Transition Pack for A-Level Chemistry

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

You could (Page 3)
Find something that interests you about Chemistry
Do a research activity on page 3

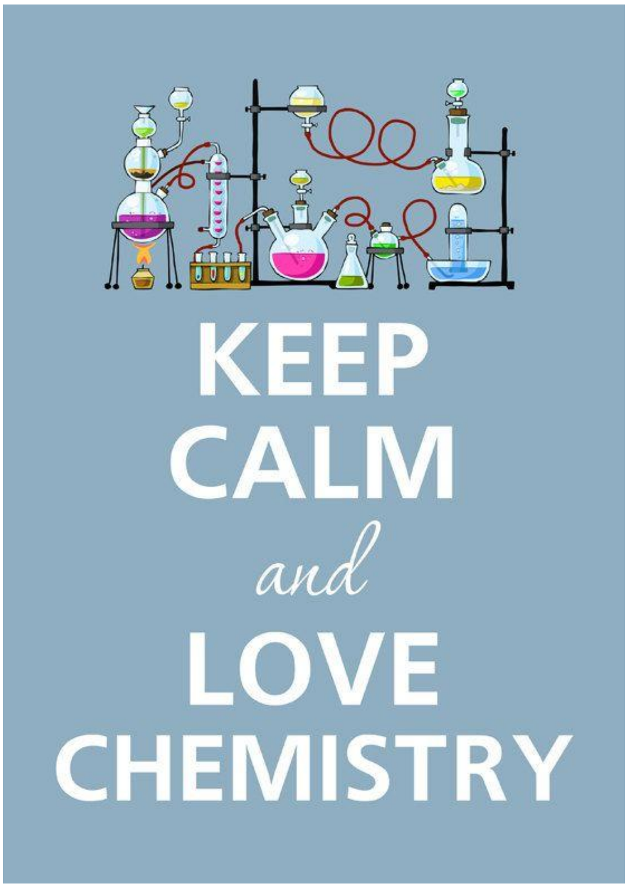
You should (Pages 4-11)
Want to hit the ground running? Work through the Pre-knowledge Topic Guides then check your answers to the tasks (pages 12-13)

Do something interesting (Pages 14-16)
A walking tour of Chemistry in Cambridge, interesting books to read, videos to watch to keep your Chemistry alive over the summer!

You must (Pages 17-19)

Take the baseline assessment and bring your answers into the first lesson in September

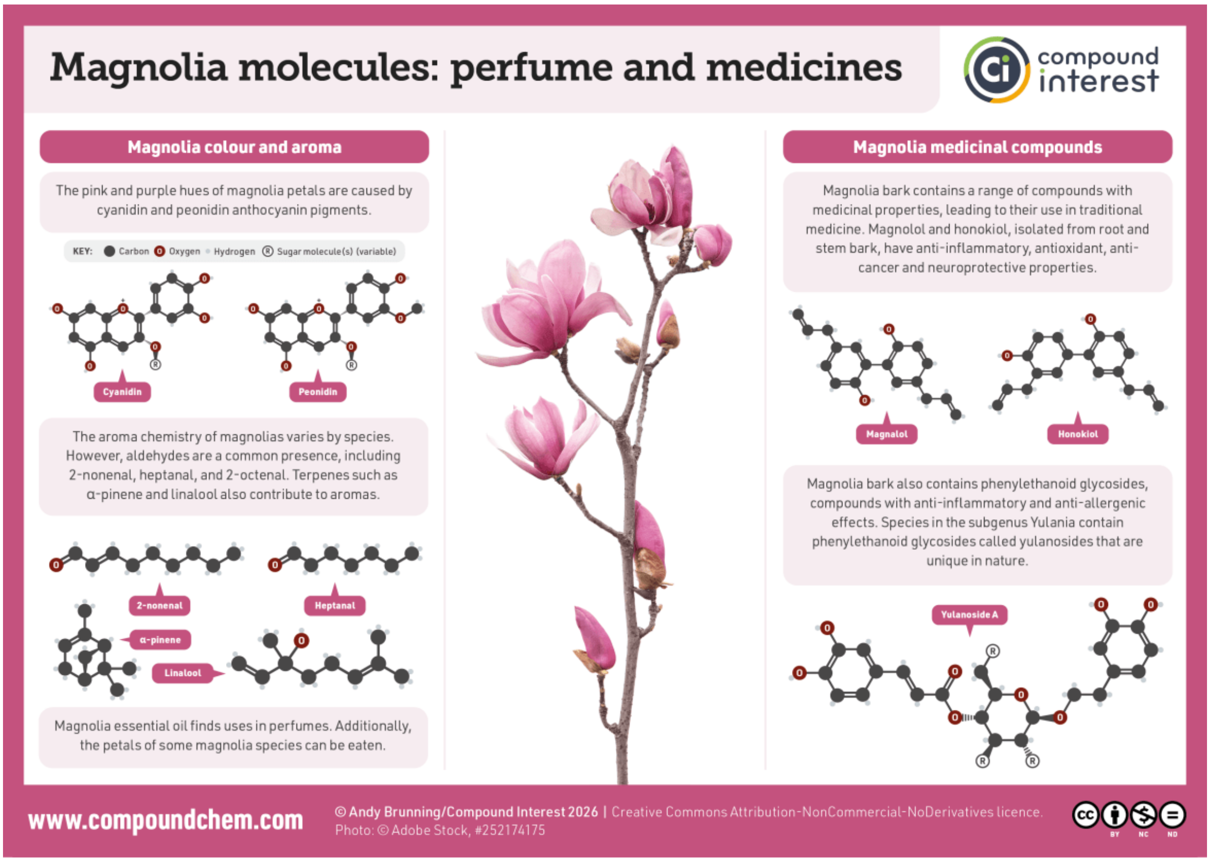
So, you are considering A-Level Chemistry?



