The Friary Sixth Form

Chemistry Bridging Pack 2025

Course Expectations

As part of your AS/A Level studies you will have nine hours of timetabled lessons across the school's two week timetable. In these lessons you will cover all the theory and practical work required for the course.

To support your learning you will be provided with a textbook for the current AS/A Level course. Your teachers are, of course, an excellent source of support both in and out of lessons. Additional texts are available in the school library and a full copy of the specification, past papers etc. can be accessed via the AQA website.

http://www.aqa.org.uk/subjects/science/as-and-a-level/chemistry-7404-7405/specification-at-a-glance

Equipment

Pen

Pencil

Ruler

Pencil Sharpener

Rubber

Calculator

Folder with dividers

Teachers

Mrs R. Whitehead (rwhitehead@friaryschool.co.uk)

Miss E Tombs (etombs@friaryschool.co.uk)

Course Overview

We study the AQA A level Chemistry course which lasts for two years. The course is split into three areas: physical chemistry, inorganic chemistry and organic chemistry. There are three exams at the end of the two years, all of which are two hours long. At least 15% of the marks for A level Chemistry are based on what you learned in the practical activities that you will carry out.

In the first year of study we will cover:

Physical chemistry

Atomic structure, amount of substance, bonding, energetics, kinetics, redox reactions, chemical equilibria and Le Chatelier's principle.

Inorganic chemistry

Periodicity, group 2 the alkaline earth metals, group 7 the halogens.

Organic chemistry

Introduction to organic chemistry, alkanes, halogenoalkanes, alkenes, alcohols, organic analysis.

In the second year of study we will cover:

Physical chemistry

Thermodynamics, rate equations, the equilibrium constant K_p, electrode potentials and electrochemical cells and , acids and bases.

Inorganic chemistry

Properties of period 3 elements and their oxides, transition metals, reactions of ions in aqueous solution.

Organic chemistry

Optical isomerism, aldehydes and ketones, carboxylic acids and their derivatives, aromatic chemistry, amines, polymers, amino acids, proteins and DNA, organic synthesis, NMR Spectroscopy and chromatography.

In addition to this, you will carry out practical activities and your performance during these will be assessed in order to gain the practical endorsement.

Tasks

<u>Key areas from your GCSE Science work that you will need for AS/A Level Chemistry</u>

1) Atomic structure – protons, neutrons, electrons, mass number, isotopes etc.

2) Electron arrangement – how many electrons each shell can hold etc.

3) Ionic compounds – dot and cross diagrams, properties, examples.

4) Covalent compounds – dot and cross diagrams, properties, examples, diamond vs graphite.

5) Metallic bonding – diagram, properties of metals.

6) Calculations – relative atomic mass, relative molecular mass, atom economy, percentage yield.

7) Reversible reactions and equilibria

8) Organic compounds – alkanes and alkenes.

9) Fractional distillation and cracking.

10) Rates of reaction – collision theory, how to speed up reactions, catalysts etc.

11) Endothermic and exothermic reactions.

12) Periodic table – overall arrangement in groups and periods.

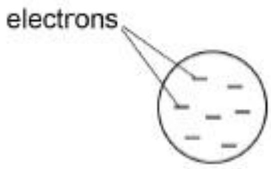
Use your knowledge of the topics above to answer the following questions.

Section A – complete all questions (1 hour)

Q1. This question is about atomic structure.

In the nineteenth century JJ Thomson discovered the electron. He suggested that negative electrons were found throughout an atom like 'plums in a pudding of positive charge'.

The diagram shows an atom of element **R** using the 'plum pudding' model.
An atom of **R** contains seven electrons.



(a) State **two** differences between the 'plum pudding' model and the model of atomic structure used today.

1. ____

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2. ____

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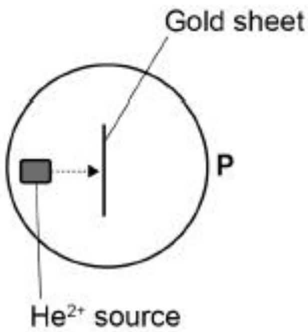
(2)
(Total 2 marks)

Q2. In the early twentieth century the apparatus shown in the diagram was used to investigate atomic structure. When He^{2+} particles were fired at a thin sheet of gold, most of the particles were detected at point **P**.



What conclusion can be drawn from the detection of He^{2+} particles at point **P**?

