St Bede's Catholic College

Year 11 into 12 Transition Work

Chemistry

At St Bede's Catholic College, you will study **OCR A Chemistry**.

What is the structure of the course?

Year 1:

Module 2: Foundations in Chemistry – atoms, moles, formula, redox, bonding

Module 3: Periodic table and energy – trends, energy changes, equilibria, rates of reaction

Module 4: Core organic chemistry – alkanes, alkenes, polymers, alcohols

Year 2:

Module 5: Physical chemistry and transition elements

Module 6: Organic chemistry and analysis

The full specification can be found on the OCR A website: https://www.ocr.org.uk/qualifications/as-and-a-level/chemistry-a-h032-h432-from-2015/specification-at-a-glance/

You will be provided with specification checklists at the beginning of every topic area so you can keep check of where you are with your learning.

What is the examination structure?

You will sit 3 exams at the end of Year 13. These are:

- **Paper 1**- Periodic table, elements and physical chemistry (37%) - modules 1, 2, 3 and 5 only
- **Paper 2**- Synthesis and analytical techniques (37%) - modules 1, 2, 4 and 6 only
- **Paper 3** - Unified chemistry (26%) – all modules

A non-assessed practical endorsement that involves attending PAG lessons (assessed practicals) and keeping a high quality lab book in order to write up these core practicals to a high standard.

A selection of past papers are found on the OCR A Chemistry website: https://www.ocr.org.uk/qualifications/as-and-a-level/chemistry-a-h032-h432-from-2015/assessment/

What support will you recieve?

Chemistry is a difficult subject and dedication to trying to fully understand ideas through grit and determination is key in order to succeed. It is a subject where you cannot just learn facts; the exams are designed to test your understanding and ability to apply this understanding to new problems and so you will face many challenges. To do well you must seek help from teachers from the beginning of the course. There will also be a 'drop-in' session for both Y12 and Y13 one lunchtime every week where students bring along questions they have been struggling with and can seek the help of teachers and peers. We also have an e-learning website with relevant videos, practical simulations, regularly updated set of resources and past paper question banks.

How can I prepare myself before starting in September?

You **MUST** complete the transition tasks

For extra practice please also complete the Seneca 'preparing for A-level Chemistry' course (details below in 'extra practice).

You are also advised to work through these books and study them so you can hit the ground running! The second book is particularly important if you are not a strong mathematician as 20% of all exam questions in A-level Chemistry are mathematical calculations.

1. Head start to A Level Chemistry by CGP books 1782942807 - currently free as an e-book https://tinyurl.com/y7jsqa33

2. Essential Maths Skills for A-Level Chemistry by CGP 978-78294-472-0

Summer Transition tasks: A bridge between GCSE Chemistry to A-Level Chemistry

These 10 tasks are to be completed to the best of your ability and **handed in on the first lesson of your Chemistry course in September**. They are designed to cover some basic chemical and mathematical skills that you will need to access A-level Chemistry and your answers will help to see if there are certain areas you need immediate help with. Please use the internet to help you solve some of the problems if you become stuck.

Writing Formulas

- In a generic ionic salt (one that is made up of a metal, M, and a non-metal, X) the overall charge is zero
- Remember the group number of an element tells you the charge on the ion; group 1 = M^+; group 2 = M^{2+} ; group 3 = M^{3+} ; group 5= X^{3-} ; group 6=X^{2-} ; group 7=X^-
- Polyatomic ions (ions where the charge is spread over more than one atom, hence ‘poly’) you should know:

- Ion name	Ion formula	Ion name	Ion formula
carbonate	CO_3^{2-}	phosphate	PO_3^{2-}
hydroxide	OH^-	sulfate	SO_4^{2-}
ammonium	NH_4^+	nitrate	NO_3^-
chlorate	ClO^-	hydrogen carbonate	HCO_3^-

- Roman numerals are used for transition metals which can have a variety of charges e.g. iron(II) means Fe^{2+} ; iron (III) means Fe^{3+} ; vanadium(V) means V^{5+}

Task 1: Writing formulas of ionic compounds

1) silver bromide ....

2) sodium carbonate ....

3) potassium oxide ....