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.

1. Research activities

Have a look at some of the infographics produced by [compoundinterest](), pick one you find interesting and do some further research



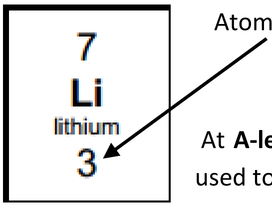
2. Pre-Knowledge Topics

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://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.

-5 0 +5

You can read about the rules for assigning oxidation numbers here:

https://chemguide.co.uk/inorganic/redox/oxidnstates.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, $NaNO_3$		Sulfate ion, SO_4^{2-}	
	Na +1	3x O^{2-}	$4xO^{2-}$	and 2- charges 'showing'
	+1	-6	-8	-2
To cancel:	N = +5		S = +6	

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

a) $Mg\underline{C}O_3$ b) $\underline{S}O_3$ c) $Na\underline{Cl}O_3$ d) $\underline{Mn}O_2$ e) $\underline{Fe}_2O_3$ f) $\underline{V}_2O_5$

g) $K\underline{Mn}O_4$ h) $\underline{Cr}_2O_7^{2-}$ i) $\underline{Cl}_2O_4$

Chemistry topic 3 – Isotopes and mass

You will remember that isotopes are elements that have differing numbers of neutrons. Hydrogen has 3 isotopes; H_1^1 H_1^2 H_1^3

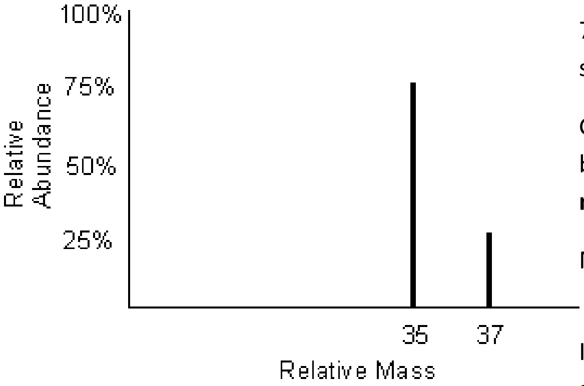
Isotopes occur naturally, so in a sample of an element you will have a mixture of these isotopes. We can accurately measure the amount of an isotope using a **mass spectrometer**. You will need to understand what a mass spectrometer is and how it works at A-level. You can read about a mass spectrometer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

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

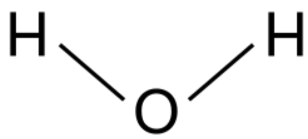
A level

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%
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 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:

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

Q5.1 Balance the following equations

a. $H_2 + O_2 \rightarrow H_20$

b. $S_8 + O_2 \rightarrow SO_3$

c. $HgO \rightarrow Hg + O_2$

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

e. $Na + H_2O \rightarrow NaOH + H_2$

f. $C_{10}H_{16} + Cl_2 \rightarrow C + HCl$

g. $Fe + O_2 \rightarrow Fe_2O_3$

h. $C_6H_{12}O_6 + 0_2 \rightarrow CO_2 + H_2O$

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 $\rightarrow$ 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.

