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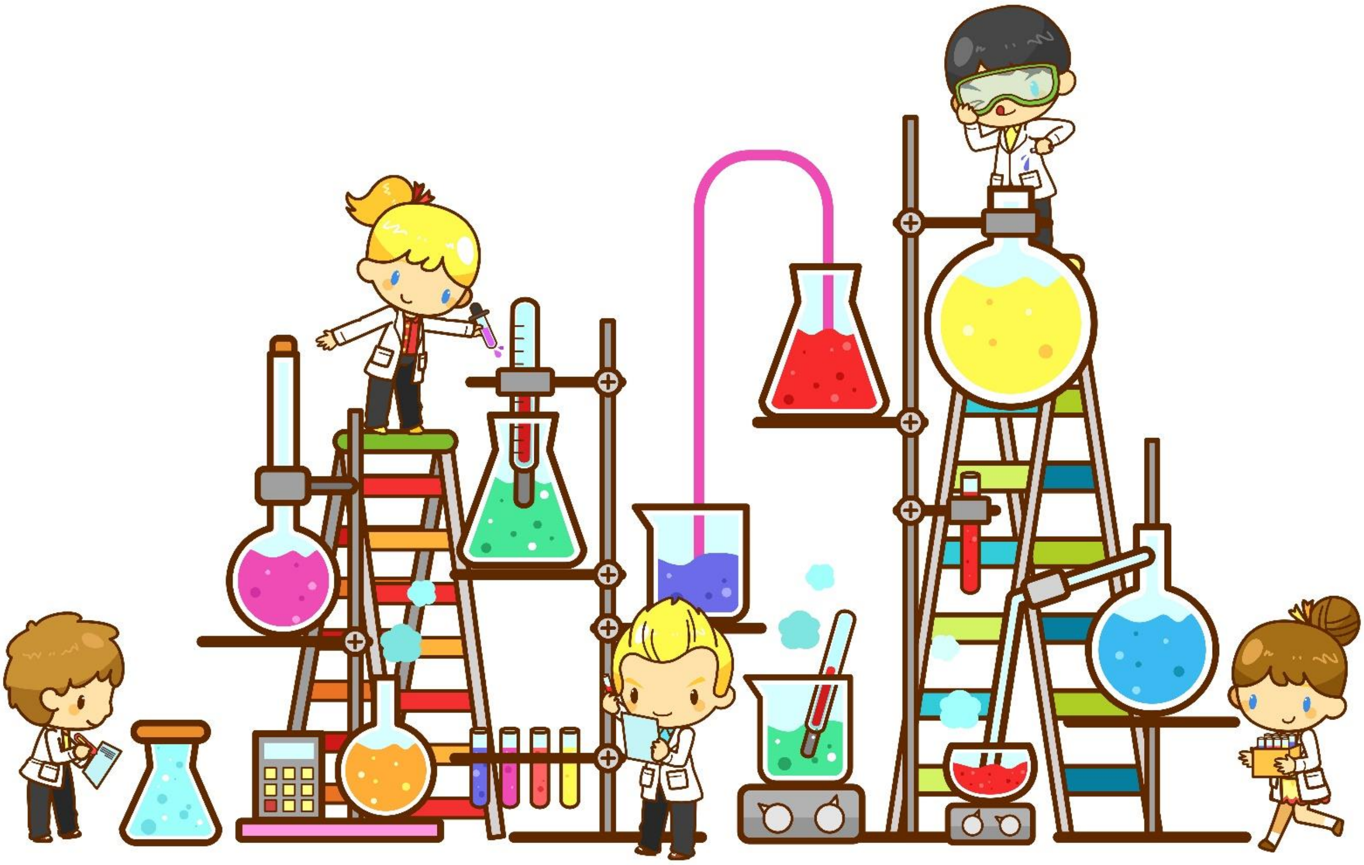

Maths (The Chemistry Bits)
AQA, Higher Chemistry
Separate Science GCSE

Other books in this series

Previously published...

- Maths as Calculator skills for Science Students — March 2016
- Maths (The Physics bits) for GCSE Core Science — April 2016
- Maths (The Chemistry bits) for GCSE Core and Additional Science — May 2016
- Maths (The Chemistry bits) for GCSE Triple Science — May 2016
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- Maths for A-Level Chemistry Year 12
- Maths for A-Level Chemistry Year 13
- Maths for A-Level Chemistry Year 12 and year 13

WOW – that is a long list! Chances are if you want a maths/science book I've written it or I am writing it.

For full book listings visit www.PrimroseKitten.com

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Acknowledgements

Thank you to my husband for putting up with my spending every night writing this and for correcting all of my SPG mistakes. To my son for being the inspiration behind this project.

Contents

Introduction

Welcome to this workbook and thank you for supporting me to make more videos by buying this.

