

GCSE to A-Level Chemistry



AS Level Chemistry

Transition Booklet

All A levels are a step up from GCSE, chemistry is typical of this. This transition pack contains:

- (i) opportunities to practice some of the harder content from GCSE to help you bridge the gap to A level, so the start of year 12 is more in your comfort zone and
- (ii) tasks to help combined students cover material triple students have covered
- (iii) things that are just enjoyable !

We do not expect you to complete everything enclosed here as the things you need to practice will depend on your strengths. I would however advise you to dip into everything. Some of the questions on the test cannot be done without you having completed certain sections. Answers are at the back. The test is the compulsory submission for the Transition Work.

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Periodic Table

1		2												3	4	5	6	7	0	
				Key																(18)
				relative atomic mass symbol name atomic (proton) number																4,0 He helium 2
				1,0 H hydrogen 1																
(1)	(2)											(13)	(14)	(15)	(16)	(17)				
6,9 Li lithium 3	9,0 Be beryllium 4											10,8 B boron 5	12,0 C carbon 6	14,0 N nitrogen 7	16,0 O oxygen 8	19,0 F fluorine 9	20,2 Ne neon 10			
23,0 Na sodium 11	24,3 Mg magnesium 12											27,0 Al aluminium 13	28,1 Si silicon 14	31,0 P phosphorus 15	32,1 S sulfur 16	35,5 Cl chlorine 17	39,9 Ar argon 18			
39,1 K potassium 19	40,1 Ca calcium 20	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	69,7 Ga gallium 31	72,6 Ge germanium 32	74,9 As arsenic 33	79,0 Se selenium 34	79,9 Br bromine 35	83,8 Kr krypton 36			
85,5 Rb rubidium 37	87,6 Sr strontium 38	88,9 Y yttrium 39	91,2 Zr zirconium 40	92,9 Nb niobium 41	96,0 Mo molybdenum 42	[97] Tc technetium 43	101,1 Ru ruthenium 44	102,9 Rh rhodium 45	106,4 Pd palladium 46	107,9 Ag silver 47	112,4 Cd cadmium 48	114,8 In indium 49	118,7 Sn tin 50	121,8 Sb antimony 51	127,6 Te tellurium 52	126,9 I iodine 53	131,3 Xe xenon 54			
132,9 Cs caesium 55	137,3 Ba barium 56	138,9 La* lanthanum 57	178,5 Hf hafnium 72	180,9 Ta tantalum 73	183,8 W tungsten 74	186,2 Re rhenium 75	190,2 Os osmium 76	192,2 Ir iridium 77	195,1 Pt platinum 78	197,0 Au gold 79	200,6 Hg mercury 80	204,4 Tl thallium 81	207,2 Pb lead 82	209,0 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86			
[223] Fr francium 87	[227] Ra radium 88	[227] Ac† actinium 89	[267] Rf rutherfordium 104	[270] Db dubnium 105	[269] Sg seaborgium 106	[270] Bh bohrium 107	[270] Hs hassium 108	[278] Mt meitnerium 109	[281] Ds darmstadtium 110	[281] Rg roentgenium 111	[285] Cn copernicium 112	[286] Nh nihonium 113	[289] Fl flerovium 114	[289] Mc moscovium 115	[293] Lv livermorium 116	[294] Ts tennessine 117	[294] Og oganesson 118			

* 58 – 71 Lanthanides

† 90 – 103 Actinides

140,1 Ce cerium 58	140,9 Pr praseodymium 59	144,2 Nd neodymium 60	[145] Pm promethium 61	150,4 Sm samarium 62	152,0 Eu europium 63	157,3 Gd gadolinium 64	158,9 Tb terbium 65	162,5 Dy dysprosium 66	164,9 Ho holmium 67	167,3 Er erbium 68	168,9 Tm thulium 69	173,0 Yb ytterbium 70	175,0 Lu lutetium 71
232,0 Th thorium 90	231,0 Pa protactinium 91	238,0 U uranium 92	[237] Np neptunium 93	[244] Pu plutonium 94	[243] Am americium 95	[247] Cm curium 96	[247] Bk berkelium 97	[251] Cf californium 98	[252] Es einsteinium 99	[257] Fm fermium 100	[258] Md mendelevium 101	[259] No nobelium 102	[262] Lr lawrencium 103

Videos

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.

[LINK](#)



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 some of the cooler properties of mercury.

[LINK](#)



The most AMAZING chemical Reactions Good demonstration of reactions [LINK](#)



NileRed/NileBlue YouTube

Lots of very interesting chemistry concepts that stretch from A Level to University-level chemistry.

Definitely a do-not-try-at-home style but very interesting!

[LINK](#)

[LINK](#)



Seneca

Join the A Level Transition class on Seneca

[LINK](#)



Assignment 1

The first assignment is a GCSE misconceptions one. During your own learning and revision for the exams, it's really common for misconceptions to creep in! This will go through most of the really common ones, and why they're not quite right!

[LINK](#)



Assignment 2

Love them or hate them, calculations form a really important part of A Level Chemistry. This assignment is a refresher on all of the different calculations that you need to be able to do for GCSE/A Level transition

[LINK](#)



Balancing Equations

Balancing chemical equations is the stepping stone to using equations to calculate masses in chemistry.