4) iron (III) oxide ....

5) chromium (III) chloride ....

9) lead (II) oxide ....

10) sodium phosphate ....

11) zinc hydrogencarbonate..........................

12) ammonium sulphate ....

13) gallium hydroxide ....

6)	calcium hydroxide	………………………..	14)	strontium selenide	…………………………
7)	aluminium nitrate	……………………….	15)	radium sulfate	………………………….
8)	sodium sulfate	………………………..	16)	sodium nitride	…………………………

Task 2: writing formulas for ionic, metallic and covalent substances

1)	lead (IV) oxide	………………………..	11)	barium hydroxide	…………………………
2)	copper	………………………..	12)	tin (IV) chloride	…………………………
3)	sodium	………………………..	13)	silver nitrate	…………………………
4)	ammonium chloride	………………………..	14)	iodine	…………………………
5)	ammonia	………………………..	15)	nickel	…………………………
6)	sulfur	………………………..	16)	hydrogen sulfide	…………………………
7)	sulfuric acid	………………………..	17)	titanium (IV) oxide	………………………….
8)	neon	………………………..	18)	lead	…………………………
9)	silica	………………………..	19)	strontium sulfate	…………………………
10)	silicon	………………………..	20)	lithium	…………………………

Equations

At A level, you will need to:

- work out the formulas in equations yourselves
- work out what is made (so you need to know some basic general equations, see below)
- for reactions involving ions in solution, be able to write ionic equations (ignoring spectator ions) – not covered in these transition tasks

Some general reactions you should know:

General Reaction	**Examples**
substance + oxygen → oxides	$2\,Mg + O_2 \rightarrow 2\,MgO$ $2\,H_2S + 3\,O_2 \rightarrow 2\,H_2O + 2\,SO_2$ $C_3H_8 + 5\,O_2 \rightarrow 3\,CO_2 + 4\,H_2O$
metal + water → metal hydroxide + hydrogen	$2\,Na + 2\,H_2O \rightarrow 2\,NaOH + H_2$
metal + acid → salt + hydrogen	$Mg + 2\,HCl \rightarrow MgCl_2 + H_2$
oxide + acid → salt + water	$MgO + 2\,HNO_3 \rightarrow Mg(NO_3)_2 + H_2O$
hydroxide + acid → salt + water	$2\,NaOH + H_2SO_4 \rightarrow Na_2SO_4 + H_2O$
carbonate + acid → salt + water + carbon dioxide	$CuCO_3 + 2\,HCl \rightarrow CuCl_2 + H_2O + CO_2$
hydrogencarbonate + acid → salt + water + carbon dioxide	$KHCO_3 + HCl \rightarrow KCl + H_2O + CO_2$
ammonia + acid → ammonium salt	$NH_3 + HCl \rightarrow NH_4Cl$
metal carbonate → metal oxide + carbon dioxide (on heating)	$CaCO_3 \rightarrow CaO + CO_2$

Task 3: writing balanced equations

1) Balance the following equations.

a) $Mg + HNO_3 \rightarrow Mg(NO_3)_2 + H_2$

b) $CuCl_2 + NaOH \rightarrow Cu(OH)_2 + NaCl$

c) $SO_2 + O_2 \rightarrow SO_3$

d) $C_4H_{10} + O_2 \rightarrow CO_2 + H_2O$

2) Give balanced equations for the following reactions.

a) sodium + oxygen → sodium oxide

b) aluminium + chlorine → aluminium chloride

c) calcium + hydrochloric acid → calcium chloride + hydrogen

d) ammonia + sulphuric acid → ammonium sulphate

Moles

- One mole of anything contains 6.02×10^{23} of those things. One mole of bananas is 6.02×10^{23} bananas. One mole of water molecules is 6.02×10^{23} water molecules
- This number is known as the Avogadro constant (= 6.02×10^{23} mol^{-1}).
- The Avogadro number was chosen so that the mass of one mole of particles of a substance equals the Mr in grams. For example, the Mr of water is 18.0, and the mass of one mole of water molecules in 18.0 grams
- The equation for moles is: Moles = Mass (in grams) / Mr (molecular mass, $gmol^{-1}$)
- Some useful conversion with mass