This book is not designed as a text book or revision guide, but as a work book. There are lots of good (and not so good) expensive and free revision guides out there, some are listed on my YouTube channel and on other great websites. So there is no point in me adding to the pile. I'm constantly telling you the best way to revise is by practising, so I've made you a book of practice questions.

All the teaching, all the new content is available for free on my YouTube channel, this book is for you to practice and learn. The best way to approach this is to watch the teaching video, or after class try a section, check the answers and then watch the video to clarify any confusion.

Periodic Table

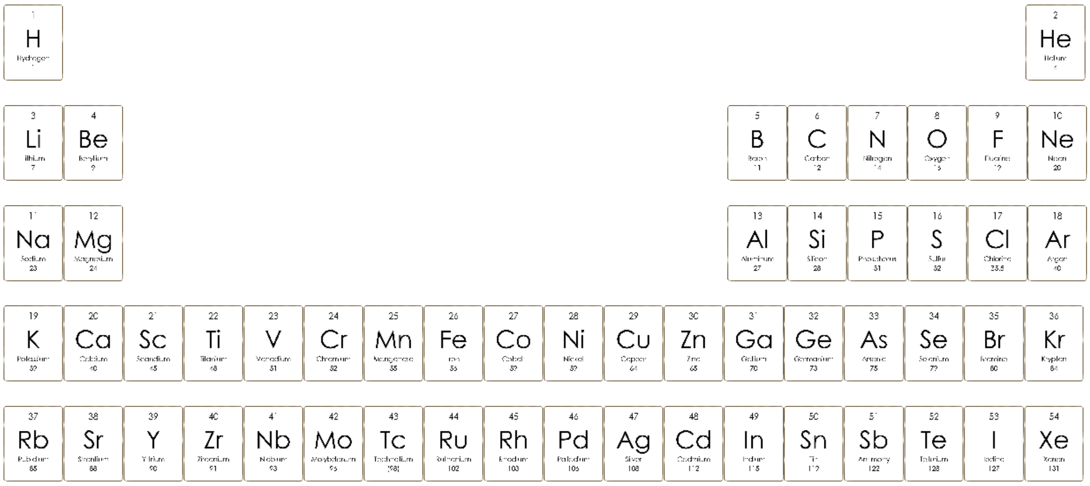
Due to copyright restrictions this periodic table is a bit different to the one you'll see in the exam, if you want to use the one for your exam board, you can down load it and ignore this one.

Periods → go across

The period tells you the number of electron shells

Groups – go down

The group tells you the number of electrons on the out shell

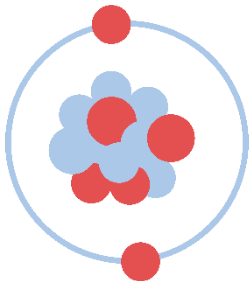


The periodic table tells us so much about the structure of atoms!

It can remind you how many electrons go in each shell, notice in the first period there are two elements, and in the first electron shell there are two electron, in the second period there are 8 electrons, and in the second shell there are 8 electrons.

Element	Period	Group
Calcium		
Beryllium		
Nitrogen		
Aluminium		
Sulfur		

Mass number and atomic number

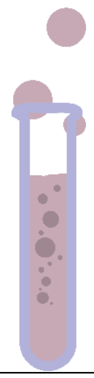


The mass number is the larger of the two numbers, in the box, it doesn't matter where its positioned and when I say larger I don't mean the size of the writing.

For each of the following give the mass number and the atomic number.

Element	Mass number	Atomic number
5 B Boron 11		
12 Mg Magnesium 24		
24 Cr Chromium 52		
11 Na Sodium 23		
14 Si Silicon 28		
Oxygen		
Helium		
	45	
	31	
		29

The number of protons, neutrons and electrons



The number of protons is the atomic number

In an atom the number of electrons is also the atomic number

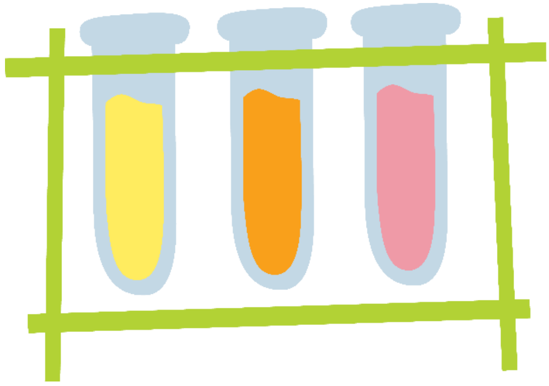
The number of neutrons is the mass number minus the atomic number

Element	Number of protons	Number of electrons	Number of neutrons
17 Cl Chlorine 35.5			
35 Br Bromine 80			
28 Ni Nickel 59			
8 O Oxygen 16			
53 I Iodine 127			
Argon			
Boron			
	56		
		27	
			16

Isotopes

An isotope is an element that the same number of protons and electrons but a different number of neutrons.