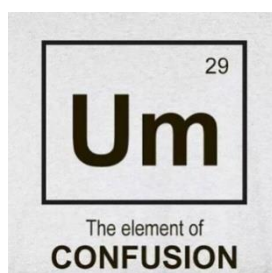
Some of the equations to balance may involve a strange chemical, don't worry about that, the key idea is to get balancing right

Here's a simulation to help with balancing if you find it hard: [LINK](#)



Balance the following equations:

-C +O₂CO →
-Ba +H₂OBa(OH)₂ +H₂ →
-C₂H₆ +O₂CO₂ +H₂O →
-HCl +Mg(OH)₂MgCl₂ + H₂O →
-N₂ +O₂NO →
-Fe₂O₃ +CFe +CO₂ →
-CH₃CH₂OH +[O]CH₃COOH +H₂O →
-HNO₃ +CuOCu(NO₃)₂ + H₂O →
-Al³⁺ +e⁻Al →
-[Fe(H₂O)₆]³⁺ +CO₃²⁻Fe(OH)₃(H₂O)₃ +CO₂ +H₂O →



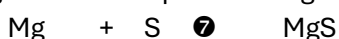
Moles

From this point on you need to be using an A level periodic table which is at the beginning of this booklet.

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 – it is just a word that represents a *number*. Atoms are so small that we cannot count them out individually, we weigh out chemicals and use moles to convert this weight to a number of particles.

For example: magnesium + sulphur \rightarrow magnesium sulphide



We can see that one atom of magnesium will react with one atom of sulphur, 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 32.1g of sulphur then I would have 1 mole of sulphur atoms.

So 24.3g of Mg will react precisely with 32.1g of sulphur, and will make 56.4g of magnesium sulphide.

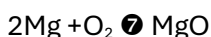
At this website you will find some videos and activities: [LINK](#)



Questions

How many moles of water are in 50g?

- How many moles of potassium are in 100g of potassium chloride?
- How many moles of water are in 300g of hydrated magnesium sulphate(VI) ($\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$)? The dot followed by $7\text{H}_2\text{O}$ means that the molecule comes with 7 water molecules so these have to be counted in as part of the molecules mass.
- What mass is 0.28 moles of ethanol ($\text{CH}_3\text{CH}_2\text{OH}$)?
- If I have 2.4g of magnesium, how many g of oxygen(O_2) will I need to react completely with the magnesium?



Solutions and Concentrations

The dm^3 is a cubic decimetre, it is actually 1 litre or 1000cm^3 but from this point on as an A level chemist you will use the dm^3 as your volume measurement

[LINK](#)



Questions

- What is the concentration (in mol dm^{-3}) of 9.53g of magnesium chloride (MgCl_2) dissolved in 100cm^3 of water?
- What is the concentration (in mol dm^{-3}) of 13.248g of lead nitrate ($\text{Pb}(\text{NO}_3)_2$) dissolved in 2dm^3 of water?
- 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?
- What mass of silver is present in 100cm^3 of 1 mol dm^{-3} silver nitrate (AgNO_3)?
- The Dead Sea, between Jordan and Israel, contains $0.0526\text{ mol dm}^{-3}$ of Bromide ions (Br^-), what mass of bromine is in 1dm^3 of Dead Sea water?

Titration

One of the early key principles you will review is the titration and the associated calculation.

[LINK](#)

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 sulphuric acid with sodium hydroxide. A 25.00cm³ sample of the unknown sulphuric acid was titrated with 0.100mol dm⁻³ sodium hydroxide and required exactly 27.40cm³ for neutralisation. What is the concentration of the sulphuric acid?

Step 1: the equation $2\text{NaOH} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$

Step 2; the ratios 2 : 1

Step 3: how many moles of sodium hydroxide 27.40cm³ = 0.0274dm³
number of moles = c x v = 0.100 x 0.0274 = 0.00274 moles

step 4: Using the ratio, how many moles of sulphuric acid for every 2 NaOH there are 1 H₂SO₄ so, we must have 0.00274/2 = 0.00137 moles of H₂SO₄

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

Here are some additional problems, which are harder. There is a link to the BBC Bitesize website to give you a refresher on the method.

[LINK](#)



Q1 A solution of sodium hydroxide contained 0.250 mol dm⁻³. Using phenolphthalein indicator, titration of 25.0 cm³ of this solution required 22.5 cm³ of a hydrochloric acid solution for complete neutralisation.

- write the equation for the titration reaction.
- what apparatus would you use to measure out (i) the sodium hydroxide solution? (ii) the hydrochloric acid solution?
- what would you rinse your apparatus out with before doing the titration ?
- what is the indicator colour change at the end-point? (e) calculate the moles of sodium hydroxide neutralised.
- calculate the moles of hydrochloric acid neutralised.
- calculate the concentration of the hydrochloric acid in mol/dm³ (molarity).

Q2 A solution made from pure barium hydroxide contained 2.74 g in exactly 100 cm³ of water. Using phenolphthalein indicator, titration of 20.0 cm³ of this solution required 18.7 cm³ of a hydrochloric acid solution for complete neutralisation. [atomic masses: Ba = 137, O = 16, H = 1] (a) write the equation for the titration reaction.

- (b) calculate the molarity of the barium hydroxide solution.
- (c) calculate the moles of barium hydroxide neutralised.
- (d) calculate the moles of hydrochloric acid neutralised. (e) calculate the molarity of the hydrochloric acid.

