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Transition Pack for A Level Chemistry

Get ready for A-level!

**A guide to help you get ready for A-level Chemistry,
including everything from topic guides to days out and
online learning courses.**

Commissioned by The PiXL Club Ltd. February 2016

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Please note: these resources are non-board specific. Please direct your students to the specifics of where this knowledge and skills most apply.

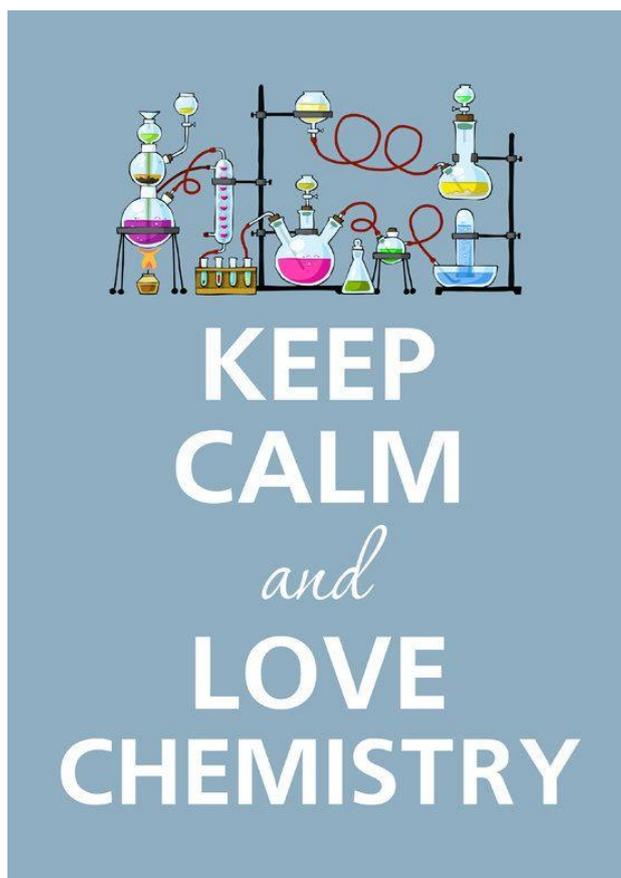
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So you are considering A Level Chemistry?



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 after you complete your GCSE, throughout the remainder of the summer term and over the Summer Holidays to ensure you are ready to start your course in September.

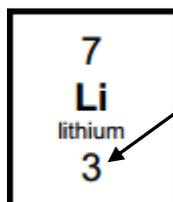
Pre-Knowledge Topics

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>

<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!

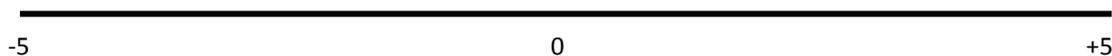
You know that the metals in group 1 react to form ions that are +1, i.e. Na^+ and that group 7, the halogens, form -1 ions, i.e. Br^- .

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>



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)

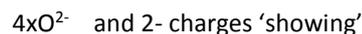
The charges in a molecule must cancel.

Examples: Sodium nitrate, NaNO_3



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

sulfate ion, SO_4^{2-}



$\text{S} = +6$

Q2.1 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) $\text{K}\underline{\text{Mn}}\text{O}_4$ 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 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 will need to understand what a mass spectrometer is and how it works at A level. You can read about a mass spectrometer here:



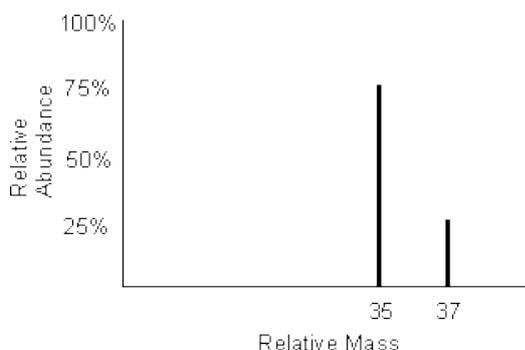
<http://bit.ly/pixlchem3>
<http://www.kore.co.uk/tutorial.htm>
<http://bit.ly/pixlchem4>
<http://filestore.aqa.org.uk/resources/chemistry/AQA-7404-7405-TN-MASS-SPECTROMETRY.PDF>