We write these with the name first then the mass number, for example carbon-12 is carbon with a mass of 12 and carbon -13 is carbon with a mass of 13.



Element	Number of protons	Number of electrons	Number of neutrons
Carbon-13			
Oxygen-18			
Nitrogen -16			
Iron-55			
Magnesium-26			
Argon-41			
Sulfur-34			
Fluorine-17			
Hydrogen-3			
Calcium-38			

Ions

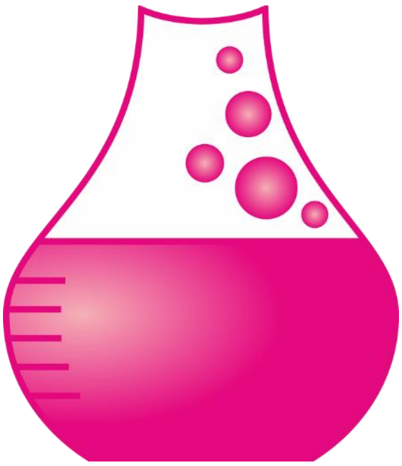
When an atom gains or losses and electrons it becomes an ion.

	Atom		Ion		
Element	Number of protons	Number of electrons	Number of protons	Number of electrons	Charge
Sodium					Na^{+}
Magnesium					Mg^{2+}
Oxygen					O^{2-}
Fluorine					F^{-}
Chlorine					Cl^{-}
Lithium					Li^{+}
Calcium					Ca^{2+}
Potassium					K^{+}
	3				Li^{-}
	53			54	

Elements and atoms

Remember elements are found on the periodic table, the small number after each elements tells you how many of that elements there is in a compound.

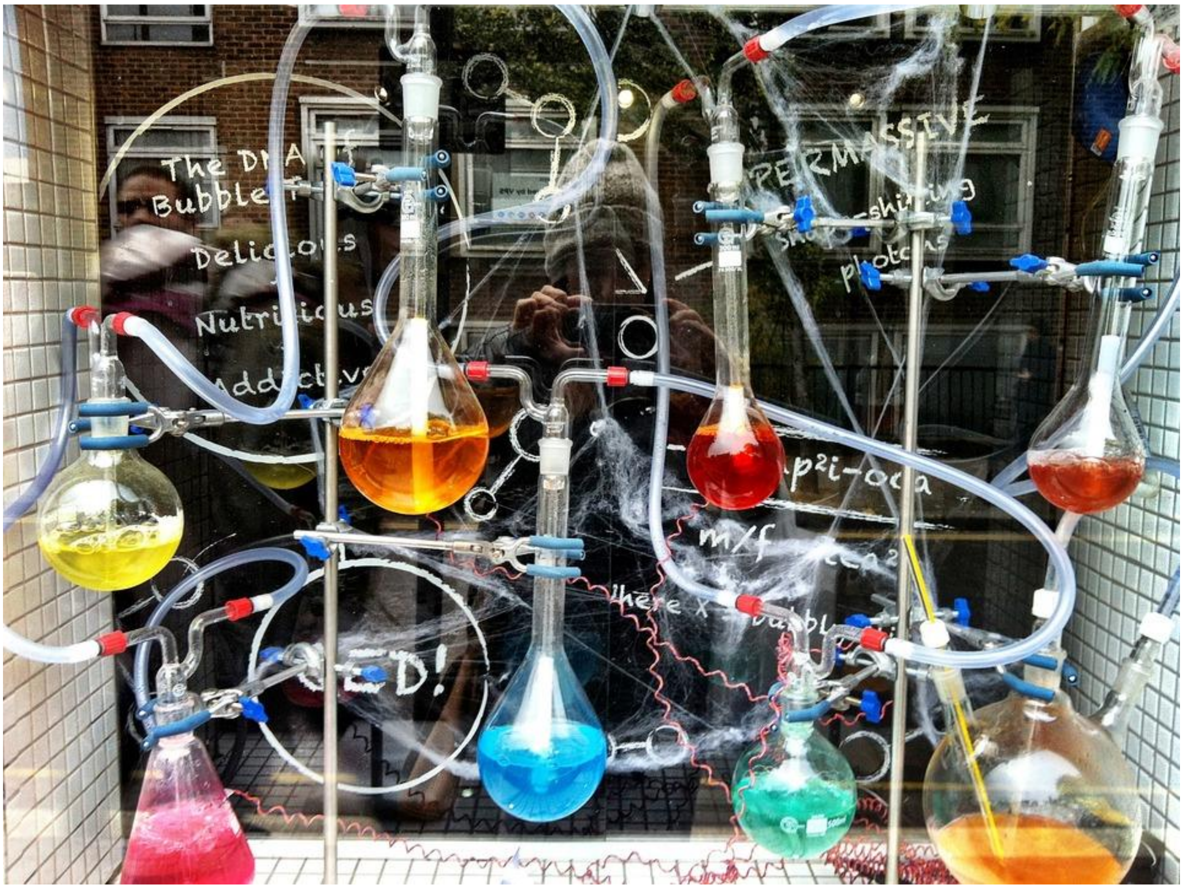
Compound	Number of elements	Number of atoms
H_2O		
O_2		
$CaCO_3$		
NH_3		
CH_4		
H_2SO_4		
HCl		
HNO_3		
CuO		
SO_2		



Brackets

The brackets mean that everything inside the brackets get multiplied by the small number outside the brackets.

