A Level Chemistry Transition Work

The Chemistry Department at Urmston Grammar School teach the AQA A Level course. Full details of this specification can be found here.

This transition work aims to achieve the following objectives:

1. Embed some of the essential knowledge and skills from GCSE Chemistry which will be needed in the A Level course.
2. Introduce some new concepts introduced at A level, to make the step up to A Level Chemistry as smooth as possible.

Some of this work you will find tricky. There will be many times when studying A level Chemistry that you need to persevere. At this stage we are more concerned that you work hard to attempt every part as fully as possible, rather than whether you get the answer right or not. Please try to avoid leaving any gaps.

This work is broken down into a series of tasks – and you will need to provide evidence when you join the sixth form in September that you have completed each.

Ideally this booklet should be printed off ready to hand in. If needed you can compete the tasks on lined paper.

Task 1 – Intro to Maths for Chemists

AS level chemistry relies on good mathematical skills as many of the topics use equations and problem solving. The following calculation methods are from the GCSE course (though you may not have done all of them if you did Combined Science)

Moles

The mole is most simply expressed as the relative '**formula mass in g**' or the '**molecular mass in g**' of the defined chemical '**species**', and that is how it is used in most chemical calculations.

The formula mass in grams = one mole of the defined substance.

One mole of a substance equals the molecular mass in grams.

moles of species = $\frac{Mass\ of\ a\ species\ in\ grams}{Relative\ Atomic\ Mass\ or\ Relative\ Formula\ Mass\ of\ thr\ species}$

1. What do we mean by the term "mole"?

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2. What is the molar mass (g/mol) of the following elements?

i. Calcium .....
ii. Aluminium .....

3. Calculate the number of moles in 120 grams of calcium.

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4. Calculate the number of moles in 500 grams of calcium carbonate ($CaCO_3$).
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5. Calcium carbonate and hydrochloric acid react together to produce calcium chloride, carbon dioxide and water. Below is the balanced symbol equation for this reaction.

$$\mathbf{CaCO_{3\,(s)} + 2HCl_{\,(aq)} \rightarrow CaCl_{2\,(aq)} + CO_{2(g)} + H_2O_{(l)}}$$

a) Work out the M_r for each of the reactants and products shown in the equations and write them below.

(i) $CaCO_3$ ..... (ii) HCl ..... (iii) $CaCl_2$ .....

(iv) CO_2 ..... (v) H_2O .....

b) What mass of calcium chloride can be produced from 2 grams of calcium carbonate?

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c) How much calcium carbonate is needed to produce 1kg (1000 grams) of calcium chloride?

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6. The reaction for making ammonia from hydrogen and nitrogen gas is shown by the following equation:

$3H_2 + N_2 \rightarrow 2NH_3$

The industrial process for making ammonia produces 5.1 tonnes of ammonia from 6 tonnes of hydrogen gas. Calculate the percentage yield of this process.

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7. a) What is meant by the term "atom economy?"

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b) what equation is used for calculating atom economy?

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8. Write a short definition for.....

a. The relative atomic mass (A_r) of an element?

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b. The relative formula mass (M_r) of a compound?

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Moles in solutions (This part is tricky!)

Titrations can be used to find the concentration of an acid or alkali from the relative volumes used and the concentration of one of the two reactants. **You should be able to carry out calculations involving neutralisation reactions in aqueous solution given the balanced equation or from your own practical results.**

Watch this youtube clip from the Royal Society of chemistry on carrying out a titration.

https://youtu.be/RI14t0R1wMY

Watch these youtube clips on how to perform titration calculations.

https://youtu.be/ovx-Sro4NXM

https://youtu.be/c3Ehqt-uW0U

Note again: **1dm^3 = 1 litre = 1000ml = 1000 cm^3**, so dividing **cm^3/1000 gives dm^3**. Other useful formulae or relationships are:

- **moles = concentration x volume** (concentration measured in molmd^{-3}, volume measured in dm^3)
- **concentration = mol / volume** (concentration measured in molmd^{-3}, volume measured in dm^3)
- **1 mole of a substance = formula mass of the substance measured out in grams**.

In most volumetric calculations of this type, you **first calculate the known moles of one reactant from a volume and molarity**.

Then, f**rom the equation, you relate this to the number of moles of the other reactant**, and then with the **volume of the unknown concentration**, you work out its molarity.