1 ton = 1,000,000 g

1 kg = 1,000 g

1 mg = 0.001 g

Task 4: using moles in calculations

You will need access to a periodic table for this

1) How many moles are there in each of the following?

a) 72.0 g of Mg   b) 4.00 kg of CuO

d) 1.00 tonne of NaCl   e) 20.0 mg of $Cu(NO_3)_2$

2) What is the mass of each of the following?

a) 5.00 moles of Cl_2 b) 0.200 moles of Al_2O_3

d) 0.00200 moles of $(NH_4)_2SO_4$ e) 0.300 moles of $Na_2CO_3.10H_2O$

3) a) Calculate the number of moles of CO2 molecules in 11.0 g of carbon dioxide.

b) Calculate the number of moles of C atoms in 11.0 g of carbon dioxide.

a) Calculate the number of moles of O atoms in 11.0 g of carbon dioxide.

4) a) Calculate the number of moles of Al2O3 in 5.10 g of Al_2O_3.

b) Calculate the number of moles of Al^{3+} ions in 5.10 g of Al_2O_3.

a) Calculate the number of moles of O^{2-} ions in 5.10 g of Al_2O_3.

5) An experiment was carried out to find the Mr of vitamin C (ascorbic acid). It was found that 1.00 g contains 0.00568 moles of Vitamin C molecules. Calculate the M_r of vitamin C.

6) Use the following data to calculate the mass of the particles shown.

Mass of proton = 1.6726×10^{-24} g

Mass of electron = 9.1094×10^{-28} g

Mass of neutron = 1.6749×10^{-24} g

Avogadro constant = 6.022×10^{23} mol^{-1}

a) Calculate the mass of a ^{1}H atom.

b) Calculate the mass of an $^{1}H^{+}$ ion.

c) Calculate the mass of one mole of ^{3}H atoms.

Maths skills

The maths skills you need for the entire course can be found in the OCR Maths handbook (http://www.ocr.org.uk/Images/295468-mathematical-skills-handbook.pdf). Remember 20% of all questions will involves maths/ calculations and the following are a range of maths skills you will be expected to know before starting the course (as mentioned before, the Essential Maths Skills for A-Level Chemistry by CGP (ISBN 978-78294-472-0) can be useful if Maths is not your strong point!)

Standard Form

- Standard form is very useful for writing very large or small numbers.
- They are written in the form A x 10^n where A is **a number between 1 and 10**.
- n represents the number of places the decimal point is moved (for +n values the decimal point has been moved to the left, for -n values the decimal point has been moved to the right).

Number	3435	1029000	0.025	23.2	0.0000278
Standard form	3.435 x 10^3	1.029 x 10^6	2.5 x 10^{-2}	2.32 x 10^1	2.78 x 10^{-5}

- To find the value of n:
  - for numbers greater than 1, n = number of places between first number and decimal place
  - for numbers less than 1, n = number of places from the decimal place to the first number (including that number)

Significant figures

Full number	1 sig fig	2 sig fig	3 sig fig	4 sig fig	5 sig fig
9.378652	9	9.4	9.38	9.379	9.3787
4204274	4000000	4200000	4200000	4204000	4204300
0.903521	0.9	0.90	0.904	0.9035	0.90352
0.00239482	0.002	0.0024	0.00239	0.00239	0.002395

Significant figures for calculations involving multiplication / division

- Your final answer should be given to the **same number of significant figures as the least number of significant figures in the data used** ("often termed appropriate number of significant figures in the exam question")

  e.g. Calculate the average speed of a car that travels 1557 m in 95 seconds.

average speed = $\frac{1557}{95}$ = 16 m/s (answer given to 2 sig fig as lowest sig figs in data is 2 sig fig for time)

e.g. Calculate the average speed of a car that travels 1557 m in 95.0 seconds.

average speed = $\frac{1557}{95}$ = 16.4 m/s (answer given to 3 sig fig as lowest sig figs in data is 3 sig fig for time)

Significant figures for calculations involving addition/subtraction ONLY

- Here the number of significant figures is irrelevant – it is about the place value of the data. For example

e.g. Calculate the total energy released when 263 kJ and 1282 kJ of energy are released.