Q3 4.90g of pure sulphuric acid was dissolved in water, the resulting total volume was 200 cm³. 20.7 cm³ of this solution was found on titration, to completely neutralise 10.0 cm³ of a sodium hydroxide solution. [atomic masses: S = 32, O = 16, H = 1]

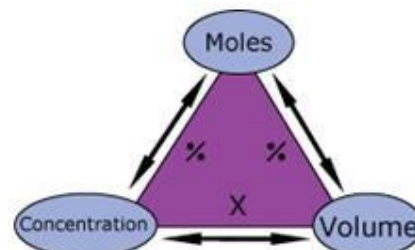
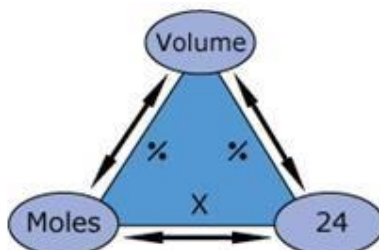
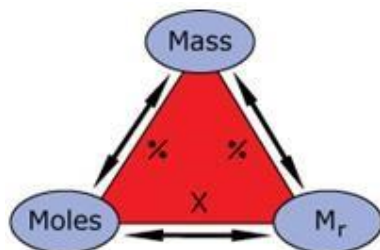
- (a) write the equation for the titration reaction.
- (b) calculate the molarity of the sulphuric acid solution.
- (c) calculate the moles of sulphuric acid neutralised.
- (d) calculate the moles of sodium hydroxide neutralised.
- (e) calculate the concentration of the sodium hydroxide in mol dm⁻³ (molarity).

Q4 100 cm³ of a magnesium hydroxide solution required 4.5 cm³ of sulphuric acid (of concentration 0.100 mol dm⁻³) for complete neutralisation. [atomic masses: Mg = 24.3, O = 16, H = 1] (a) give the equation for the neutralisation reaction.

- (b) calculate the moles of sulphuric acid neutralised.
- (c) calculate the moles of magnesium hydroxide neutralised.
- (d) calculate the concentration of the magnesium hydroxide in mol dm⁻³ (molarity). (e) calculate the concentration of the magnesium hydroxide in g cm⁻³.

Calculations

Remember these formula triangles – including the volume one in the middle 24 dm³ = 1 mole of any gas!



1. Use this formula to calculate the mass of each of the following (a) 2.50 mol of hydrogen, H₂.
(b) 0.500 mol of sodium chloride, NaCl.
2. Use this formula to calculate the amount (in mol) of each substance listed below...
 - a) 31.0 g of phosphorus molecules, P₄
 - b) 50.0 g of calcium carbonate, CaCO₃.

3. Use this formula to calculate the molar mass of an 11g gas sample of compound X, which is 0.25mol.

Molar mass: _____ gmol^{-1}

Possible identity of the gas sample X: _____

4. Use this formula to calculate the amount of gas (in mol) of....

- a) 3600 cm^3 of hydrogen gas, H_2

Amount of H_2 gas: _____ mol

- b) 4 dm^3 of hydrogen gas, CO_2 amount of CO_2 gas: _____ mol

5. Use this formula to calculate the volume of gas....

- a) 6 mol of hydrogen gas, SO_2

Volume of SO_2 gas: _____ dm^3

- b) 0.25mol of oxygen gas, O_2

Volume of CO_2 gas: _____ cm^3

6. Use this formula to calculate the volume produced in the following solutions....

- a) a solution with a concentration of 2 mol dm^{-3} that contains 2 moles of solute.

Volume of solution: _____ dm^3

- b) a solution with a concentration of 0.25 mol dm^{-3} that contains 0.005 moles of solute.

Volume of solution: _____ dm^3

7. Use this formula to calculate the concentration (in mol dm^{-3}) for the following solutions.... (a)

0.5 moles of solid dissolved in 250 cm^3 of solution

Concentration: _____ mol dm^{-3}

- (b) 0.00875 moles of solid dissolved in 25 cm^3 solution

Concentration: _____ mol dm^{-3}

8. Find the mass concentration, in gdm^{-3} , for the following solutions:

a) 0.0042 moles of HNO_3 dissolved in 250cm^3 of solution

Mass concentration: _____ gdm^{-3}

b) 0.5 moles of HCl dissolved in 4dm^3 of solution

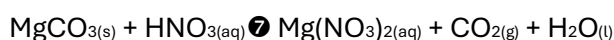
Mass concentration: _____ gdm^{-3}

9. The following reaction can take place, shown in this equation: $\text{NaHCO}_{3(s)} \rightarrow \text{Na}_2\text{CO}_{3(s)} + \text{CO}_{2(g)} + \text{H}_2\text{O}_{(l)}$

a) Balance the equation shown above

b) What volume of CO_2 is formed by the decomposition of 5.04g of NaHCO_3 ?

Volume of CO_2 : _____ dm^3 10. The following reaction can take place, shown in this equation:



(a) Balance the equation shown above

(b) 2.529g of MgCO_3 reacts with an excess of HNO_3 . What volume of CO_2 is formed?

(c) The final volume of the solution is 50.0cm^3 . What is the concentration of $\text{Mg}(\text{NO}_3)_{2(aq)}$ formed?