A Gold atoms contain electrons. ⬭

B Gold atoms contain protons. ⬭

C Gold atoms contain neutrons. ⬭

D Gold atoms are mainly empty space. ⬭

(Total 1 mark)

Q3. Magnesium exists as three isotopes: ^{24}Mg, ^{25}Mg and ^{26}Mg

(a) In terms of sub-atomic particles, state the difference between the three isotopes of magnesium.

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(1)

(b) State how, if at all, the chemical properties of these isotopes differ.

Give a reason for your answer.

Chemical properties ____

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Reason ____

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(2)

(Total 3 marks)

Q4. Which of these correctly shows the numbers of sub-atomic particles in a $^{41}K^{+}$ ion?

	Number of electrons	Number of protons	Number of neutrons	
A	19	19	20	○
B	18	20	21	○
C	18	19	22	○
D	19	18	23	○

(Total 1 mark)

Q5. Which of these contains the greatest number of atoms?

A 127 mg of iodine ○

B 1.54×10^{-4} kg of phosphorus ○

C 81.0 mg of carbon dioxide ○

D 1.70×10^{-4} kg of ammonia ○

(Total 1 mark)

Q6. A sample of titanium was ionised by electron impact in a time of flight (TOF) mass spectrometer. Information from the mass spectrum about the isotopes of titanium in the sample is shown in the table.

m/z	46	47	48	49
Abundance / %	9.1	7.8	74.6	8.5

(a) Calculate the relative atomic mass of titanium in this sample.

Give your answer to one decimal place.

Relative atomic mass of titanium in this sample ____________________

(2)

(Total 2 marks)

Q7. Which is the correct crystal structure for the substance named?

	Substance	Structure	
A	Iodine	Simple molecular	○
B	Diamond	Ionic	○
C	Sodium chloride	Giant covalent	○
D	Graphite	Metallic	○

(Total 1 mark)

Q8. The table shows some data about the elements bromine and magnesium.

Element	Melting point / K	Boiling point / K
Bromine	266	332
Magnesium	923	1383

In terms of structure and bonding explain why the boiling point of bromine is different from that of magnesium.

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(Total 4 marks)

Q9. Methanol can be manufactured in a reversible reaction as shown by the equation.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

(a) State and explain the effect of using a catalyst on the yield of methanol in this equilibrium.

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(2)

(Total 2 marks)

Q10. For this reaction at equilibrium, which combination of temperature and pressure would give the greatest equilibrium yield of products?

$W(g) + X(g) \rightleftharpoons 2Y(g) + Z(g)$ Forward reaction is endothermic

A High pressure and high temperature ☐

B High pressure and low temperature ☐

C Low pressure and high temperature ☐

D Low pressure and low temperature ☐

(Total 1 mark)

Q11. Petrol contains saturated hydrocarbons. Some of the molecules in petrol have the molecular formula C_8H_{18} and are referred to as octanes. These octanes can be obtained from crude oil by fractional distillation and by cracking suitable heavier fractions.

Petrol burns completely in a plentiful supply of air but can undergo incomplete combustion in a car engine.

(a) State the meaning of both the words *saturated* and *hydrocarbon* as applied to the term *saturated hydrocarbon*.

Name the homologous series to which C_8H_{18} belongs.

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____**(3)**

(b) Outline the essential features of the fractional distillation of crude oil that enable the crude oil to be separated into fractions.

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(4)

(c) C_8H_{18} is obtained by the catalytic cracking of suitable heavy fractions.
State what is meant by the term *cracking* and explain why oil companies need to crack 'suitable heavy fractions'.

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(2)
(Total 9 marks)