Energy released = 263 + 1282 = 1545 kJ (answer is to nearest unit as both values are to nearest unit)

e.g. Calculate the total mass of calcium carbonate when 0.154 g and 0.01234 g are mixed.

Mass = 0.154 + 0.01234 = 0.166 g (answer is to nearest 0.001 g as least precise number is to nearest 0.001 g)

Task 5: significant figures & standard form

1) Write the following numbers to the quoted number of significant figures.

a) 345789	4 sig figs	…………………	d) 6.0961	3 sig figs	………………
b) 297300	3 sig figs	…………………	e) 0.001563	3 sig figs	………………
c) 0.07896	3 sig figs	…………………	f) 0.010398	4 sig figs	………………

2) Complete the following sums and give the answers to the appropriate number of significant figures.

a) 6125 x 384	…………………	d) 7550 ÷ 25	………………
b) 25.00 x 0.01 0	…………………	e) 0.000152 x 13.00	………………
c) 13.5 + 0.18	…………………	f) 0.0125 x 0.025	………………

3) Write the following numbers in non-standard form.

a) 1.5×10^{-3}	…………………….	d) 5.34×10^{2}	……………………
b) 4.6×10^{-4}	……………………...	e) 1.03×10^{6}	……………………
c) 3.575×10^{5}	……………………...	f) 8.35×10^{-3}	……………………

4) Write the following numbers in standard form.

a) 0.000167	…………………….	d) 34500	……………………
b) 0.0524	……………………...	e) 0.62	……………………
c) 0.000000015	……………………...	f) 87000000	……………………

5) Complete the following calculations and give the answers to the appropriate number of significant figures.

a) $6.125 \times 10^{-3} \times 3.5$ ……………………………………………………………..

b) $4.3 \times 10^{-4} \div 7.00$ ……………………………………………………………..

c) $4.0 \times 10^{8} + 35000$ ……………………………………………………………..

d) $0.00156 + 2.4 \times 10^{3}$ ……………………………………………………………

e) $6.10 \times 10^{-2} - 3.4 \times 10^{-5}$ ……………………………………………………………

f) $8.00 \times 10^{-3} \times 0.100 \times 10^{-3}$ ……………………………………………………………

Converting between units

Different unit prefixes are used in chemistry . Unit prefixes indicate particular multiples and fractions of units. A full list of unit prefixes is given in Table 1, with the prefixes that are most likely to be used within the A Level Chemistry course highlighted. You will need to remember these highlighted ones as they will not be given.

Factor	Name	Symbol	Factor	Name	Symbol
10^{24}	yotta	Y	10^{-1}	deci	d
10^{21}	zeta	Z	10^{-2}	centi	c
10^{18}	exa	E	10^{-3}	milli	m
10^{15}	peta	P	10^{-6}	micro	μ
10^{12}	tera	T	10^{-9}	nano	n
10^{9}	giga	G	10^{-12}	pico	p
10^{6}	mega	M	10^{-15}	femto	f
10^{3}	kilo	k	10^{-18}	atto	a
10^{2}	hecto	h	10^{-21}	zepto	z
10^{1}	deca	Da	10^{-24}	yocto	y

*e.g 1 **n**m is 1 **nano**meter, so 1 x 10^{-9} m; 10 **μ**m is 1 **micro**meter, so 10 x 10^{-6} m but in standard format = 1 x 10^{-5} m*

You would be expected to be able to convert between commonly encountered multiples without conversion 'facts' being given (e.g. 1 kg = 10^3 g). Converting between different multiples is a matter of multiply-ing by the appropriate factor.

When converting a length quantity from a factor, 10^a, to another factor, 10^b, the quantity needs to be multiplied by a factor 10^{a-b} .

- For example, converting 7 mg (milligram, 10^{-3} g) to kg (kilogram, 10^3 g) requires a multiplication by $10^{(-3) - (3)} = 10^{-6}$. So, 7 mg = 7 × 10^{-6} kg.

Volumes and unit prefixes

Volumes are the cube of the length eg. m^3. This means the factor listed above needs to be cubed.