11. The following reaction can take place, shown in this equation:



Calculate the concentration of the potassium hydroxide in mol dm^{-3} . Use the following steps to

help: 1. Number of moles in 20cm^3 of 0.200mol dm^{-3} of hydrochloric acid

2. Number of moles of potassium hydroxide neutralISED.

3. Average titre in cm^3 using titration 2, 3 and 4

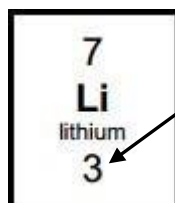
titration number	1	2	3	4
final burette reading in cm^3	26.9	27.6	27.0	28.2
initial burette reading in cm^3	0.5	2.5	2.0	3.3
titre (volume of alkali used) in cm^3	26.4	25.1	25.0	24.9

Electronic Structure

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.

An electron SHELL is really an ENERGY LEVEL rather than a position in space. Electrons do not really orbit a nucleus like planets round a solar system.

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: [LINK](#)

You will be taught this in your first topic, Elements of Life. Please move on if you don't want to practice these. THIS IS NEW.

If you want to practice then now that you know electrons are in principle energy levels (1,2,3,4,5 etc) which are divided up into sublevels called orbitals labelled as s, p and d orbitals.



Try these problems, write your answer in the format: $1s^2, 2s^2, 2p^6$ etc.

Questions

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

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+}

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 a term OXIDATION NUMBER, which helps us understand when something has been oxidised or reduced. If the number gets smaller, then it is reduced; bigger and it is oxidised.

The OXIDATION NUMBER is the charge an element has if it was an ion!

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 oxidation, 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:

[LINK](#)



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: what is the oxidation number of Nitrogen in Sodium nitrate, NaNO_3 ?

Na +1 3x O^{2-}
Total charge +1 -6 but overall NaNO_3 has no charge so $+1 -6 +(\text{N}) = 0$ so N must be +5
= +5

What is the oxidation number of sulphur in a sulphate ion, SO_4^{2-}

4x O^{2-}
-8 overall ionic charge is 2- so $-9 + (\text{S}) = -2$, so S must be +6
S = +6

Questions

–

Work out the oxidation state of the underlined atom in the following:

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

Organic Chemistry

You know what molecules look like that are called alkanes, alkenes, alcohols, carboxylic acids and esters. These different molecules behave different due to the different FUNCTIONAL GROUPS in them.

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.

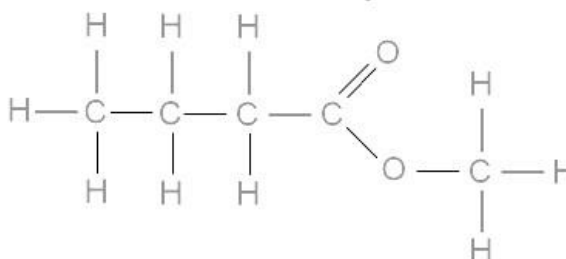
You will find a menu for organic compounds here: [LINK](#)
And how to name organic compounds here: [LINK](#)

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



Questions

- 1) Draw
a) heptane b) but-1-ene
d) propanoic acid e) propyl ethanoate c) 2methylbutane
f) ethyl propoate
- 2) What is made when propene reacts with Cl_2 ?
- 3) What two different molecules can be made when propene reacts with HCl ?
- 4) Alcohols - How could you make ethanol from ethene?
- 5) 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?
- 6) NEW MOLECULES - Aldehydes and ketones Look up and draw the structures of a) propanal b) propanone
How are these two functional groups different?
- 7) How would you go about making methyl butanoate?



Acids, Bases and 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 on Theory of acids and bases: [LINK](#)



Read the following pages on Weak acids and bases: [LINK](#)



Questions

- 1) Write your own new definition of an acid and a base.
- 2) Show how sulphuric acid acts as an acid.
- 3) Show how ammonia acts as a base.
- 4) Explain the idea of strong and weak acids and why this is different to concentrated or dilute acids.
- 5) Explain why ethanoic acid is a weaker acid than HCl.
- 6) EXTRA – why is fluoroethanoic acid a stronger acid than ethanoic acid?
- 7) If a solution of acid which has a $pH = 2$ is diluted 1cm^3 into 100cm^3 volume, what is the new pH ?
- 8) If the $pH = 2$ solution is diluted into 50cm^3 , what is the pH (trickier?)

Research

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

Remember you are a prospective A level student of chemistry so go one step beyond your understanding.

Try using [Cornell Notes](#) to make a 1-page summary for each one you research. Or a short presentation.

Task 1: The chemistry of fireworks (explosions for some reason are not in the specification!)

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 some plastic, like polyacetylene can conduct electricity

Organic materials are always insulators, aren't they? Have you thought why?

Task 3: Why is copper sulphate blue? (cover this in Developing Metals, Year 13)

Copper compounds like many of the transition metal compounds have got vivid and distinctive colours – but why?