Compound	Number of elements	Number of atoms
$Ca(OH)_2$		
$Cu(NO_3)_2$		
$Cr_2(SO_4)_3$		
$Fe_2(SO_4)_3$		



Conservation of mass

When a reaction takes place we don't lose any mass and we don't gain any mass, in other words the left hand side must weigh the same as the right hand side.

Fill in the missing bits below

Magnesium	+	Oxygen	→	Magnesium oxide		
5g	+	0.1g	→	…………..		
Sodium	+	Water	→	Sodium hydroxide	+	Hydrogen
2.1g	+	0.5g	→	2.3g	+	…………….
Silver sulfate	+	Magnesium	→	Magnesium sulfate	+	Silver
14.65g	+	7.56g	→	13.98g	+	………….
Calcium	+	Hydrochloric acid	→	Calcium chloride	+	Hydrogen
17.0g	+	……….	→	19.2g	+	0.9g
Iron oxide	+	Carbon	→	Iron	+	Carbon dioxide
45.8g	+	…………	→	52.3g	+	1.2g

Balancing equations

Easy – grade 5

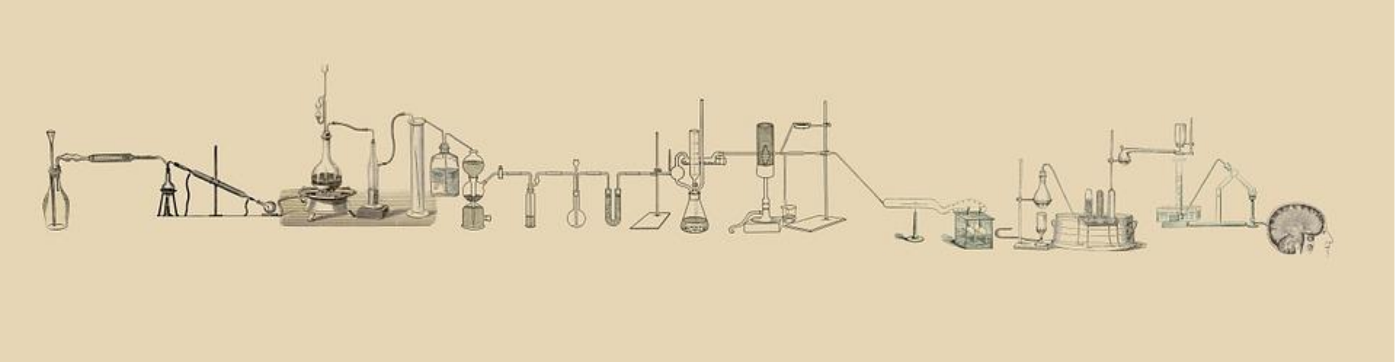
1. ....H_2 + O_2 → ....H_2O
2. H_2 + Cl_2 → ....HCl
3. ....Mg + O_2 → ....MgO
4. N_2 + ...H_2 → ....NH_3
5. ....Zn + O_2 → ....ZnO
6. N_2 + O_2 → ....NO
7. ....K + S → K_2S
8. Mg + ...HCl → $MgCl_2$ + H_2
9. ....Na + ...H_2O → ....$NaOH$ + H_2
10. ....Ca + O_2 → ....CaO
11. Ca + ...HCl → $CaCl_2$ + H_2
12. ....Na + Cl_2 → ....$NaCl$
13. ....SO_2 + O_2 → ....SO_3
14. ....KOH + $MgSO_4$ → $Mg(OH)_2$ + K_2SO_4
15. K_2O_2 + ...H_2O → H_2O_2 + ...KOH
16. ......Na + ...H_2O → ......$NaOH$ + H_2
17. ....$NaOH$ + H_3PO_4 → Na_3PO_4 + ...H_2O
18. ....K + ...H_2O → ....KOH + H_2
19. Ag_2SO_4 + Mg → $MgSO_4$ + ...Ag
20. ....Al + ...O_2 → ....Al_2O_3