1) A titration is carried out and 0.05 dm^3 of hydrochloric acid neutralises 0.3 dm^3 of potassium hydroxide of concentration 0.5 mol dm^{-3} . The equation for this reaction is shown below. Calculate the concentration of this hydrochloric acid.

HCl + KOH → KCl +H$_2$O

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2. Given the equation: **$NaOH_{(aq)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$**

25.0 cm^3 of a sodium hydroxide solution was pipetted into a conical flask and titrated with a standard solution of 0.200 mol dm^{-3} (0.2M) hydrochloric acid. It was found that 15 cm^3 of hydrochloric acid was needed to neutralise the sodium hydroxide. What was the concentration of the acid?

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Task 2 – Atomic Structure

Part 1

Use the periodic table to find the following:

1. The atomic number of: osmium, sodium, lead, chlorine.

2. The relative atomic mass of: helium, barium, europium, oxygen.

3. The number of protons in: mercury, iodine, calcium.

4. The symbol for: gold, lead, copper, iron.

5. The name of: Sr, Na, Ag, Hg.

6. THInK can be written using a combination of the symbols for Thorium, Indium and Potassium (ThInK). Which combinations of element symbols could be used to make the following words?

   AMERICA, FUN, PIRATE, LIFESPAN, FRACTION, EROSION, DYNAMO

Relative atomic mass (A_r)

Isotopes are atoms of the same element, but with a different number of neutrons. They still have the same number of protons. If there are several isotopes of an element, the relative atomic mass will take into account the proportion of atoms in a sample of each isotope.

For example, chlorine gas is made up of 75% of chlorine-35 (^{35}Cl) and 25% of chlorine-37 (^{37}Cl).

The *relative atomic mass(A_r)* of chlorine is calculated by:

$A_r = \frac{(75x35)+(25x37)}{100} = 35.5$

The relative atomic mass of chlorine is therefore the mean atomic mass of all the isotopes, taking into account that there isn't an equal proportion of each isotope.

Part 2

1. What is the relative atomic mass of Bromine, if the two isotopes, ^{79}Br and ^{81}Br, exist in equal amounts?

2. Neon has three isotopes. ^{20}Ne accounts for 90.9%, ^{21}Ne accounts for 0.3% and the last 8.8% of a sample is ^{22}Ne. What is the relative atomic mass of neon?

3. Magnesium has the following isotope abundances: ^{24}Mg: 79.0%; ^{25}Mg: 10.0% and ^{26}Mg: 11.0%. What is the relative atomic mass of magnesium?

Harder:

4. Boron has two isotopes, ^{10}B and ^{11}B. The relative atomic mass of boron is 10.8. What are the percentage abundances of the two isotopes?

5. Copper's isotopes are ^{63}Cu and ^{65}Cu. If the relative atomic mass of copper is 63.5, what are the relative abundances of these isotopes?

Task 3 – Common Ions and Ionic Compounds

A level chemistry requires you to recall a range of different positive and negative ions. Research the formulae of the following ions. At this stage you are not expected to know them all already, but by the end of Year 13 these should all be familiar to you:

Positive Ions		Negative Ions	
Hydrogen		Fluoride	
Lithium		Chloride	
Sodium		Bromide	
Potassium		Iodide	
Magnesium		Oxide	
Calcium		Sulfide	
Strontium		Nitride	
Barium		Hydroxide	
Ammonium		Carbonate	
Silver		Hydrogencarbonate	
Aluminium		Nitrate	
Copper (II)		Sulfate	
Iron (II)		Phosphate	
Iron (III)		Manganate	
Nickle (II)		Chromate	
Manganese (III)		Dichromate	
Cobalt (II)		Chlorate	
Vanadium (III)		Hypochlorate	

Ionic compounds are made by combining positive and negative ions. The overall charge should be zero. In order to achieve this the positive and negative ions need to be combined in the correct ratio in order to give a zero overall charge.

e.g. Sodium Chloride
Because a Sodium ion is Na^+, and a Chloride ion in Cl^-, the two charges cancel, to give the formula NaCl

e.g. Magnesium Hydroxide
Because a Magnesium ion is Mg^{2+}, and a Hydroxide ion is ^-OH, two ^-OH ions will be needed to cancel out the 2+ charge on the Magnesium. The overall formula is $Mg(OH)_2$.

