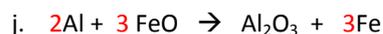
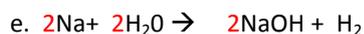
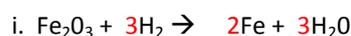
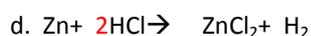
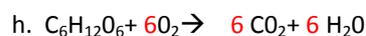
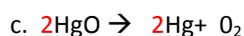
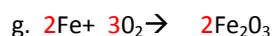
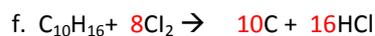
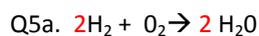
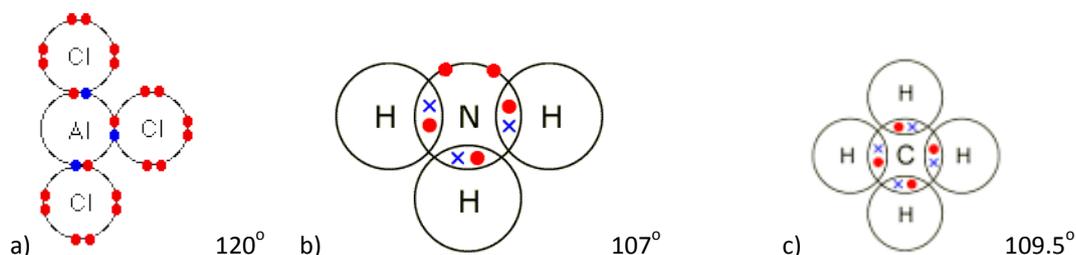
- Q2.1 a) +4 b) +6 c) +5 d) +4 e) +3 f) +5 g) +7 h) +6 i) +4

Q3.1 They must be ionised / turned into ions

Q3.2 The ions are all given the same amount of kinetic energy, as $KE = \frac{1}{2} mv^2$ the lighter ions will have greater speed / heavier ions will have less speed.

- Q3.3 a) 121.855 b) 67.796 c) 107.973 d) 204.41 e) 87.710 / 87.7102

Q4.1



Q6.1 a) $85.2/284 = 0.3$ moles

b) $73.56/122.6 = 0.6$ moles

c) $249.5/249.5 = 1.0$ moles

d) $0.125 \times 212.8 = 26.6$ g e) $2Mg : 2O$ or 1:1 ratio 2.4g of Mg = 0.1moles so we need 0.1 moles of oxygen (O_2): $0.1 \times 32 = 3.2$ g

7.1 a) $9.53g/95.3 = 0.1$ moles, in $100cm^3$ or $0.1dm^3$ in $1dm^3$ $0.1moles/0.1dm^3 = 1.0$ mol dm^{-3}

b) $13.284g/331.2 = 0.04$ moles, in $2dm^3$ in $1dm^3$ $0.04moles/2dm^3 = 0.02$ mol dm^{-3}

c) $100cm^3$ of 0.1 mol $dm^{-3} = 0.01$ moles added to a total volume of $2dm^3 = 0.01moles/2dm^3 = 0.005$ mol dm^{-3}

d) in 1dm^3 of 1mol dm^{-3} silver nitrate, 1 mole of Ag = 107.9g in $0.1\text{dm}^3 = 107.9 \times 0.1 = 10.79\text{g}$

e) $0.0526 \times 79.7 = 42.0274\text{g}$

=====

8.1

$\text{Ba}(\text{NO}_3)_2 : \text{Na}_2\text{SO}_4$

1 : 1 ratio

12.5cm^3 of $\text{Ba}(\text{NO}_3)_2 = 0.0125\text{dm}^3$

$0.15\text{mol dm}^{-3} \times 0.0125\text{dm}^3 = 0.001875$ moles

same number of moles of sodium sulfate needed, which has a concentration of 0.25mol dm^{-3}

0.001875 moles / $0.25\text{mol dm}^{-3} = 0.0075\text{dm}^3$ or 7.5cm^3

=====

9.1 1-chlorobutane

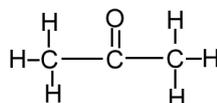
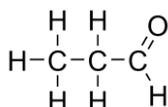
Add butan-1-ol to concentrated HCl and shake

9.2 react ethene with hydrogen gas at high temperature and pressure with a nickel catalyst

The reaction is similar in that it releases hydrogen but different as it proceeds much slower than in water

9.3 propanal

propanone



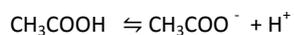
The carbon atom joined to oxygen in propanal has a hydrogen attached to it, it does not in propanone.

=====

10.1 An acid is a proton donor

10.2 Ammonia can accept a proton, to become NH_4^+

10.3 ethanoic acid has not fully dissociated, it has not released all of its hydrogen ions into the solution.



Mostly this Very few of these

10.4 $\text{pH} = -\log [0.01] = 2$ The $\text{pH} = 2$