Medium – grade 7

1. $Fe_2O_3 + Al \rightarrow Fe + Al_2O_3$
2. $N_2 + Cl_2 \rightarrow NCl_3$
3. $C + Cl_2 \rightarrow CCl_4$
4. $CaCl_2 + KOH \rightarrow Ca(OH)_2 + KCl$
5. $P_4 + Cl_2 \rightarrow PCl_3$
6. $C_2H_4 + O_2 \rightarrow CO_2 + H_2O$
7. $Mg + CO_2 \rightarrow MgO + C$
8. $H_2O_2 \rightarrow H_2O + O_2$
9. $C_2H_6 + O_2 \rightarrow CO_2 + H_2O$
10. $Fe_2O_3 + C \rightarrow Fe + CO$
11. $TiCl_4 + Mg \rightarrow MgCl_2 + Ti$
12. $PH_3 + O_2 \rightarrow P_2O_3 + H_2O$
13. $PH_5 + O_2 \rightarrow P_2O_5 + H_2O$
14. $CuCl_2 + NaOH \rightarrow Cu(OH)_2 + NaCl$
15. $KI + Pb(NO_3)_2 \rightarrow KNO_3 + PbI_2$
16. $PCl_3 + H_2O \rightarrow P(OH)_3 + HCl$
17. $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$
18. $Pb(NO_3)_2 \rightarrow PbO + NO_2 + O_2$
19. $C_6H_{12}O_6 + O_2 \rightarrow H_2O + CO_2$
20. $NH_3 + O_2 \rightarrow NO + H_2O$

Hard – grade 9/A-Level

1. $Mg + HIO_3 \rightarrow MgIO_3 + H_2$
2. $BaCl_2 + Na_2SO_4 \rightarrow NaCl + BaSO_4$
3. $NaI + HOCl \rightarrow NaIO_3 + HCl$
4. $Al + MnO_2 \rightarrow Al_2O_3 + Mn$
5. $Ba(OH)_2 + H_2SO_4 \rightarrow BaSO_4 + H_2O$
6. $K_2CO_3 + AgNO_3 \rightarrow KNO_3 + Ag_2CO_3$
7. $Sr(ClO_4)_2 + K_2SO_4 \rightarrow SrSO_4 + KClO_4$
8. $Al + H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2$
9. $HNO_3 + H_2S \rightarrow NO + S + H_2O$
10. $Pb(NO_3)_2 + KCl \rightarrow PbCl_2 + KNO_3$
11. $MgCO_3 + HNO_3 \rightarrow Mg(NO_3)_2 + H_2O + CO_2$
12. $H_2SO_4 + NaOH \rightarrow Na_2SO_4 + H_2O$
13. $SO_2 + HNO_2 \rightarrow H_2SO_4 + NO$
14. $HI + H_2SO_4 \rightarrow H_2O + H_2S + I_2$
15. $HCl + Al(OH)_3 \rightarrow H_2O + AlCl_3$
16. $NaOH + CuSO_4 \rightarrow Na_2SO_4 + Cu(OH)_2$
17. $HF + Ba(NO_3)_2 \rightarrow HNO_3 + BaF_2$
18. $NO_2 + H_2 \rightarrow NH_3 + H_2O$
19. $NH_3 + O_2 \rightarrow NO + H_2O$
20. $HCl + FeCl_2 + H_2O_2 \rightarrow FeCl_3 + H_2O$



Relative formula mass

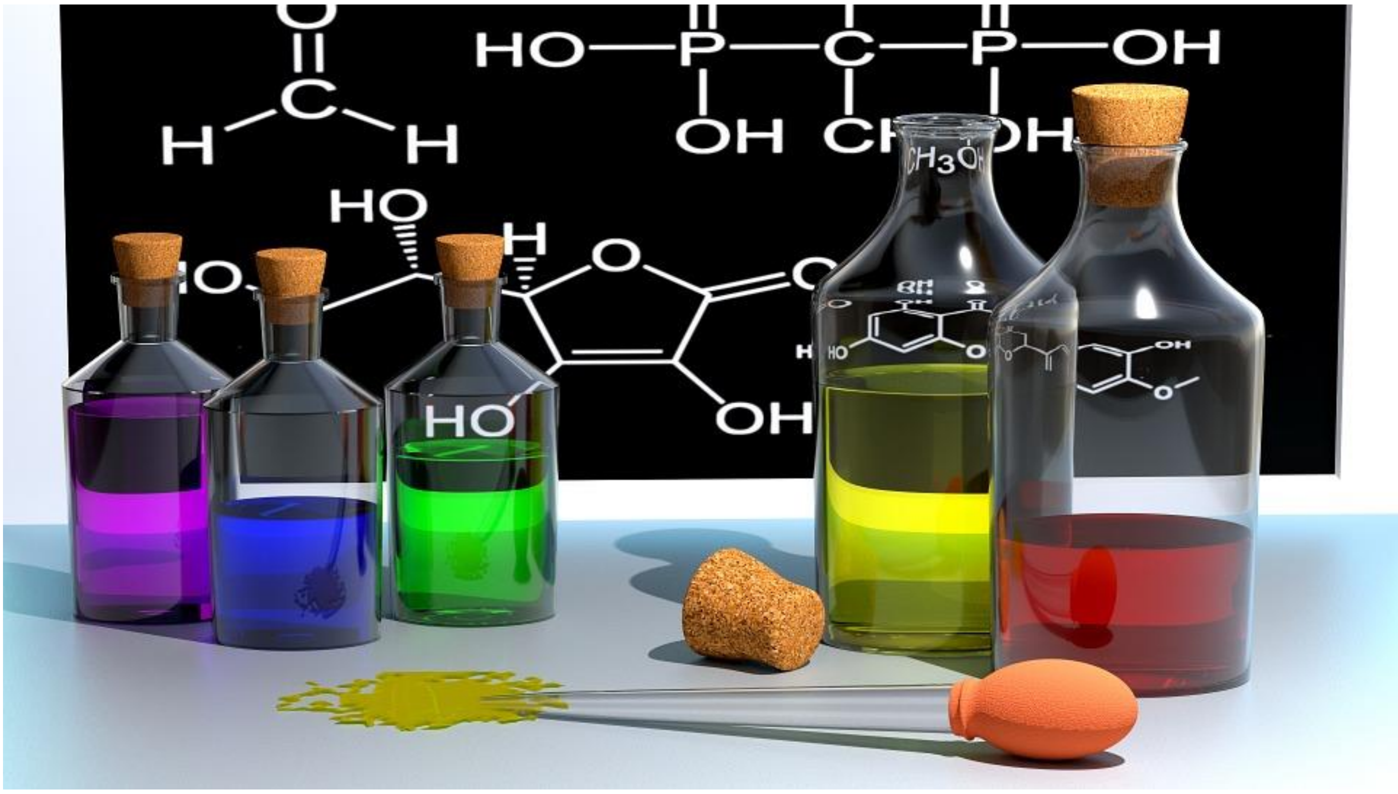
To find the mass of the compound, add the mass numbers of the elements together.