Here is a comprehensive page on measuring moles, there are several descriptions, videos and practice problems.

You will find the first 6 tutorials of most use here, and problem sets 1 to 3.

http://www.chemteam.info/Mole/Mole.html

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.
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? $2Mg + O_2 \rightarrow MgO$

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://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?
d) What mass of silver is present in $100cm^3$ of $1moldm^{-3}$ silver nitrate ($AgNO_3$)?
e) The Dead Sea, between Jordan and Israel, contains 0.0526 $moldm^{-3}$ 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.

https://www.bbc.co.uk/bitesize/guides/zx98pbk/revision/2

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

E.g. a titration of an unknown sample of sulfuric acid with sodium hydroxide.

A $25.00cm^3$ 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 $\leftarrow$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:

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

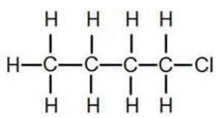
And how to name organic compounds here:

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://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://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 $moldm^{-3}$ of the strong acid, hydrochloric acid?

Pre-Knowledge Topics Answers to problems

Q1.1a) $1s^2\ 2s^2\ 2p^63s^23p^64s^2$ b) $1s^2\ 2s^2\ 2p^63s^23p^1$ c) $1s^2\ 2s^2\ 2p^63s^23p^4$ d) $1s^2\ 2s^2\ 2p^63s^23p^5$

e) $1s^2\ 2s^2\ 2p^63s^23p^6$ f) $1s^2\ 2s^2\ 2p^63s^23p^6\ 3d^64s^2$ g) $1s^2\ 2s^2\ 2p^63s^23p^6\ 3d^34s^2$

h) $1s^2\ 2s^2\ 2p^63s^23p^6\ 3d^84s^2$ i) $1s^2\ 2s^2\ 2p^63s^23p^6\ 3d^{10}\ 4s^1$ j) $1s^2\ 2s^2\ 2p^63s^23p^6\ 3d^{10}\ 4s^2$

k) $1s^2\ 2s^2\ 2p^63s^23p^6\ 4s^2\ 3d^{10}\ 4p^3$

Q1.2a) $1s^2\ 2s^2\ 2p^63s^23p^6$ b) $1s^2\ 2s^2\ 2p^6$ c) $1s^2\ 2s^2\ 2p^63s^23p^6\ 3d^{10}$

d) $1s^2\ 2s^2\ 2p^63s^23p^6$ e) $1s^2\ 2s^2\ 2p^63s^23p^6\ 3d^7$

==

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 = ½ mv^2 the lighter ions will have greater speed / heavier ions will have less speed.

Q3.3 a) 121.855 b) 69.796 c) 107.973 d) 204.41 e) 87.710 / 87.7102

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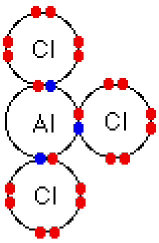
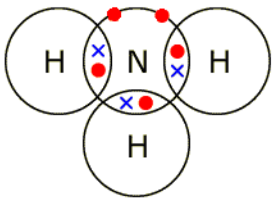
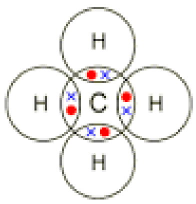
Q4.1



a) 120°



b) 107°



c) 109.5°

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Q5a. $2H_2 + 0_2 \rightarrow 2\ H_20$

b. $S_8 + 1202 \rightarrow 8S0_3$

c. $2HgO \rightarrow 2Hg + 0_2$

d. $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

e. $2Na + 2H_20 \rightarrow 2NaOH + H_2$

f. $C_{10}H_{16} + 8Cl_2 \rightarrow 10C + 16HCl$

g. $4Fe + 30_2 \rightarrow 2Fe_20_3$

h. $C_6H_{12}0_6 + 60_2 \rightarrow 6\ CO_2 + 6\ H_20$

i. $Fe_20_3 + 3H_2 \rightarrow 2Fe + 3H_20$

j. $2Al + 3\ FeO \rightarrow Al_2O_3 + 3Fe$

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 x 212.8 = 26.6g 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 x 32 = 3.2g