When converting a volume quantity from a factor, $(10^a)^3$, to another factor, $(10^b)^3$, the quantity needs to be multiplied by a factor $10^{(a\times3)-(b\times3)}$ *(this is due to the power rule means that $(10^x)^y = 10^{xy}$)*

- For example, converting 9 nm^3 (nano, 10^{-9}) to dm^3 (deci, 10^{-1}) requires a multiplication by $10^{(-9\times3) - (-1\times3)} = 10^{-24}$. So, 9 nm^3 = 9 × 10^{-24} dm^3.

For more help see https://www.youtube.com/watch?v=5EcNAxweb44 (title: Metric Prefix Conversions Tutorial: How to Convert Metric System Prefixes | Crash Chemistry Academy)

Task 6: converting units

Convert the following (remember 1 tonne = 1 x 10^6 g). Show your answer in **standard form and non-standard form**:

e.g. 0.3 kg = 3 x 10^2 g (standard form) OR 300 g (non-standard form)

0.25 kg = ………………………..… g

15 kg = ………………………...….. g

0.05 mg = ………………………..…. g

100 tonnes = ………………..…. Kg

0.25 g = ………………………..…. mg

2 tonnes = ……………………..…. g

5 mg = …………………………..…….. Kg

0.25 dm^3 = …………………..…. cm^3

15 m^3 = ……………………….. dm^3

0.05 cm^3 = …………………….. dm^3

100 m^3 = ……………………… dm^3

0.25 dm^3 = ……….………... cm^3

2 m^3 = ………………………… cm^3

5 cm^3 = ………………….…. dm^3

7 nm = ……………………………... cm

10 µm = …………………………….. m

Task 7: Titration Calculations

Worked example:

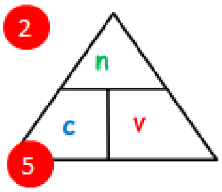
1. Work out the information for the known reactant (i.e. you have/ can calculate two pieces of information [volume and concentration] for it). To work out volume you work out the mean average of the concordant titres (those within 0.1cm³ of one another)
2. Work out moles of known using n=v x c
3. Use molar ratio to work out the number of moles of unknown (?)
4. Use volume from question information
5. Use numbers from steps 3 and 4 to work out concentration of unknown

(3) $HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$

In a titration experiment 25cm³ of an unknown concentration of sodium hydroxide was placed into a conical flask. It was titrated with 0.15 mol/dm³ of hydrochloric acid. The titre results are shown to the right. Calculate the concentration of the sodium hydroxide in the flask

Run	Start (cm³)	End (cm³)	Difference (cm³)
1	29.30	2.40	26.90
2	31.00	4.20	26.80
3	28.20	1.50	26.70

(1) *Mean is (26.90+26.80+26.70)/3 = 26.80cm³.*
26.80 cm³ / 1,000 = 0.0268 dm³



	✓	?
	HCl	NaOH
n	(2) 0.00402	0.00402 (3)
V (dm³)	(1) 0.0268 dm³	0.025 (4)
c	(1) 0.15	0.16 (5)
Molar ratio	1	1

1:1 ratio (3)

1. Calculate the concentration of the following solutions in mol/dm³.

   a. 0.20 moles of NaCl in 150 cm³

   b. 0.50 moles of HNO_3 in 200 cm³

   c. 0.040 moles of NaOH in 50 cm³

2. Calculate the number of moles in the following solutions.

   a. 200 cm³ of 0.50 mol/dm³ HNO_3

   b. 75 cm³ of 3.00 mol/dm³ KOH

   c. 25 cm³ of 0.40 mol/dm³ H_2SO_4

3. Calculate the concentration of the following solutions in g/dm^3.

    a. 0.200 mol/dm^3 NaOH

    b. 0.300 mol/dm^3 CH_3COOH

    c. 2.00 mol/dm^3 HNO_3

4. 0.40 moles of NaOH is dissolved in 500 cm^3 of water.

    a. Calculate the concentration in mol/dm^3

    b. Calculate the concentration in g/dm^3

5. 5.5 g of KNO_3 is dissolved in 125 cm^3 of water.

    a. Calculate the concentration in g/dm^3

    b. Calculate the concentration in mol/dm^3

6. 22.5 cm^3 of sodium hydroxide solution reacted with 25.0 cm^3 of 0.100 mol/dm^3 hydrochloric acid.