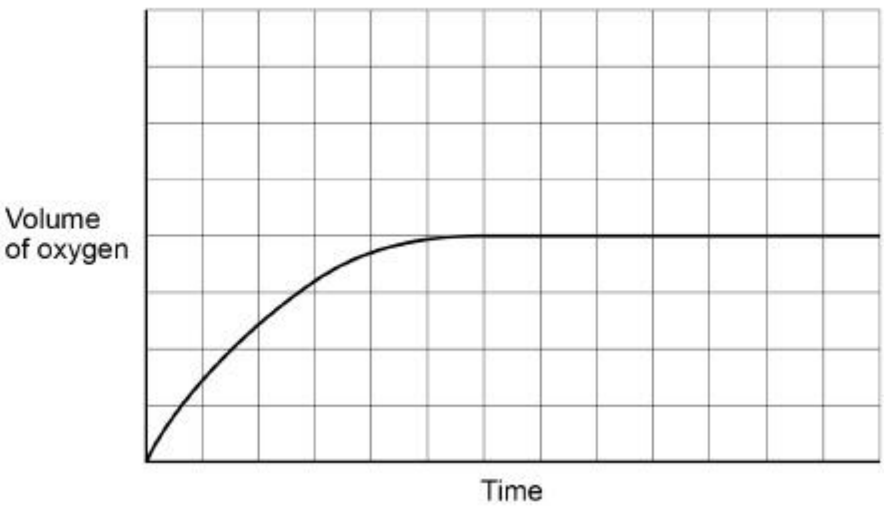
Q12. Hydrogen peroxide solution decomposes slowly to form water and oxygen.
The reaction is much faster in the presence of a manganese(IV) oxide catalyst.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

Three experiments, shown in the table, were carried out to investigate how the volume of oxygen produced varied over time under different conditions. The same mass of catalyst was used in each experiment.

Experiment	Concentration of H_2O_2(aq) / mol dm^{-3}	Volume of H_2O_2(aq) / cm^3	Temperature / °C	Catalyst
1	1.0	50	20	lumps
2	1.0	50	20	powder
3	0.5	50	20	lumps

The graph shows how the volume of oxygen collected varied with time in Experiment **1**.



(a) Explain, in general terms, how a catalyst increases the rate of a reaction.

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(2)

(b) Draw **two** lines on the graph to show how the volume of oxygen collected varied with time in Experiments **2** and **3**.
Label each line with the experiment number.

(2)

(c) Explain, in terms of collision theory, the effect of increasing the concentration of hydrogen peroxide on the rate of reaction.

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(2)

(Total 6 marks)

Q13. Hydrogen is produced in industry from methane and steam in a two-stage process.

(a) In the first stage, carbon monoxide and hydrogen are formed.
The equation for this reaction is

$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$ forward reaction is endothermic

(i) Use Le Chatelier's principle to state whether a high or low temperature should be used to obtain the highest possible equilibrium yield of hydrogen from this first stage.
Explain your answer.

Temperature ____

Explanation ____

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(3)

(ii) Le Chatelier's principle suggests that a high pressure will produce a low yield of hydrogen in this first stage.

Explain, in terms of the behaviour of particles, why a high operating pressure is used in industry.

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(2)

(iii) A nickel catalyst is used in the first stage.

Explain why the catalyst is more effective when coated onto an unreactive honeycomb.

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(2)

(b) The second stage is carried out in a separate reactor. Carbon monoxide is converted into carbon dioxide and more hydrogen is formed.

The equation for this reaction is

$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$ Forward reaction is exothermic

Use Le Chatelier's principle to state the effect, if any, of a **decrease** in the total pressure on the yield of hydrogen in this second stage. Explain your answer.

Effect ____

Explanation ____

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(2)

(Total 9 marks)

Section B (5 hours)

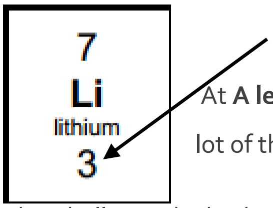
Pre-Knowledge Topics

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 shell, 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:

https://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

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

a) K^+ b) O^{2-} c) Zn^{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.

-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, $NaNO_3$

Na +1 3x O^{2-}

+1 -6

To cancel: N = +5

sulfate ion, SO_4^{2-}

4xO^{2-} and 2- charges 'showing'

-8 -2

S = +6

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

f) $K\underline{Mn}O_4$ g) $\underline{Cr}_2O_7^{2-}$

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

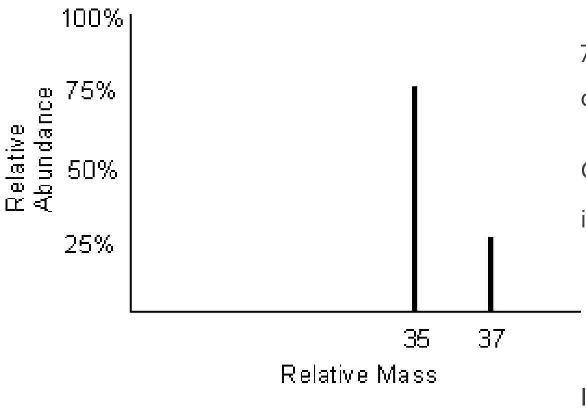
Isotopes occur naturally, so in a sample of an element you will have a mixture of these isotopes. We can accurately measure the amount of an isotope using a **mass spectrometer**. You will need to understand what a mass spectrometer is and how it works at A level. You can read about a mass spectrometer here:

https://www.chemguide.co.uk/analysis/masspec/howitworks.html#top

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 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:

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

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** 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

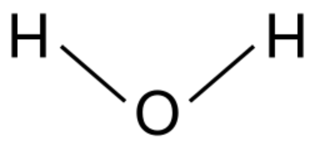
10.8 5 **B** boron	12.0 6 **C** carbon	14.0 7 **N** nitrogen	16.0 8 **O** oxygen	19.0 9 **F** fluorine
27.0 13 **Al** aluminium	28.1 14 **Si** silicon	31.0 15 **P** phosphorus	32.1 16 **S** sulphur	35.5 17 **Cl** chlorine

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.

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%

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://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:

https://www.chemguide.co.uk/atoms/bonding/covalent.html

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)

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

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

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

Q5.1 Balance the following equations

a. $H_2 + O_2 \rightarrow H_2O$

b. $S_8 + O2 \rightarrow SO_3$

c. $HgO \rightarrow Hg + O_2$

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

e. $Na + H2O \rightarrow NaOH + H_2$

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

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

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 → 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.

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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.

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://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 ($Pb(NO_3)_2$) 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?

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.

https://www.bbc.co.uk/bitesize/guides/zx98pbk/revision/1

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

A 25.00cm^3 sample of the unknown sulfuric acid was titrated with 0.100moldm^{-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://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.

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

What volume of 0.25moldm^{-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 – 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:

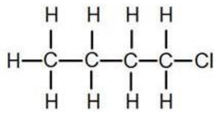
https://www.chemguide.co.uk/orgpropsmenu.html

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:

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://www.chemguide.co.uk/physical/acidbaseeqia/theories.html

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

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

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

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

Section C (1 hour)

Chemistry A level transition - baseline assessment. **40 marks**

All data is given on this paper, you will not need a periodic table

Answer all questions.

1. Here is part of a periodic table, use it to answer the following questions

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	20.2 Ne 10 neon
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	39.9 Ar 18 argon

a. Which is the correct electron configuration for a nitrogen atom, circle the correct answer [1]

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

b. Which is the correct electron configuration for a chlorine atom, circle the correct answer [1]

$1s^2 2s^8 2p^7$ $1s^2 2s^2 2p^8 2d^5$ $1s^2 2s^2 2p^6 3d^7$ $1s^2 2s^2 2p^6 3p^7$ $1s^2 2s^2 2p^6 3s^2 3p^5$

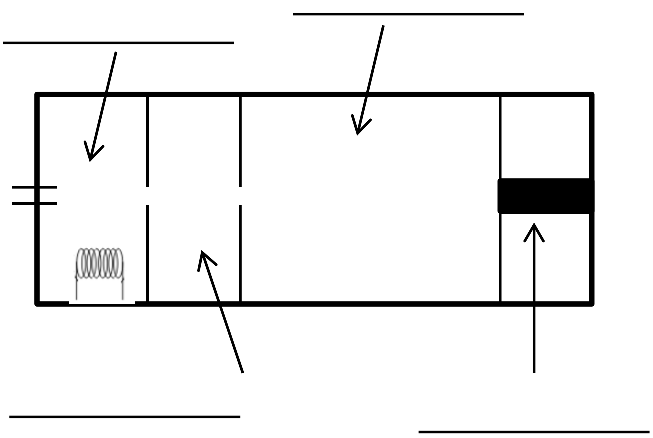
c. Which is the correct electron configuration for an aluminium **ion**, Al^{3+}? Circle the correct answer [1]

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

2. Draw a dot and cross diagram to show the bonding in a molecule of water, H_2O. [2]
Atomic numbers: H =1, O =8

3. A time of flight mass spectrometer has 4 main stages. put the correct stage in the diagram below:

Drift region **Ionisation** **Detector** **Acceleration**



[4]