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 1 mol dm^{-3} = 0.1 moles added to a total volume of 2 dm^3 = 0.1moles/2dm^3 = 0.05 mol dm^{-3}

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

e) 0.0526 x 79.7 = 4.20274g

===

8.1

$Ba(NO_3)_2 : Na_2SO_4$

1 : 1 ratio

12.5cm^3 of $Ba(NO_3)_2$ = 0.0125dm^3

0.15 moldm^{-3} x 0.0125dm^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 mol dm^{-3} = 0.0075 dm^3 or 7.5cm^3

===

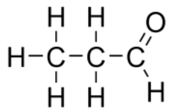
9.1 1-chlorobutane

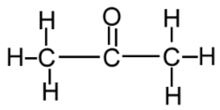
Add butan-1-ol to concentrated HCl and shake

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.

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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.

$CH_3COOH \leftrightharpoons CH_3COO^- + H^+$

Mostly this Very few of these

10.4 pH = -log [0.01] = 2 The pH = 2

3. Go outside!

You are lucky to live near Cambridge, one of the most historical and influential science centres of the world. This curated self-guided walking tour takes you through the historic centre of Cambridge. While physics and biology often steal the local spotlight, this route focuses specifically on the **chemical sciences**—tracing the evolution of the discipline from early 18th-century laboratory experiments to the molecular chemistry that unlocked the structure of life.

The Walk at a Glance

- **Start:** Trinity College Great Gate
- **Finish:** The University Department of Chemistry (Lensfield Road)
- **Total Distance:** Approx. 1.5 miles (2.4 km)
- **Walking Time:** 30–40 minutes (plus stopping time)

Stop 1: Trinity College & The Birth of the 1702 Chair

- **Location:** Trinity Street, CB2 1TQ
- **The Chemistry Connection:** Trinity College is famous for Sir Isaac Newton (who spent decades performing secretive alchemical and chemical experiments in a lab near the Great Gate). More importantly, it was the academic home of Richard Watson, an influential early Professor of Chemistry.
- **What to note:** Cambridge holds the **1702 Chair of Chemistry**, which is the oldest continuously occupied chair of chemistry in Great Britain. Early pioneers here helped transition chemistry away from the mystical "handmaiden of alchemy" into an empirical, rigorous academic discipline.

Stop 2: The Eagle Pub & The Updated DNA Blue Plaque

- **Location:** Bene't Street, CB2 3QN
- **The Chemistry Connection:** On February 28, 1953, Francis Crick and James Watson walked into this pub to announce they had discovered the "secret of life"—the double-helix structure of DNA. While often taught as biology, mapping the double helix was fundamentally a triumph of **structural biochemistry and molecular chemistry**.
- **What to look for:** Look outside the pub for the **brand-new Blue Plaque** (unveiled in August 2023). The original 2003 plaque was heavily criticized—and even famously graffitied with "+ Franklin"—because it completely left out the structural chemist whose X-ray crystallography data made the discovery possible. The updated plaque formally recognizes the crucial contributions of **Rosalind Franklin** and Maurice Wilkins alongside Watson and Crick.

Stop 3: The Old Cavendish Laboratory

- **Location:** Free School Lane, CB2 3RH (Just around the corner from The Eagle)
- **The Chemistry Connection:** Named after the eccentric, pioneering British chemist and physicist **Henry Cavendish** (the man who discovered hydrogen), this site was the epicenter of late 19th and early 20th-century physical chemistry.
- **What to note:** Walk through the large stone archway into the courtyard. This is where J.J. Thomson discovered the electron in 1897 and where Ernest Rutherford oversaw the splitting of the atom—

discoveries that redefined the periodic table and laid the groundwork for modern quantum chemistry and chemical bonding theories.

Stop 4: The New Museums Site & The Whipple Museum

- **Location:** Free School Lane, CB2 3RH
- **The Chemistry Connection:** The New Museums Site was the university's primary scientific hub before departments outgrew the city center. It houses the Whipple Museum of the History of Science.
- **What to see inside:** If the museum is open, head upstairs to see their collection of antique laboratory apparatus. Keep an eye out for historic chemical glassware, early handheld calculators, and the original, omitted DNA blue plaque that was retired from The Eagle and preserved here for its historical significance.