    $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$

    a. Calculate the concentration of the sodium hydroxide solution in mol/dm^3.
    b. Calculate the concentration of the sodium hydroxide solution in g/dm^3.

7. 24.5 cm^3 of sodium hydroxide solution reacted with 25.0 cm^3 of 0.150 mol/dm^3 hydrochloric acid.

    $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$

    Calculate the concentration of the sodium hydroxide solution in mol/dm^3.
    Calculate the concentration of the sodium hydroxide solution in g/dm^3.

8. What volume of 0.100 mol/dm^3 rubidium hydroxide reacts with 25.0 cm^3 of 0.220 mol/dm^3 nitric acid?

    $RbOH(aq) + HNO_3(aq) \rightarrow RbNO_3(aq) + H_2O(l)$

9. 25.0 cm^3 of 0.250 mol/dm^3 sodium hydroxide solution reacted with 26.9 cm^3 sulfuric acid.

    $2\ NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2\ H_2O(l)$

    Calculate the concentration of the sulfuric acid in mol/dm^3.

10. 25.0 cm^3 of 0.300 mol/dm^3 barium hydroxide solution reacted with 24.9 cm^3 of hydrochloric acid.

    $Ba(OH)_2(aq) + 2HCl(aq) \rightarrow BaCl_2(aq) + 2H_2O(l)$

    Calculate the concentration of the hydrochloric acid in mol/dm^3.

Task 8 = Volume of Gases

Example: What volume of helium gas balloons can be filled from a 8kg bottle?

Part 1 – convert units:

Convert Kg to g 8kg x 1000 = 8000g

Part 2 – find out how many moles of the gas you have:

$$\text{Number of moles} = \frac{\text{Mass}}{\text{Relative formula mass}} = \frac{8000g}{4} = 2000 \text{ moles}$$

Part 3 – Work out the volume the gas occupies:

$$\text{Number of moles of a gas} = \frac{\text{Volume of gas } (dm^3)}{24dm^3} \quad 2000 = \frac{V}{24} = 2000 \times 24 = 48000 \text{ dm}^3$$

Tasks – show ALL your working

1. What volume of Oxygen, O_2, would be obtained from a 5Kg dive tank?
2. What volume of methane, CH_4, would be obtained from a 30000g tank?
3. How many moles of Helium in a 4dm^3 birthday balloon? What mass of helium would this be?
4. How many moles of nitrogen in a 34dm^3 air bag? What mass of nitrogen would this be?

Super-extension:
What is the mass of nitrogen in this room? (assume 78% of the room volume is N_2)

More Gas Questions….

5. How much gas is produced when 19.5g of potassium is reacted with excess water at RTP?

6. How much sodium chloride is produced from 600cm3 of chlorine and an excess of sodium at RTP?

7. The equation for the reaction of the Haber Process is:

$$N_2 (g) + 3H_2 (g) \rightleftharpoons 2NH_3(g)$$

Calculate the volume of ammonia produced from the reaction of 795dm^3 of hydrogen (4 marks)

Task 9 = Atom Economy and percentage yield questions

Percentage yield is the amount (in moles or mass) of product actually obtained divided by the amount (in moles or mass - needs to match previous) multiplied by 100:

$$\textbf{percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$$

Here is a walkthrough of a typical question, the step order is shown in red:

Barium sulfate is formed from barium chloride and sulfuric acid.

(1) (4) $BaCl_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2HCl(aq)$

2.08g of barium chloride is used to give 1.96 g of barium sulfate. What is the percentage yield?