Task 4: Aspirin (cover this in What's in a Medicine? Year 12)

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

Task 5: The hole in the ozone layer (cover this in Ozone, Year 12)

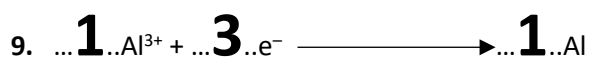
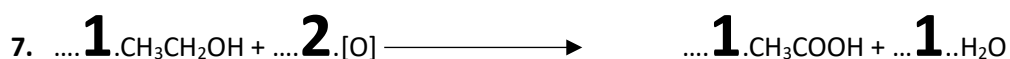
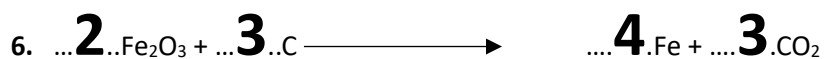
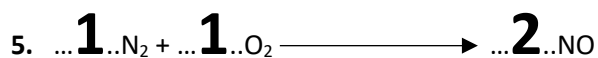
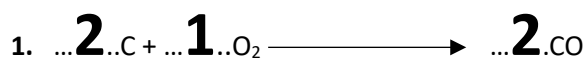
Why did we get a hole in the ozone layer? What chemicals were responsible for it? Why were we producing so many of these chemicals? What is the chemistry behind the ozone destruction?

Task 6: ITO and the future of touch screen devices (rare earth metals – we don't cover)

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?

Answers

Balance the following equations



2. The mole

Question

- a) How many moles of water are in 50g?

$$Mr(H_2O) = 18 \quad n(H_2O) = 50/18 = 2.78 \text{ moles}$$

- b) How many moles of potassium are in 100g of potassium chloride?

$$Mr(KCl) = 74.5 \quad n(KCl) = 100/74.5 = 1.34g$$

- c) How many moles of water are in 300g of hydrated magnesium sulphate(VI) ($MgSO_4 \cdot 7H_2O$)? The dot followed by $7H_2O$ means that the molecule comes with 7 water molecules so these have to be counted in as part of the molecules mass.

$$Mr(MgSO_4 \cdot 7H_2O) = 96 + 126 = 222 \quad n(MgSO_4 \cdot 7H_2O) = 300/222 = 1.351 \text{ moles}$$

$$\text{Each contains 7 moles of water so } n(H_2O) = 7 \times 1.351 = 9.46 \text{ moles}$$

- d) What mass is 0.28 moles of ethanol (CH_3CH_2OH)?

$$Mr(CH_3CH_2OH) = 46 \quad n(CH_3CH_2OH) = 0.28 \times 46 = 12.88g$$

- e) If I have 2.4g of magnesium, how many g of oxygen(O_2) will I need to react completely with the magnesium?



$$n(Mg) = 2.4/24 = 0.1 \text{ moles ratio}$$



$$2 : 1$$

$$0.1 : 0.05 \text{ moles}$$

$$m(O_2) = 0.05 \times 32 = 1.6g$$

3 Solutions and concentrations (In Y12 topic Elements of life)

Question

- a) What is the concentration (in mol dm⁻³) of 9.53g of magnesium chloride (MgCl₂) dissolved in 100cm³ of water?

$$\text{Mr}(\text{MgCl}_2) = 95 \quad n(\text{MgCl}_2) = 9.53/95 = 0.1003 \text{ moles} \quad c(\text{MgCl}_2) = 0.1003/0.1 = 1.003 \text{ mol/dm}^3$$

- b) What is the concentration (in mol dm⁻³) of 13.248g of lead nitrate (Pb(NO₃)₂) dissolved in 2dm³ of water?

$$\text{Mr}(\text{Pb}(\text{NO}_3)_2) = 331 \quad n(\text{Pb}(\text{NO}_3)_2) = 13.248/331 = 0.04002 \text{ moles} \quad c(\text{Pb}(\text{NO}_3)_2) = 0.04/2 = 0.02 \text{ mol/dm}^3$$

- c) If I add 100cm³ of 1.00 mol dm³ HCl to 1.9dm³ of water, what is the molarity of the new solution?

$$n(\text{HCl}) = c \times v = 1 \times 0.1 = 0.1 \text{ moles} \quad \text{new vol} = 2.0 \text{ dm}^3 \quad \text{so new } c(\text{HCl}) = 0.1/2 = 0.05 \text{ mol/dm}^3$$

- d) What mass of silver is present in 100cm³ of 1mol dm⁻³ silver nitrate (AgNO₃)?

$$\text{Mr}(\text{AgNO}_3) = 107.9 \quad n(\text{AgNO}_3) = 1 \times 0.1 = 0.1 \text{ moles} \quad m(\text{AgNO}_3) = 0.1 \times 107.9 = 10.79 \text{ g}$$

- e) 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?

$$\text{Mr}(\text{Br}) = 80 \quad m(\text{Br}) = 0.0526 \times 80 = 4.208 \text{ g}$$

4 Titrations

1. Use this formula to calculate the mass of each of the following

- (a) 2.50 mol of hydrogen, H₂(g)

$$m(\text{H}_2) = 2.5 \times 2 = 5.0 \text{ g}$$

- (b) 0.500 mol of sodium chloride, NaCl.

$$m(\text{NaCl}) = 0.5 \times 58.5 = 29.25 \text{ g}$$

2. Use this formula to calculate the amount (in mol) of each substance listed below....

- (a) 31.0 g of phosphorus molecules, P₄ $n(\text{P}_4) = 31/(4 \times 31) = 0.25 \text{ moles}$

(b) 50.0 g of calcium carbonate, CaCO_3 . $n(\text{CaCO}_3) = 50/100 = 0.5 \text{ moles}$