4. A mass spectrometer was used to analyse a sample of chlorine; the results of the analysis are as follows:

isotope mass	% of sample
Cl-35	75.53
Cl-37	24.47

Calculate the accurate atomic mass of chlorine. Give your answer to **3 decimal places**. [3]

mass: ________________________

5. Give the oxidation state of the underlined atom in the following chemicals.
Useful information: H = +1, K = +1, Na = +1, Mg = +2, O = -2, Cl = -1 [7]

a) $\underline{C}O_2$ b) $\underline{S}O_3$ c) $H_2\underline{S}O_4$ d) $\underline{Al}Cl_3$

e) $\underline{Cr}_2O_3$ f) $Na\underline{N}O_3$ g) $\underline{V}Cl_4$

6. Balance the following chemical equations:

a) C_3H_8 + ___ O_2 → ___ CO_2 + ___ H_2O [3]

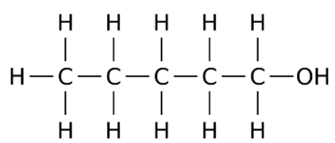
b) ___ HCl + $Mg(OH)_2$ → $MgCl_2$ + ___ H_2O [2]

c) Na_2CO_3 + ___ HCl → ___ NaCl + ___ H_2O + CO_2 [3]

7. Calculate the relative formula masses of the following:
Atomic masses: H = 1, O = 16, S = 32.1, C = 12, Ca = 40.1, Na = 23, Cl = 35.5, Zn = 65.4

a) $CaCl_2$ b) H_2CO_3 c) Na_2SO_4 d) C_3H_7OH e) $Zn(NO_3)_2$ [5]

8. A student carried out a reaction with this molecule:



a. What is the name of this molecule? __________________ [2]

9. Vinegar is a solution of ethanoic acid (CH_3COOH) in water. A student carried out a titration of a sample of vinegar. He used a pipette to measure exactly 25.0cm^3 of vinegar into a flask, added an indicator and titrated it with a 1.00 mol dm^{-3} solution of sodium hydroxide (NaOH).
The reaction is:

$$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$$

The student found that his average titration was 27.50cm^3

c = n/v c = concentration (mol dm^{-3}), n = number of moles, v = volume (dm^3)

n = m/Rfm n = number of moles, m = mass in grams, Rfm = formula mass

1dm^3 = 1000 cm^3

a. Using the chemical equation, how many moles of sodium hydroxide will react with 1 mole of ethanoic acid?

___________moles [1]

b. How many moles of sodium hydroxide are in 27.50cm^3 of 1.00 moldm^{-3} sodium hydroxide?

___________moles [2]

c. How many moles of ethanoic acid are in 25.0cm^3 of the vinegar sample?

___________moles [1]

d. How many moles of ethanoic acid are in 1dm^3 of vinegar?

___________moles [1]

e. Ethanoic acid has a formula mass of 48. What mass of ethanoic acid is present in 1dm^3 of vinegar?

___________g [2]

Section D (3 hours) Research activities

Use your online searching abilities to see if you can find out as much about the topic as you can. Remember it 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

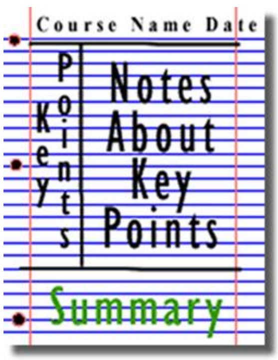
What was the history of the discovery of aspirin, how do we manufacture aspirin in a modern chemical process?

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?



Glossary

Relative Atomic Mass	The mean mass of an atom relative to 1/12 of the mass of one atom of carbon-12
Acid	A species that is a proton donor
Activation energy	The minimum energy required to start a reaction by breaking bonds
Addition polymer	A polymer formed from alkene monomers, one at a time
Addition reaction	A reaction in which a reactant is added to an unsaturated molecule to make a saturated one
Alkanes	The homologous series with the general formula C_nH_{2n+2}
Anhydrous	A substance containing no water
Anion	A negatively charged ion
Avagadro constant	The number of atoms or molecules in one mole of that substance
Base	A species that is a proton acceptor
Boltzmann distribution	The distribution of energies of molecules at a particular temperature
Carbocation	An organic ion in which a carbon has a positive charge
Cation	A positively charged ion
Compound	A substance formed from two or more chemically bonded elements in a fixed ratio
Coordinate bond	A shared pair of electrons which has been provided by one of the bonding atoms
Covalent bond	A bond formed by a shared pair of electrons
Cracking	The breakdown of long-chained saturated hydrocarbons to form a mixture of shorter chain alkanes and alkenes.
Curly arrow	A symbol used in reaction mechanisms to show the movement of a pair of electrons in the breaking or formation of the molecule
Dehydration	An elimination reaction in which a water molecule is removed
Displayed formula	A formula showing the relative position of all the atoms in a molecule and the bonds between them
Dynamic Equilibrium	The equilibrium that exists in a closed system when the rate of the forward reaction is equal to the rate of the reverse reaction