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 – 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>

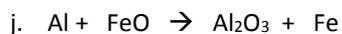
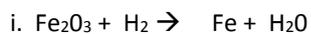
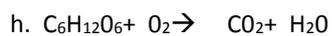
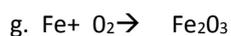
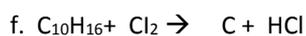
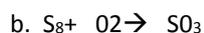
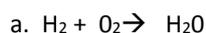
This website has a download; it is safe to do so:



<http://bit.ly/pixlchem8>

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

Q5.1 Balance the following equations



Chemistry topic 5 – 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 1dm³ of water.

The dm³ is a cubic decimetre, it is actually 1 litre, but from this point on as an A level chemist you will use the dm³ as your volume measurement.

<http://bit.ly/pixlchem10>

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



Q7.1

- What is the concentration (in mol dm⁻³) of 9.53g of magnesium chloride (MgCl₂) dissolved in 100cm³ of water?
- What is the concentration (in mol dm⁻³) of 13.248g of lead nitrate (Pb(NO₃)₂) dissolved in 2dm³ of water?
- If I add 100cm³ of 1.00 mol dm⁻³ HCl to 1.9dm³ of water, what is the molarity of the new solution?
- What mass of silver is present in 100cm³ of 1mol dm⁻³ silver nitrate (AgNO₃)?
- The Dead Sea, between Jordan and Israel, contains 0.0526 mol dm⁻³ of Bromide ions (Br⁻), what mass of bromine is in 1dm³ of Dead Sea water?

Chemistry topic 6 – 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:



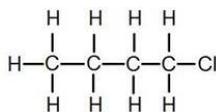
<http://bit.ly/pixlchem14>

<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?



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) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7$

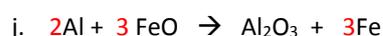
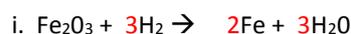
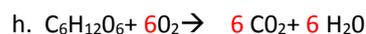
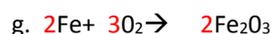
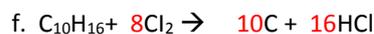
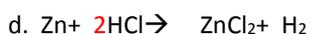
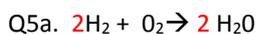
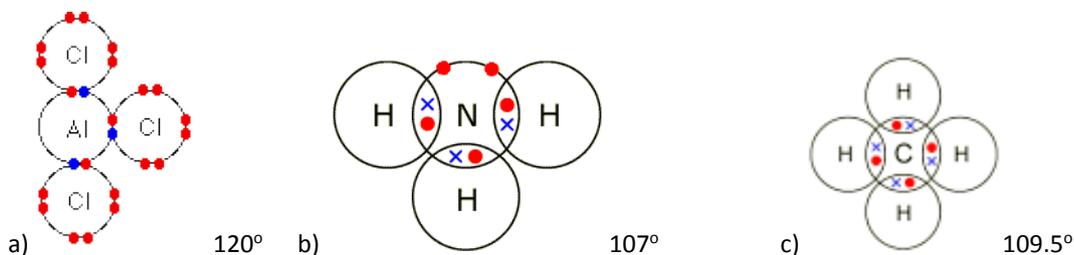
- Q2.1 a) +4 b) +6 c) +5 d) +4 e) +3 f) +5 g) +7 h) +6 i) +4

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) $85.2/284 = 0.3 \text{ moles}$

b) $73.56/122.6 = 0.6 \text{ moles}$

c) $249.5/249.5 = 1.0 \text{ moles}$

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

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

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

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

d) in 1dm^3 of 1 mol dm^{-3} silver nitrate, 1 mole of $\text{Ag} = 107.9\text{g}$ 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 0.25 mol dm^{-3}

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

9.1 1-chlorobutane

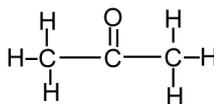
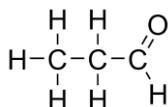
Add butan-1-ol to concentrated HCl and shake

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.

$\text{CH}_3\text{COOH} \rightleftharpoons \text{CH}_3\text{COO}^- + \text{H}^+$

Mostly this Very few of these

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