Compound	Relative mass
H_2O	
O_2	
$CaCO_3$	
NH_3	
CH_4	
H_2SO_4	
HCl	
HNO_3	
CuO	
$Ca(OH)_2$	
$Cu(NO_3)_2$	
$Cr_2(SO_4)_3$	
$Fe_2(SO_4)_3$	

Calculating relative atomic mass or relative isotopic mass

If you've ever wondered why Cl has a mass of 35.5 then this section is for you. The mass shown on the periodic table is an average mass of all the isotopes found on Earth. Give all answers to 4 significant figures.

1. Chlorine is found as 2 naturally occurring isotopes ^{35}Cl and ^{37}Cl, 75% of the chlorine is ^{35}Cl and 25% is ^{37}Cl, calculate the relative atomic mass of chlorine from its isotopes.
2. Bromine is found as 50% ^{79}Br and 50% ^{81}Br, what is the average relative atomic mass?
3. Iron can be found as 4 different naturally occurring isotopes, the most common (91.6%) is ^{56}Fe, followed by (5.9%) ^{54}Fe, (2.2%) ^{57}Fe and (0.2%) ^{58}Fe, what is the relative isotopic mass of iron?
4. Calcium can be found as a wide range of different isotopes, the one with the highest percentage is ^{40}Ca (96.9%), followed by ^{44}Ca (2.0%) ^{42}Ca (0.8%) ^{48}Ca (0.2%) and ^{43}Ca (0.1%) what is the relative atomic mass of calcium?
5. Iridium is listed on the periodic table as having a mass of 192.2, it has 2 naturally occurring isotopes ^{191}Ir and ^{193}Ir. What are the relative percentages of each isotope?



Moles

Moles = mass in grams / relative mass

Compound	Relative mass	Mass in grams	Moles
N_2		28	
CO_2		22	
CaO		112	
Fe_2O_3		40	
PCl_3		27.5	
$Mg(OH)_2$			2
$KHSO_4$			0.75
Na_2SO_4			2.3
H_3AsO_4			0.67
$Cu(NO_3)_2$			1.56

1. 1.8g of water is used in a reaction, how many moles are being used?
2. If 3 moles of magnesium hydroxide are required for a practical, how much should the students weigh out?
3. When decomposing calcium carbonate 1.75 moles of calcium hydroxide is produced, how much does it weigh?
4. After a reaction had finished it was found that a solid has lost 0.5 moles of nitrogen gas. How much did the weight of the solid reduce by?
5. 5.2g of hydrogen peroxide (H_2O_2) decomposed to make water and oxygen gas, how many moles of oxygen were released?

Percentage yield

When I'm baking cakes I follow a recipe, and always expect to end up with 24 lovely yummy cupcakes!

This never actually works, I always end up with less cupcakes then I want!

This is the difference between theoretical yield (how many you expect to get) and actual yield (how many you actually get).

To calculate the percentage yield we divide the actual mass by the theoretical mass and turn it into a percentage.

