Sixth Form Preparation for Success

Welcome to Chemistry

AQA Chemistry 7405

Introduction: Chemistry is one of the most desirable subjects to study at A level. It is the only A-level that is essential to study medicine, veterinary science or dentistry. If you choose to study Chemistry, you are opening doors to your future. Chemistry can be difficult, but if you work hard to learn things as you go and look to build connections between topics, you'll do well. Let's start with the foundations!

Part I – Y11 into 12 Chemistry Specific Bridging Work

Remember that prizes will be awarded for 'exceptional' work that demonstrates effort above the normal!

A) Investigate places of interest – If you can't physically visit them, try a virtual tour

1. Science museums. You could visit your nearest science museum. They often have special exhibitions that may be of interest to you.
   https://en.wikipedia.org/wiki/List_of_science_museums#United_Kingdom

   Try this one from the Science Museum in London:
   https://360tour.sciencemuseum.org.uk/

2. You could also try contacting your nearest university to see if they are running any summer schools for Chemistry/ Medicine/ Forensics etc – they are usually free and give you the opportunity to experience the resources of a University faculty.

3. Take a virtual tour of a laboratory or chemical plant. The link below allows you to have a look around a typical laboratory.
   https://www.abpischools.org.uk/topic/labpilotplant/1/1

4. Thackray medical museum. Learn about the heritage of medicine & healthcare
   https://www.thackraymedicalmuseum.co.uk/

5. Catalyst science discovery centre. The only museum in the UK which explores the science and technology behind the chemical industry
https://www.catalyst.org.uk/

6. The UK Association for Science and Discovery Centres (ASDC)
This association brings together over 60 major science engagement organisations in the UK. http://sciencecentres.org.uk/centres/weblinks.php

B) Wider reading: Below is a selection of books that should appeal to anyone with an interest in the physical world around them. None of these are textbooks full of information to be learned - there will be plenty of time for that! Instead each provides some interesting and often humorous background to chemistry and its applications.

1. **The pleasure of finding things out – Richard Feynman**
2. **Periodic Tales - Hugh Aldersey-Williams**
3. **The Disappearing Spoon - Sam Kean**
4. **Uncle Tungsten - Oliver Sachs**
5. **The Science of Everyday Life: Why Teapots Dribble, Toast Burns and Light Bulbs Shine - Marty Jopson**
6. **Bad Science - Ben Goldacre**
7. **The Shocking History of Phosphorus: A Biography of the Devil's Element - John Emsley**
8. **A brief history of nearly everything – Bill Bryson**
9. **Magazines or journals such as: New Scientist, Education in Chemistry, The Mole**

Movie / Video Clip Recommendations: Hopefully you'll get the opportunity to soak up some of the Sun's rays over the summer – synthesising some important Vitamin-D – but if you do get a few rainy days where you're stuck indoors (this is highly likely this year!) then here are some ideas for videos to find 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://www.dailymotion.com/playlist/x2igjq_Rough-Science_rough-science-full-series/1#video=xxw6pr or 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.
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?
https://www.youtube.com/watch?v=0Bt6RPP2ANI

C) Compulsory tasks

Below are 4 topics that you will study in more detail for A-Level Chemistry. You are to complete the task set for each of them.

Atomic Structure

You will study the structure of atoms in more detail at A-level. In order to explain what happens you need to have a good understanding of the GCSE model of the atom. You need to know what the atom is made up of, relative charges and masses and how sub-atomic particles are arranged. You also need to know about isotopes and how relative atomic mass is calculated. Use the following link to review what you need to know about atomic structure.
https://www.bbc.co.uk/bitesize/guides/z3sg2nb/revision/1

Task: Using carbon-12 as an example, draw a clearly labelled diagram showing the structure of an atom including details of the individual particles that make up the atom, their location and the relative charges and masses of these particles. Include definitions of atomic (proton) number and mass number. Carbon also exists as the isotopes C-13 and C-14. Define the terms isotope and relative atomic mass and describe the similarities and differences between the 3 isotopes of carbon.