3. Use this formula to calculate the molar mass of an 11g gas sample of compound X, which is 0.25mol.

$$n = m/M_r \text{ so } M_r = m/n = 11/0.25 = 44$$

Molar mass: _____44_____ g mol^{-1}

Possible identity of the gas sample X: _____ CO_2 _____

4. Use this formula to calculate the amount of gas (in mol) of... (a) 3600 cm^3 of hydrogen gas, H_2

$$n = 3600/24000 = 0.15 \text{ moles}$$

Amount of H_2 gas: _____0.15_____ mol

(b) 4 dm^3 of hydrogen gas, CO_2

$$n = 4000/24000 = 0.167 \text{ moles}$$

Amount of CO_2 gas: _____0.167_____ mol

5. Use this formula to calculate the volume of gas....

(a) 6 mol of hydrogen gas, SO_2

$$V = n \times 24 = 6 \times 24 = 144$$

Volume of SO_2 gas: _____144_____ dm^3

(b) 0.25mol of oxygen gas, O_2

$$V = n \times 24 = 0.25 \times 24 = 6$$

Volume of CO_2 gas: _____6_____ cm^3

6. Use this formula to calculate the volume produced in the following solutions....

(a) a solution with a concentration of 2 mol dm^{-3} that contains 2 moles of solute.

$$C = n/v \text{ so } v = n/c = 2/2 = 1 \text{ dm}^3$$

Volume of solution: _____1_____ dm^3 (1 significant figures)

(b) a solution with a concentration of 0.25 mol dm^{-3} that contains 0.005 moles of solute.

$$V = n/c = 0.005/0.25 = 0.02 \text{ dm}^3$$

Volume of solution: 0.002 dm³ (1 significant figures)

7. Use this formula to calculate the concentration (in mol dm⁻³) for the following solutions....

(a) 0.5 moles of solid dissolved in 250 cm³ of solution

$$C = n/v = 0.5/0.25 = 2$$

Concentration: 2 mol dm⁻³ (1 significant figures)

(b) 0.00875 moles of solid dissolved in 25 cm³ solution

$$C = n/v = 0.00875/0.025 = 0.35$$

Concentration: 0.35 mol dm⁻³ (2 significant figures)

8. Find the mass concentration, in gdm^{-3} , for the following solutions:

(a) 0.0042 moles of HNO_3 dissolved in 250cm^{-3} of solution

$$\text{Mr}(\text{HNO}_3) = 63 \quad m = 0.0042 \times 63 = 0.2646\text{g in } 250\text{cm}^3$$

$$C = \text{mass/volume} = 0.2646/0.25 = 1.0584$$

$$\text{Mass concentration: } \underline{\quad 1.06 \quad} \text{ gdm}^{-3} \text{ (2 significant figures)}$$

(b) 0.5 moles of HCl dissolved in 4dm^3 of solution

$$\text{Mr}(\text{HCl}) = 36.5 \quad m = 0.5 \times 36.5 = 18.25\text{ g in } 4\text{ dm}^3$$

$$C = \text{mass/volume} = 18.25/4 = 4.5625$$

$$\text{Mass concentration: } \underline{\quad 5 \quad} \text{ gdm}^{-3} \text{ (1 significant figures)}$$

9. The following reaction can take place, shown in this equation: $\text{NaHCO}_3(\text{s}) \rightleftharpoons \text{Na}_2\text{CO}_3(\text{s}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$

(a) Balance the equation shown above



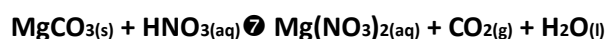
(b) What volume of CO_2 is formed by the decomposition of 5.04g of NaHCO_3 ?

$$\text{Mr}(\text{NaHCO}_3) = 84 \quad n = m/\text{Mr} = 5.04/84 = 0.06 \text{ moles}$$

$$V = n \times 24 = 0.06 \times 24 = 1.44$$

$$\text{Volume of } \text{CO}_2: \underline{\quad 1.44 \quad} \text{ dm}^3$$

10. The following reaction can take place, shown in this equation:



(a) Balance the equation shown above



(b) 2.529g of MgCO_3 reacts with an excess of HNO_3 . What volume of CO_2 is formed?

$$\text{Mr}(\text{MgCO}_3) = 84 \quad n = 2.529/84 = 0.0301 \text{ moles}$$

$$\text{Ratio } \text{MgCO}_3 : \text{CO}_2 \quad 1 : 1 \text{ so } 0.0301 \text{ moles } \text{CO}_2 \text{ made } V(\text{CO}_2) =$$

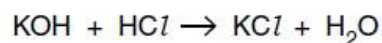
$$0.0301 \times 24 = 0.7224 \text{ dm}^3$$

(c) The final volume of the solution is 50.0cm^3 . What is the concentration of $\text{Mg}(\text{NO}_3)_2(\text{aq})$ formed?

$$n(\text{Mg}(\text{NO}_3)_2) = 0.0301 \quad c = n/v = 0.0301/0.050 = 0.602 \text{ mol/dm}^3$$

11

Look at the equation for the reaction between potassium hydroxide and hydrochloric acid.