1 Work out theoretical mass of product that should be formed if it was 100% completion by using the mass of reactant used

	✔	?
	$BaCl_2$	$BaSO_4$
m	(1) 2.08g	mass = $mols \times M_r$ mass = 0.01×233 = 2.33g (7)
Mr	(2) 137 + (2 × 35.5) = 208	M_r of $BaSO_4$ = 137 + 32 + (4 × 16) = 233 (6)
n	(3) No of moles = 2.08g / 208 = 0.01 moles	*0.01 moles* (5)
Molar ratio	(4) 1	1

2 Use this in the % yield equation

$$\textbf{percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$$

$$\textbf{percentage yield} = \frac{1.96\text{g}}{2.33\text{g}} \times 100\% = 84\%$$ (7)

Questions to try:

1) Sulfur dioxide reacts with oxygen to make sulfur trioxide. $2\ SO_2 + O2 \rightarrow 2\ SO_3$

a) Calculate the maximum theoretical mass of sulfur trioxide that can be made by reacting 96.0 g of sulfur dioxide with an excess of oxygen.

b) In the reaction, only 90.0 g of sulfur trioxide was made. Calculate the percentage yield.

c) Give three reasons why the amount of sulfur trioxide made is less than the maximum theoretical maximum.

2) Iron is extracted from iron oxide in the Blast Furnace as shown. $Fe_2O_3 + 3\ CO \rightarrow 2\ Fe + 3\ CO_2$

a) Calculate the maximum theoretical mass of iron that can be made from 1.00 tonne of iron oxide.

b) In the reaction, only 650000 g of iron (to 3 significant figures) was made. Calculate the percentage yield.

3) Nitrogen reacts with hydrogen to make ammonia. $N_2 + 3\ H_2 \rightarrow 2\ NH_3$

a) Calculate the maximum theoretical mass of ammonia that can be made by reacting 90.0 g of hydrogen with an excess of nitrogen.

b) In the reaction, only 153 g of ammonia was produced. Calculate the percentage yield.

4) Titanium can be extracted from titanium chloride by the following reaction. $TiCl_4 + 2\ Mg \rightarrow Ti + 2\ MgCl_2$

a) Calculate the maximum theoretical mass of titanium that can be extracted from 100 g of titanium chloride .

b) In the reaction, only 20.0 g of titanium was made. Calculate the percentage yield.

c) Give three reasons why the amount of titanium made is less than the maximum theoretical maximum.

5) Aluminium is extracted from aluminium oxide in the following reaction. $2\ Al_2O_3 \rightarrow 4\ Al + 3\ O_2$

a) Calculate the maximum theoretical mass of aluminium that can be made from 1.00 kg of aluminium oxide.

b) In the reaction, only 500 g of aluminium was made. Calculate the percentage yield.

Task 10 Atom economy

Atom economy is a measure of what proportion of the products of a reaction are the desired product and how much is waste. The higher the atom economy, the less waste that is produced.

$$\text{Percentage atom economy, \%} = \frac{\text{sum of molar masses of all desired products}}{\text{sum of molar masses of all products}} \times 100\%$$

Worked example:

Iron is extracted from iron oxide by reduction with carbon. The equation for the reaction is:
$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$
Carbon monoxide is created as an unwanted by-product of this reaction.
Calculate the percentage atom economy for this process.

Step 1
Calculate the sum of the molar masses of the desired products. **M_r(desired) x molar ratios**

$= 2 \times$ Fe atoms $= 2 \times 55.8\ g\ mol^{-1}$
$= 111.6\ g\ mol^{-1}$

Step 2
Calculate the sum of the molar masses of *all* the products **M_r(all products) – again taking into account their molar ratios**

$= 2Fe + 3CO$
$= (2 \times 55.8\ g\ mol^{-1}) + (3 \times 28.0\ g\ mol^{-1})$
$= 195.6\ g\ mol^{-1}$

Step 3
Substitute the values into the equation for percentage atom economy.

$$\text{Percentage atom economy, \%} = \frac{\text{sum of molar masses of all desired products}}{\text{sum of molar masses of all products}} \times 100\%$$

57.1%

1) Calculate the atom economy to make sodium from sodium chloride.

$2\ NaCl \rightarrow 2\ Na + Cl_2$

2) Calculate the atom economy to make hydrogen from the reaction of zinc with hydrochloric acid.

$Zn + 2 HCl \rightarrow ZnCl_2 + H_2$

3) Calculate the atom economy to make iron from iron oxide in the Blast Furnace.