Using the formulae of the ions you've already researched, determine the overall formula of the following compounds:

Compound	Formula
Calcium Fluoride	
Aluminium Hydroxide	
Silver Nitrate	
Barium Chloride	
Potassium Dichromate	
Calcium Carbonate	
Copper Sulfate	
Iron (II) Phosphate	
Lithium Hydrogencarbonate	
Potassium Manganate	
Hydrogen Carbonate	
Ammonium Bromide	
Magnesium Hydroxide	
Strontium Oxide	
Sodium Sulfide	

Task 3 – Balancing Equations

Chemical reactions never create or destroy atoms. They are only rearranged or joined in different ways. When hydrogen and oxygen react to make water:

hydrogen + oxygen → water

$H_2 + O_2 \rightarrow H_2O$

There are two hydrogen atoms on both sides of this equation, but two oxygen atoms on the left and only one on the right. This is not balanced.

This can be balanced by writing: $2H_2 + O_2 \rightarrow 2H_2O$

The reactants and products in this reaction are known and you can't change them. The compounds can't be changed and neither can the subscripts because that would change the compounds. So, to balance the equation, a number must be added in front of the compound or element in the equation. This is a coefficient. Coefficients show how many atoms or molecules there are.

Write balanced symbol equations for the following reactions. You'll need to use the information on the previous pages to work out the formulas of the compounds. Remember some of the elements may be diatomic molecules.

1. Aluminium + oxygen → aluminium oxide

2. Methane + oxygen → carbon dioxide + water

3. Aluminium + bromine → aluminium bromide

4. Calcium carbonate + hydrochloric acid → calcium chloride + water + carbon dioxide

5. Aluminium sulfate + calcium hydroxide → aluminium hydroxide + calcium sulfate

Task 4 – Empirical Formula

This is a new type of calculation which you are unlikely to have seen at GCSE.

If you measure the mass of each reactant used in a reaction, you can work out the simplest ratio of atoms of each reactant in the product. This is known as the empirical formula. This may give you the actual chemical formula, as the actual formula may be a multiple of this. For example….

Hydrogen peroxide is H_2O_2 but would have the empirical formula HO

Ethane is C_2H_6, but would have an empirical formula of CH_3

To learn how to calculate the empirical formula, either follow the instructions below or watch this youtube clip… https://www.youtube.com/watch?v=k_GTEtK01Wg

Use the following to find an empirical formula:

1. Write down reacting masses
2. Find the amount in moles of each element 3. Find the ratio of moles of each element

Example:

A compound contains 2.232 g of ion, 1.284 g of sulfur and 1.920 g of oxygen. What is the empirical formula?

Element	Fe	S	O
Mass?	2.232g	1.284g	1.920g
Divide by atomic mass	$\frac{2.232}{55.6} =$	$\frac{1.284}{32.1} =$	$\frac{1.920}{16.0} =$
	0.04	0.04	0.12
Take that answer, and divide by the smallest of all the answers…	$\frac{0.04}{0.04} =$	$\frac{0.04}{0.04} =$	$\frac{0.12}{0.04} =$
This is your simplest whole number ratio	1	1	3

Empirical Formula = $FeSO_3$

If the question gives the percentage of each element instead of the mass, replace mass with the percentage of an element present and follow the same process.

Activity

Work out the following empirical formulas:

1. The smell of a pineapple is caused by ethyl butanoate. A sample is known to contain only 0.180g of carbon, 0.030g of hydrogen and 0.080g of oxygen. What is the empirical formula of ethyl butanoate?

2. Find the empirical formula of a compound containing 0.0578 g of titanium, 0.288 g of carbon, 0.012 g of hydrogen and 0.384 g of oxygen.

3. 300 g of a substance are analysed and found to contain only carbon, hydrogen and oxygen. The sample contains 145.9 g of carbon and 24.32 g of hydrogen. What is the empirical formula of the compound?

4. Another 300 g sample is known to contain only carbon, hydrogen and oxygen. The percentage of carbon is found to be exactly the same as the percentage of oxygen. The percentage of hydrogen is known to be 5.99%. What is the empirical formula of the compound?

Task 5 – Mass Spectrometry Research

Read the following documents on Mass Spectroscopy:
Document 1
Document 2
Watch this youtube clip on Mass Spectrometry:
Video 1

Use them to help answer the following question:

The four key stages which occur inside a mass spectrometer are….