1. In a reaction a student expected to produce 56g of calcium oxide, they only produced 42g. What is the percentage yield?
2. An industrial reaction was expected to give a total of 1.53 tonnes, in the end it was found that 0.95 tonnes was produced, find the percentage yield.
3. When a reaction is performed on an industrial scale it is found that only 95Kg is produced, it was expected that 145kg would be produced. What is the percentage yield?
4. While in the lab a student was expecting to make 65g of magnesium oxide, she only produced 54g, what is the percentage yield?
5. When producing ammonia from nitrogen and hydrogen, the theoretical yield was 1.75kg, in reality 0.35kg less then this was produced. Calculate the percentage yield and give reason that the actual yield was less than the theoretical yield.

These questions combine reacting masses and percentage yield, if you haven't covered reacting masses yet do that first and come back here.

6. In the following reaction $Fe_3O_2 + 3CO \rightarrow 2Fe + 3CO_2$, 0.95Kg of iron ore yields 0.46kg of iron, calculate the percentage yield.
7. 1000 tonnes of Cyclohexane (M_r=98) reacts to produce 834 tonnes of methylene cyclohexane (M_r=96) what is the percentage yield.
8. Ethanoic acid (CH_3COOH) is reacted with ethanol (C_2H_5OH) to produce ethyl ethanoate ($CH_3COOC_2H_5$), if we start with 21g of ethanol and produce 36g of ethyl ethanoate, calculate the percentage yield.

Atom economy

Atom economy is a lot like percentage yield but we need to look at the M_r not the mass.

$$\% \text{ atom economy} = \frac{M_r \text{ useful product}}{M_r \text{ total reactants}}$$

This is one example where producing ethanol from crude oil is advantageous to producing it from fermentation as there is no waste product.

1. Calculate the atom economy for the production of iron from its ore. $Fe_3O_2 + 3CO \rightarrow 2Fe + 3CO_2$.
2. Photosynthesis produces glucose from carbon dioxide and water, what is the atom economy of this reaction? $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$
3. The reaction for producing copper hydroxide is $CuCl_2 + NaOH \rightarrow Cu(OH)_2 + NaCl$, calculate the atom economy of this reaction.
4. Calculate the atom economy when producing calcium oxide from calcium carbonate
5. Compare the atom economy when producing ethanol by hydration and by fermentation.

Half equations

We use half equations to describe what goes on at each electrode during electrolysis, you can only add or take away electrons and make sure that the elements and charges are balanced.

Label each reaction as oxidation or reduction and give the location where it happens

Reaction	Oxidation or Reduction	Anode or Cathode
Cu^{2+} …………. → Cu		
F^- ………… → F_2		
Na^+ ……………. → Na		
O^{2-} → O_2 ………….		
Al^{3+} ……………… → Al		
Li^+ ………… → Li		
Cl^- → Cl_2 ………………		
H^+ ……………. → H_2		
S^{2-} ………………. → S		
Mg^{2+} ……………… → Mg		

Oxidation	**P**ositive
Is	**A**node
Loss (of electrons)	**N**egative
Reduction	**I**s
Is	**C**athode
Gain (of electrons)	

Reacting masses

We can use equations to predict how much of a substance can be formed when a reaction takes place. There are two ways to do this, by using mole calculations or approaching it as a simple ratios question.

1. Water can be split into hydrogen and oxygen ($2H_2O \rightarrow 2H_2 + O_2$) how much oxygen would be produced from 56g of water?
2. Hydrogen peroxide can be broken down to water and oxygen gas ($2H_2O_2 \rightarrow 2H_2O + O_2$) how much hydrogen peroxide will be needed to make 17g of oxygen?
3. Magnesium chloride can be produced by the reaction of sodium metal with chlorine gas, ($Mg + Cl_2 \rightarrow MgCl_2$) how much magnesium is needed to produce 193.5g of magnesium chloride?
4. The reaction between limewater (calcium hydroxide) and carbon dioxide produces a white precipitate (the cloudy bits) how much calcium carbonate is produced from 196g of limewater? ($Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$)
5. Aluminium reacts with oxygen to produce aluminium oxide ($Al + O_2 \rightarrow Al_2O_3$) how much aluminium oxide will be produced from 36g of aluminium metal?

For each of these you are expected to first write and balance the equation.

6. Copper oxide (CuO) is reacted with hydrogen gas (H_2) to produce copper and water, how much copper oxide is needed to give 21g of copper?
7. Propane gas burns completely in oxygen, how much carbon dioxide will be produced if 19g of propane is burnt?
8. In respiration glucose is converted to carbon dioxide and water, if 36g of glucose is reacted how much carbon dioxide will be produced?
9. Calcium carbonate reacts with hydrochloric acid how much carbon dioxide is produced from 21g of hydrochloric acid?
10. Iron metal is reacted with hydrochloric acid and 17.9g iron chloride is produced, how much iron is needed?

Avogadro's constant and gas volume

A mole has a fixed number of particles in it, 6.02×10^{23} and one moles of gas takes up $24 dm^3$ of space.