$Fe_2O_3 + 3 CO \rightarrow 2 Fe + 3 CO_2$

4) Calculate the atom economy to make calcium oxide from calcium carbonate.

$CaCO_3 \rightarrow CaO + CO_2$

5) Calculate the atom economy to make sulfur trioxide from sulfur

dioxide.

$2 SO_2 + O_2 \rightarrow 2 SO_3$

6) Calculate the atom economy to make oxygen from hydrogen

peroxide.

$2 H_2O_2 \rightarrow 2 H_2O + O_2$

7) Hydrazine (N_2H_4) was used as the rocket fuel for the Apollo missions to the moon. It is by reaction of ammonia (NH_3) with sodium chlorate (NaOCl).

ammonia + sodium chlorate → hydrazine + sodium chloride + water

$2 NH_3 + NaOCl \rightarrow N_2H_4 + NaCl + H_2O$

a) Calculate the maximum theoretical mass of hydrazine that can be made by reacting 340g of ammonia with an excess of sodium chlorate.

b) In the reaction, only 280 g of hydrazine was produced. Calculate the percentage yield.

c) Calculate the atom economy for this way of making hydrazine.

d) Explain clearly the difference between atom economy and percentage yield.

Extra practice

Seneca: OCR A Level Chemistry Preparation
https://app.senecalearning.com/classroom/course/9127b1a4-7e1e-4394-a184-ef26ed6d64c3

Resources to support your learning & extra information

Useful Websites

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

Physics & Maths Tutor - https://www.physicsandmathstutor.com/chemistry-revision/a-level-ocr-a/

Youtube channels

Dr Beattie's A-Level Chemistry Essentials -
https://www.youtube.com/channel/UCVuUJOkVPoNiWXfpHarV2iQ/

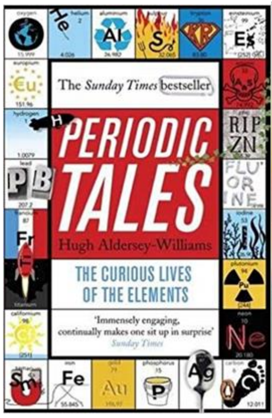
Allery Tutors - https://www.youtube.com/channel/UCPtWS4fCi25YHw5SP

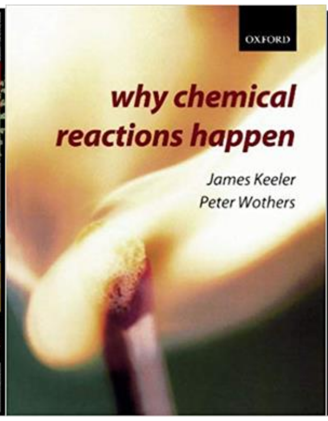
Careers information

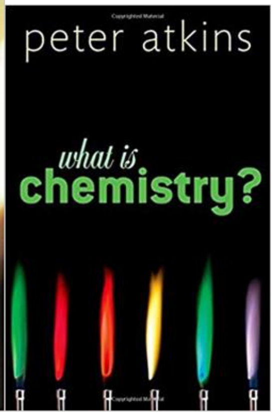
Royal Society of Chemistry's 'A future in Chemistry' - contains videos and information about careers in Chemistry and related disciplines - https://edu.rsc.org/future-in-chemistry

Wider reading books

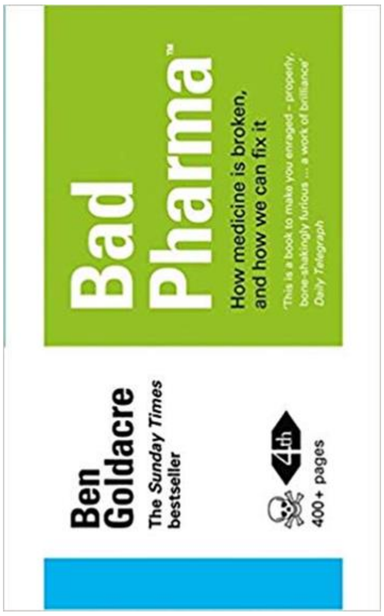
Chemistry







Medicine



Mrs Pascoe is Head of Chemistry. Please email her on j.pascoe@stbcc.org with any queries.