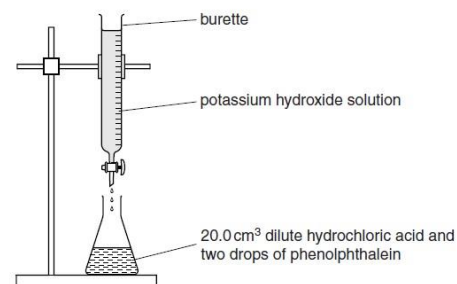
Calculate the **concentration** of potassium hydroxide in mol/dm^3 .

These steps may help.

Work out the:

- number of moles in 20.0 cm^3 of 0.200 mol/dm^3 hydrochloric acid
- number of moles of potassium hydroxide neutralised
- average titre, in cm^3 , using titration numbers 2, 3 and 4.

Look at the apparatus she uses.



titration number	1	2	3	4
final burette reading in cm^3	26.9	27.6	27.0	28.2
initial burette reading in cm^3	0.5	2.5	2.0	3.3
titre (volume of alkali used) in cm^3	26.4	25.1	25.0	24.9

$$n(\text{HCl}) = c \times v = 0.200 \times 20/1000 = 0.004 \text{ moles average titre} =$$

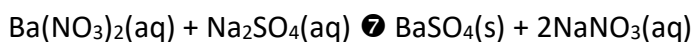
$$(25.1 + 25.0 + 24.9)/3 = 25.0 \text{ (26.4 is an anomaly)}$$

$$\text{Ratio HCl : KOH is } 1 : 1 \text{ so } 0.004 \text{ moles KOH used which was in } 25.0 \text{ cm}^3 \text{ } c =$$

$$n / v = 0.004/0.025 = 0.16 \text{ mol/dm}^3$$

12

A solution of barium nitrate will react with a solution of sodium sulphate to produce a precipitate of barium sulphate.



What volume of 0.25 mol/dm^3 sodium sulphate solution would be needed to precipitate all of the barium from 12.5 cm^3 of 0.15 mol/dm^3 barium nitrate?

$$n(\text{Ba}(\text{NO}_3)_2) = c \times v = 0.15 \times 12.5/1000 = 1.875 \times 10^{-3} \text{ (0.001875) moles Ratio}$$

$$(\text{Ba}(\text{NO}_3)_2 : \text{Na}_2\text{SO}_4 \text{ is } 1 : 1 \text{ so } 0.001875 \text{ moles } \text{Na}_2\text{SO}_4 \text{ needed}$$

$$C = n / v \text{ so } v = n / c = 0.001875 / 0.25 = 7.5 \times 10^{-3} \text{ dm}^3 = 7.5 \text{ cm}^3$$

5 – Electronic structure, how electrons are arranged around the nucleus (In Y12 Topic Elements of life)

Question

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 a) $1s^2 2s^2 2p^6 3s^2 3p^4 4s^2$
- 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) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^3$

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+}

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

6 – Oxidation and reduction (In Y12 topic Elements from the Sea)

Question

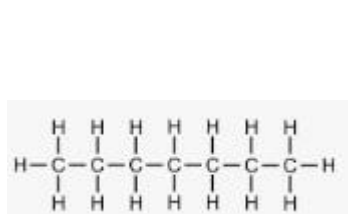
Work out the oxidation state of the underlined atom in the following:

- a) MgCO₃ b) SO₃ c) NaClO₃ d) MnO₂ e) Fe₂O₃ f) V₂O₅
- +4 +6 +5 +4 +3 +5
- g) KMnO₄ h) Cr₂O₇²⁻ i) Cl₂O₄
- +7 +6 +4

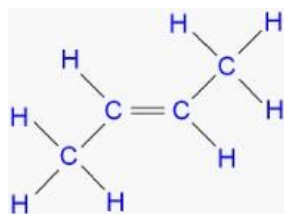
7 – Organic chemistry (in Y12 Topic Developing Fuels)

Questions

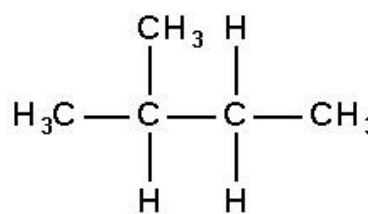
1 Draw



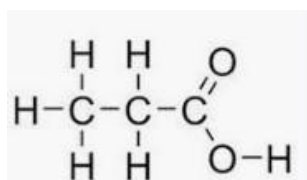
a) heptane



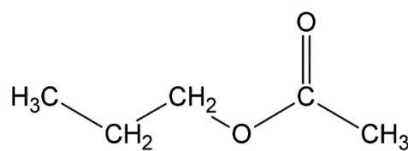
b) but-1-ene



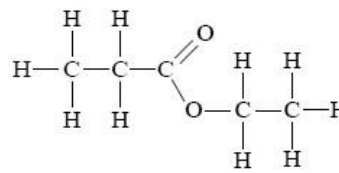
c) 2methylbutane



d) propanoic acid



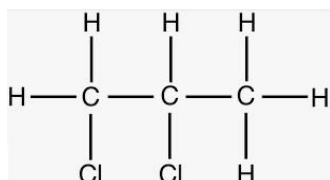
e) propyl ethanoate



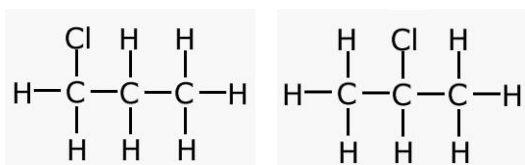
f) ethyl propoate

2 What is made when propene reacts with Cl₂?

1,2-dichloropropane



3) What two different molecules can be made when propene reacts with HCl?