- Ionisation
- Acceleration
- Ion Drift
- Detection

(1) Name the two methods which could be used to ionise the sample.

(2) How is the sample accelerated?

(3) Once accelerated, what do all the particles have in common?

(4) X has a mass of 54, Y has a mass of 55 and Z has a mass of 56. Out of the ions X^+, Y^+ and Z^+,

i. Which has the highest m/z ratio?

ii. Which will travel at the highest velocity?

iii. Which will have the longest time of flight?

(5) Why is it important that the flight tube is a vacuum?

(6) For each isotope, the detector records two key pieces of information. What are they?

Task 6 Enthalpy Calculations

Enthalpy changes are generally measured by carrying out a reaction under controlled conditions in a laboratory and measuring the temperature change.

The amount of heat required to change the temperature of a system by 1K is known as the heat capacity of a system (H_c). It is measured in JK^{-1}.

The heat energy change for a given reaction can therefore be calculated from the equation:

$$q = \Delta T \times H_c.$$

The **specific heat capacity (c)** is the amount of heat required to heat 1g of a substance by 1K.
So: heat capacity = specific heat capacity x mass

Mass = volume x density
So: heat capacity = specific heat capacity x volume x density

If a reaction is taking place in solution (and therefore water is the main species present) it is reasonable to assume that the solution behaves as if it were pure water.

The density of water is 1.0 gcm^{-3} and the specific heat capacity of water is 4.18 $Jg^{-1}K^{-1}$.

So the calculation is q = (volume of solution) x 4.18 x ΔT.

$$\mathbf{q = mc\Delta T}$$

The enthalpy change (ΔH) can then be calculated by dividing the energy change by the number of moles of reactants.

$$\mathbf{\Delta H = \frac{q}{moles}}$$

If the temperature goes up the enthalpy change is negative. If the temperature goes down the enthalpy change is positive.

Watch these youtube clips on the enthalpy of combustion.

https://youtu.be/DWNsZfyFLr4

https://youtu.be/GBtVuztQDMQ

Use them to help you answer the following questions.

Write an equation for the reaction that represents the enthalpy change of combustion of ethanol (C_2H_5OH).

1.24 g of ethanol was burned in a spirit burner and used to heat 50.0 g of water in a copper calorimeter. The temperature of the water rose by 38°C. Calculate the enthalpy of combustion of ethanol determined by this experiment. The specific heat capacity of the solution is 4.18 J K^{-1} g^{-1}.

Task 9 Bonding

Watch the following youtube clips on bonding and fill in the table below.

https://youtu.be/FKTsQOpLwdE

https://youtu.be/-s9AggUNmbw

Name	Formula	Structure type				
		Monatomic	Molecular	Giant covalent	Ionic	metallic
potassium oxide						
diamond						
oxygen						
sodium						
argon						
ammonia						
magnesium hydroxide						
chromium(III) nitrate						

Task 10 Chemical tests

Watch the following youtube clips on chemical tests and fill in the table below.

https://youtu.be/KY8g0mt0W0o

https://youtu.be/soOmx4lgsWE

https://youtu.be/ZXcS3oY9wQo

https://youtu.be/F-Emzzls6Io

Outline how you would use aqueous silver nitrate to distinguish between solutions of magnesium chloride and magnesium bromide.

Construct equations, including state symbols, for the reactions which occur.

Explain why aqueous ammonia is often used to help distinguish between chloride ions and bromide ions.

Describe how barium chloride can be used to test for sulfate(VI) ions in a solution potassium sulfate(VI). In your answer you should include any reagents that are needed, a positive observation for the test and any relevant equations.

Outline a chemical test you could use to distinguish between an alkane and an alkene.

Outline a chemical test you could use to distinguish an aldehyde from a ketone.

Useful Websites

Webpage	Detail
www.s-cool.co.uk	Excellent revision materials provided and a good place to recap your GSCE knowledge.
www.chemrevise.org	Excellent summary notes explaining all the topics.
www.chemguide.co.uk	Some brilliant notes provided on all of the topics at AS and A level.
www.rsc.org	The royal society of chemistry website, good for anyone keen on continuing the subject to university level. Lots of news of up to date chemistry.
www.chemistrygeek.com	An interactive website with some good resources.
www.mp-docker.demon.co.uk	Includes revision quizzes for A level students but requires Java on your computer.