Stop 5: Pembroke College

- **Location:** Trumpington Street, CB2 1RF
- **The Chemistry Connection:** Cross over Trumpington Street to view Pembroke College. In 1944, a brilliant young scientist named Alexander Todd (Lord Todd) arrived in Cambridge and took up a fellowship at Pembroke.
- **What to note:** Lord Todd established a massive research group dedicated to the chemistry of nucleotides. At Pembroke and the nearby university labs, he achieved the first definitive chemical synthesis of **ATP (Adenosine triphosphate)**, the primary energy carrier in all living cells. His groundbreaking work on nucleotide co-enzymes earned him the **Nobel Prize in Chemistry in 1957**.

Stop 6: The Modern Department of Chemistry

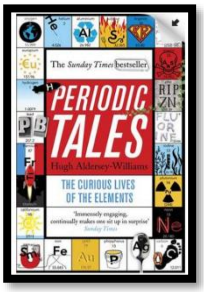
- **Location:** Lensfield Road, CB2 1EW (Head south down Trumpington Street, turn left onto Lensfield Road)
- **The Chemistry Connection:** Your walk concludes at the massive, sprawling home of modern chemistry in Cambridge. Opened in the 1950s to unify the university's scattered chemical laboratories, this building has hosted multiple Nobel Prize-winning breakthroughs.
- **What to note:** This is where **John Pople** developed the computational chemistry methodologies that allowed scientists to model chemical reactions using computers (earning the 1998 Nobel Prize). It is also where **Sir Shankar Balasubramanian and Sir David Klenerman** invented Next-Generation DNA Sequencing—a revolutionary chemical sequencing technology that fundamentally changed modern medicine and biology.

Extension Option (For the Dedicated Chemist)

If you have a bicycle or don't mind a longer journey, head 2 miles north to the **Cambridge Science Park (Milton Road)**. Outside Thomas Graham House (the publishing headquarters of the **Royal Society of Chemistry**), you can find a unique hexagonal blue plaque erected in 2011 to commemorate 170 years of world-class chemical scientific publishing.

Book Recommendations

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

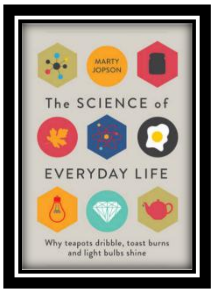


ISBN-10: 0141041455

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

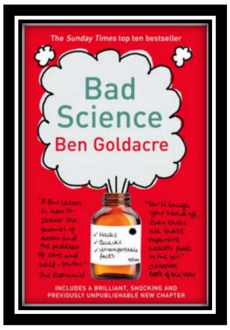


ISBN-10: 1782434186

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'.

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 Rough-Science videos - Dailymotion

NileRed

Check out some of the chemistry done by NileRed on his YouTube channel.

https://www.youtube.com/@NileRed

4. Chemistry 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]

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

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

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

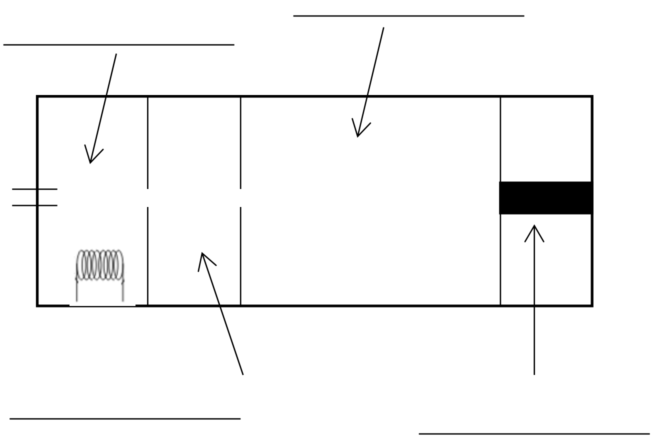
c. Which is the correct electron configuration for an aluminium **ion**, Al^{3+}? Circle the correct answer [1]

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

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]

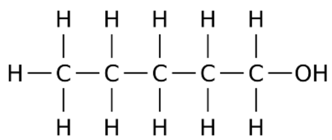
b) ___ HCl + $Mg(OH)_2$ → $MgCl_2$ + ___ H_2O [2]

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]