1-chloropropane and 2-chloropropane

4) Alcohols - How could you make ethanol from ethene?

Add water – conc sulphuric acid and water

5) How does ethanol react with sodium, in what ways is this

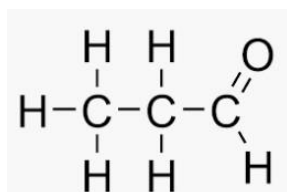
a) similar to the reaction with water, b) different to the reaction with water?

a) sodium reacts with water to make sodium HYDRoxide and Hydrogen (H lost from water leaving OH) sodium reacts with ethanol to make sodium ETHoxide and Hydrogen (H lost from ethanol leaving OCH₂CH₃)

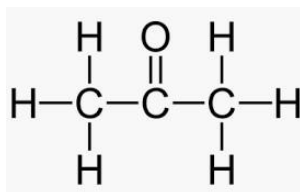
b) difference is that water reacts vigorously and with ethanol only very slowly.

6) NEW MOLECULES - Aldehydes and ketones

Look up and draw the structures of



a) propanal



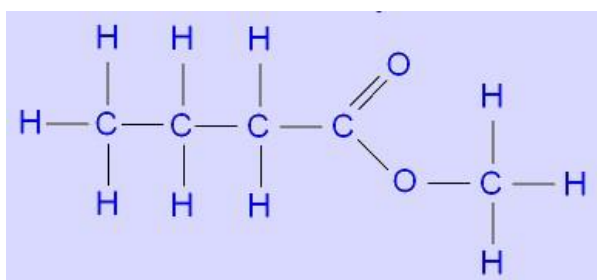
b) propanone

How are these two functional groups different?

C=O is at the end in propanal – carbon on one side and H on the other (an aldehyde)

C=O is in the middle in propanone – carbon on both sides of it.

7) How would you go about making methyl butanoate?



React butanoic acid with methanol in the presence of conc sulphuric acid and warm.

Pour into sodium carbonate, to neutralise the conc sulphuric acid.

8 Acids, bases, pH

Questions

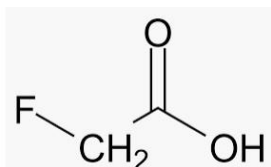
- 1) Write your own new definition of an acid and a base.
- 2) Show how sulphuric acid acts as an acid.
- 3) Show how ammonia acts as a base.
- 4) Explain the idea of strong and weak acids and why this is different to concentrated or dilute acids.
- 5) Explain why ethanoic acid is a weaker acid than HCl.
- 6) EXTRA – why is fluoroethanoic acid a stronger acid than ethanoic acid?
- 7) If a solution of acid which has a pH = 2 is diluted 1cm³ into 100cm³ volume, what is the new pH?
- 8) If the pH = 2 solution is diluted into 50cm³, what is the pH (trickier?)

- 1) An acid donates protons and a base accepts protons
- 2) $\text{H}_2\text{SO}_4 \rightleftharpoons 2\text{H}^+ + \text{SO}_4^{2-}$
- 3) $\text{NH}_3 + \text{H}^+ \rightleftharpoons \text{NH}_4^+$
- 4) A strong acid is fully dissociated e.g. $\text{HCl} \rightleftharpoons \text{H}^+ + \text{Cl}^-$ 100% is on the right hand side.

A weak acid is only partially dissociated e.g. $\text{HOOCCH}_3 \rightleftharpoons \text{H}^+ + \text{OOCCH}_3^-$ only 1% is on the right hand side
Concentration means how many particles / molecules are in a certain volume. Ethanoic acid can be concentrated (there is a lot in 100 cm³) but is still weak (110 x weaker) compared to the same HCl concentration.

- 5) $\text{HCl} \rightleftharpoons \text{H}^+ + \text{Cl}^-$ 100% is on the right hand side.

$\text{HOOCCH}_3 \rightleftharpoons \text{H}^+ + \text{OOCCH}_3^-$ only 1% is on the right hand side



- 6) fluoroethanoic acid – the fluorine pulls electrons from the acid group causing the oxygen to hydrogen bond to have a lower electron density than the corresponding bond in ethanoic acid. Fluorine does this because it is a small atom with lots of protons in the nucleus which attracts electrons strongly (compared to the hydrogen in the equivalent place on ethanoic acid).
- 7) pH is a 10^x scale, so each pH increase (i.e. 1 to 2, or 5 to 6) is a reduction x 10 in concentration of H⁺ ions. Therefore diluting 1cm³ into 10cm³ would change the pH by one (so pH2 \rightleftharpoons pH3), and diluting again 10 into 100cm³ changes it again by pH one (so pH3 \rightleftharpoons pH 4)
Another way of thinking about this is what power is 10 raised by to give 100 (which is the dilution). Answer 100 = 10² so the pH changes by a pH of 2, from 2 to 4.
- 8) pH 2 solution diluted 1 into 50, so a 50 x dilution. So what power is 10 raised by to give 50.
Or mathematically 10^x = 50, what is x? On your calculator this is the Log function. 10^{1.69897} = 50, so the pH increases by 1.7 to pH = 3.7