E/Z isomerism	A type of stereoisomerism in which different groups attached to carbons in a C=C double bond are arranged differently in space because of the restricted rotation of the C=C bond
Electron configuration	The arrangement of electrons in an atom
Electronegativity	The power of an atom to attract an electron pair in a covalent bond towards itself
Electrophile	An atom (or group of atoms) that is attracted to an electron rich centre or atom where it can accept a pair of electrons
Elimination reaction	A type of reaction where a small molecule is removed
Empirical formula	The simplest whole-number ratio of atoms of each element present in a compound
Endothermic reaction	A reaction in which the enthalpy of the products is greater than the enthalpy of the reactants, resulting in heat being taken in from the surroundings
Enthalpy change of combustion	The enthalpy change that takes place when one mole of a substance reacts completely with oxygen under standard conditions and in their standard states
Enthalpy change of formation	The enthalpy change that takes place when one mole of a compound in its standard state is formed from its constituent elements in their standard states under standard conditions
Exothermic reaction	A reaction in which the enthalpy of the products is smaller than the enthalpy of the reactants, resulting in heat loss to the surroundings
First ionization energy	The energy required to remove an electron from each atom in one mole of gaseous atoms
Fractional distillation	The separation of the components in a liquid mixture into fractions with similar boiling points
Fragmentation	The process in mass spectrometry that causes a positive ion to split into pieces, one of which is a positive ion
Functional group	The part of the organic molecule responsible for its chemical reactions
General formula	The simplest algebraic formula of a member of a homologous series
Giant ionic lattice	A three-dimensional structure of oppositely charged ions, bonded together by strong electrostatic attractions
Greenhouse effect	The process in which the absorption and subsequent emission of infrared radiation by atmospheric gases warms the lower atmosphere and the planet's surface
Group	A vertical column in the periodic table
Homologous series	A series of organic compounds with the same functional group, but with each successive member differing by CH_2
Hydrocarbon	An organic compound made of hydrogen and carbon atoms only

Hydrogen bond	A strong dipole-dipole attraction between an electron deficient hydrogen atom on one molecule and a lone pair of electrons on a highly electronegative atom on a different molecule
Initiation	The first step in a radical substitution reaction in which the free radicals are generated by UV radiation
Intermolecular force	An attractive force between neighbouring molecules
Ion	A positively or negatively charged atom or group of atoms
Ionic bond	The electrostatic attraction between oppositely charged ions
Ionisation energy	A measure of the energy required to remove one electron from an atom
Isotopes	Atoms of the same element with different numbers of neutrons
Le Chatelier's principle	When a system in dynamic equilibrium is subjected to a change, the position of equilibrium will shift to minimize the change
Limiting reagent	The substance in a chemical reaction that runs out first
Lone pair	An outer shell electron pair that is not involved in chemical bonding
Mass number	The number if particles in the nucleus
Mechanism	A sequence of steps showing the path taken by electrons in a reaction
Metallic bond	The electrostatic attraction between positive metal ions and delocalized electrons
Mole	The amount of any substance containing as many particles as there are carbon atoms in exactly 12g of the carbon-12 isotope
Molecular formula	The number of atoms of each element in a molecule
Molecular ion	The positive ion formed in mass spectrometry when a molecule loses an electron
Molecule	A small group of atoms held together by covalent bonds
Monomer	A small molecule that combines with many other monomers to form a polymer
Nomenclature	A system of naming compounds
Nucleophile	An atom (or group of atoms) that is attracted to an electron deficient centre or atom, where it donates a pair of electrons to form a new covalent bond

Additional Reading

Below are a number of Catalyst articles and books which you can read to support your learning before starting your A-level.

Please record all your additional reading on the attached additional reading log.