Chemical bonding

At GCSE you studied the 3 types of chemical bonding and at A level you will explore this topic in more detail so it is essential you have a good understanding of the content covered at GCSE. You will be expected to describe and explain each type of bonding and use these to explain the characteristic properties of different materials.
The following videos contain explanations of each type:
Ionic bonding: https://www.youtube.com/watch?v=QTmpQUunQCA
Covalent bonds: https://www.youtube.com/watch?v=fYdZaAPrUcQ
Metallic bonds: https://www.youtube.com/watch?v=oUqygTeBSbs

Task: Describe and **explain** the melting point, hardness & electrical conductivity of: ionic compounds (e.g. sodium chloride), simple molecules (e.g. methane) and metals (e.g. magnesium)

Kinetics

At GCSE you learned about collision theory and the factors that affect the rate of chemical reactions. At A-level you will learn about this in more detail and will develop a much deeper understanding of how rate of reaction can be investigated practically and calculated mathematically.
Watch this video to remind yourself about collision theory:
https://www.youtube.com/watch?v=jd6U5nQcqKc

Task: State the 5 factors that affect the rate of a chemical reaction. For each one explain, in terms of particles and collisions, how and why it affects the rate of reaction. Explain why catalysts are so important in industry.

Organic chemistry

You have studied different types of organic (carbon based) compounds including alkanes, alkenes, alcohols and carboxylic acids. At A-level you will study these groups in more detail along with many other families of organic compounds: A quick refresher!!
https://www.youtube.com/watch?v=UloIw7dhnlQ

Task:

1) Name and draw displayed formulae for the first 4 members of each of the alkane, alkene and alcohol families of organic molecules.

2) Explain how alkanes are separated from crude oil and what the majority of them are used for.

3) Define the terms complete and incomplete combustion and write balanced symbol equations for the complete combustion of propane and the incomplete combustion of butane forming carbon monoxide and water.

D) Stretch! (not compulsory, but interesting and valuable)

Applications in real life:

Use your online searching abilities to see if you can find out as much about the topics below as you can. Start by having a look at Cornell notes. Many students find this very useful. Remember you are a prospective A-level chemist, you should aim to push **your** knowledge.

Make a 1-page summary for each one you research using the Cornell notetaking skills (see http://coe.jmu.edu/learningtoolbox/cornellnotes.html for a reminder):

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 sulphate 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?

Part II - Year 12 Head Start! for completion June – September

Preparatory tasks to give you a head start to your A-level studies

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 and the third up to 8 (or you may have been told it can hold up to 18!).
For example, for Lithium - Atomic number = 3 so number of 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 about the chemical properties of elements.
The 'shells' can be broken down into sub-shells or 'orbitals', which are given letters: 's' orbitals, 'p' orbitals and 'd' orbitals. You can read about orbitals here:
http://www.chemguide.co.uk/atoms/properties/atomorbs.html

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 – Isotopes and mass

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

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://www.kore.co.uk/tutorial.htm
http://filestore.aqa.org.uk/resources/chemistry/AQA-7404-7405-TN-MASS-SPECTROMETRY.PDF

Q2.1 What must happen to the atoms before they are accelerated in the mass spectrometer?
Q2.2 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 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:

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

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

Q2.3 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%

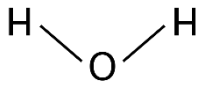
b) Gallium has 2 isotopes: Ga-69 60.2% and Ga-71 39.8%

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 3 – 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://www.chemguide.co.uk/atoms/bonding/covalent.html

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://www.chemguide.co.uk/atoms/bonding/shapes.html

Q3.1 Draw a dot and cross diagram to show the bonding in a molecule of aluminium chloride ($AlCl_3$)
Q3.2 Draw a dot and cross diagram to show the bonding in a molecule of ammonia (NH_3)
Q3.3 What is the shape and the bond angles in a molecule of methane (CH_4)?

Chemistry topic 4 – 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://www.chemguide.co.uk/orgpropsmenu.html

And how to name organic compounds here:
http://www.chemguide.co.uk/basicorg/conventions/names.html

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

Q4.1 Halogenoalkanes
What is the name of this halogenoalkane?
How could you make it from butan-1-ol?

Q4.2 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?

Q4.3 Aldehydes and ketones
Draw the structures of a) propanal b) propanone
How are these two functional groups similar? How do they differ from each other?