Topic 1: Using Plastics in the Body

Available at: https://www.stem.org.uk/system/files/elibrary-resources/2017/05/Using%20plastics%20in%20the%20body.pdf

This Catalyst article looks at how scientists are learning to use polymers for many medical applications, including implants, bone repairs and reduction in infections.

Topic 2: Catching a Cheat

Available at: https://www.stem.org.uk/system/files/elibrary-resources/2017/03/Catching%20a%20cheat.pdf

This Catalyst article looks at analytical chemists who are involved in many kinds of testing, including drug testing to catch cheats in sport.

Topic 3: Diamond: More than just a gemstone

Available at https://www.stem.org.uk/system/files/elibrary-resources/2017/02/Diamond%20more%20than%20just%20a%20gemstone.pdf

This Catalyst article looks at diamond and graphite which are allotropes of carbon. Their properties, which depend on the bonding between the carbon atoms, are also examined.

Topic 4: The Bizarre World of High Pressure Chemistry

Available at: https://www.stem.org.uk/system/files/elibrary-resources/2016/11/Catalyst27_1_the_bizarre_world_of_high_pressure_chemistry.pdf

This Catalyst article investigates high pressure chemistry and discovers that, when put under extreme pressure, the properties of a material may change dramatically.

Topic 5: Microplastics and the Oceans

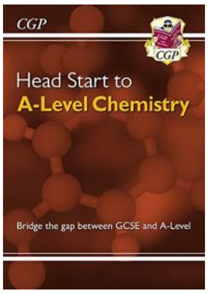
Available at: https://www.stem.org.uk/system/files/elibrary-resources/2016/11/Catalyst27_1_microplastics_%20and_the_oceans.pdf

This Catalyst article looks at microplastics. Microplastics are tiny particles of polymer used in many products. They have been found to be an environmental pollutant especially in oceans.

You can find archived copies of Catalyst magazine here for further reading on a wide range of topics.

https://catalyst-magazine.org/archive/

Book Recommendations

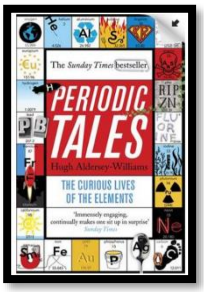


Head Start to A-Level Chemistry

ISBN: 9781782942801

This book goes over crucial topics from GCSE and includes detailed explanations of important A-level topics.

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

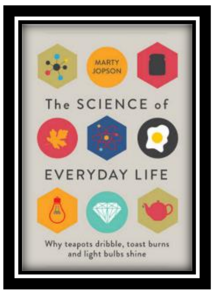


ISBN-10: 0141041455

http://bit.ly/pixlchembook1

This 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 have never even thought about.

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

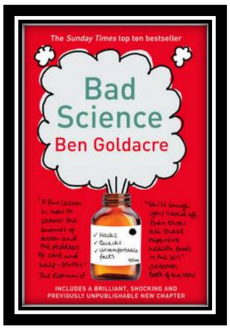


ISBN-10: 1782434186

http://bit.ly/pixlchembook2

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

Bad Science (Paperback) Ben Goldacre

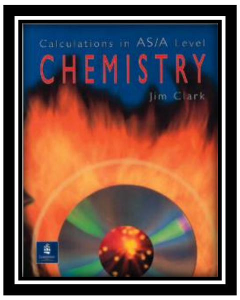


ISBN-10: 000728487X

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.

Additional Reading Log:

Additional Reading Title	Dates?	Points of interest	How does it link to the course?

Supporting Resources

There are a number of websites that will be useful to you now and throughout your time studying A-level Chemistry.

These include:

Physics and Maths Tutor

https://www.physicsandmathstutor.com/chemistry-revision/a-level-aqa/

This website allows you to access a range of resources, from course notes, flashcards and tutorial videos to exam question packs and mark schemes for every topic covered at A-level.

Chemguide

https://www.chemguide.co.uk/

This website has detailed notes on all areas of the A-level course and also identifies and addresses common misconceptions.

Seneca Learning

https://senecalearning.com/en-GB/

This website has many subjects linked to the specific exam boards which you can use to support your knowledge. It allows you to study and then test the information you have learnt.

Isaac Physics

Mastering essential pre-university chemistry — Isaac Physics

This website is useful for physical chemistry, particularly the calculation topics.