You can think of it like a shoe collection, each collection is going to take the same amount of space. Just some collections are going to be full of flip flops, some full of fabulous, colourful high heels and some are going to be full of walking boots, but it not a complete collection until there are 6.02×10^{23} shoes in it…….I wish ☺

Compound	M_r	Mass in grams	Number of moles	Number of particles	Gas volume (dm^3)
KOH			1		
CO_2			0.5		
NaOH			2		
$CaCO_3$		50			
PCl_3		34.375			
SF_6		14.6			
MgO				6.02×10^{23}	
C_2H_6					24
NH_3					6
$P(OH)_3$					2

Endothermic and exothermic reactions

Each bond has a certain amount of energy associated with it, this energy is released when a bonds are made (an exothermic process) and energy is needed to break bonds (an endothermic process) to find the total energy given off or taken in during a reaction you needed to find the difference.

Bond energy rules

a) Write the balanced equation for the reaction
b) Draw the structural formula for each compound
c) List the types of bonds
d) List the number of each type of bond
e) Use the table to work out the energy associated with each bond
f) Multiply the number of bonds by the energy for that bond
g) Work out the total amount for bond breaking and bond making
h) Work out the difference

Bond	Bond energy in kJ per mole
H - H	436
O = O	498
O - H	464
C - H	435
C - Cl	327
C = O	805
Cl-Cl	242
H-Cl	431
H-Br	366
Br-Br	193

Bond energy questions

1. Burning hydrogen (H-H) in oxygen (O=O) will give off water (H-O-H), calculate the energy change for this reaction.
2. Hydrogen bromide breaks down to form hydrogen gas and bromine gas, what is the energy change?
3. Hydrogen and chlorine can be reacted together to make hydrochloric acid, calculate the energy change for this reaction.
4. The combustion of methane in oxygen give off water and carbon dioxide (C=O=C) calculate the energy change for this reaction.
5. Methane reacts with chlorine gas to give chloromethane and hydrochloric acid, calculate the energy change for this reaction.

Titration calculations

This is potentially the hardest maths you'll come across, I'm going to break it down bit by bit.

In a titration we're looking for the end point where $H^+ = OH^-$

dm^3 = 1 litre

A mole is the M_r in grams

mol/dm^3 is saying 1 mole dissolved in 1 litre

You don't get given these equations in the exam, you need to remember them

$$n = c \times v$$

n = number of moles (mol)

c = concentration (mol/dm^3)

v = volume (dm^3)

1. Calculate the number of moles in $4dm^3$ of 1.2 mol/dm^3 HCl.
2. Calculate the number of moles in $2dm^3$ of 0.3 mol/dm^3 NaOH
3. Calculate the number of moles of KOH in $25cm^3$ of 0.2 mol/dm^3
4. Find the concentration of 3mol HBr in a $2dm^3$ solution
5. Calculate the concentration in 1mol of NaOH in $30cm^3$ of solution
6. Calculate the volume of 2.3 mol/dm^3 solution that contains 0.5mol HCl

$$m = n \times M_r$$

m = mass (g)

n = number of moles (mol)

M_r = relative formula mass

1. What mass of NaOH is there in $2dm^3$ of 0.3 mol/dm^3 solution?
2. What mass of H_2SO_4 is there in $3dm^3$ of 2 mol/dm^3 solution?
3. What is the mass of NaOH in $25cm^3$ of 0.3 mol/dm^3 solution?
4. What is the mass of HNO_3 that would dissolve in $500cm^3$ of water to produce a 2 mol/dm^3 solution?

Titration rules

Assuming acid is known and alkali is unknown, if opposite is true just reverse.

a) Calculate the number of moles of acid used
b) Using this find the number of H^+ ions involved in the reaction
c) This is equal to the number of OH^- ions involved in the reaction
d) Calculate the number of moles of alkali used
e) Calculate the concentration of the alkali

Titration calculations

1. $25cm^3$ of NaOH was neutralised by $15cm^3$ of 0.2 mol/dm^3 HCl, calculate the concentration of the alkali.
2. A solution of sodium hydroxide at 0.25 mol/dm^3, was used in a titration using a phenolphthalein indicator it was found that $25cm^3$ of this solution was titrated with $22.5cm^3$ of hydrochloric acid. What was the concentration of the acid?
3. $20.0cm^3$ of sulfuric acid was titrated against 0.05 mol/dm^3 potassium hydroxide. If the acid required $36.0cm^3$ of the alkali to be neutralised, what is the concentration of the acid?
4. $20cm^3$ of a solution made from pure barium hydroxide (containing 2.74g in $100cm^3$) is titrated, using phenolphthalein indicator, against $18.7cm^3$ of hydrochloric acid. What was the concentration of the HCl?
5. $25.0cm^3$ of sodium hydroxide (0.100 mol/dm^3) was titrated with $30.0cm^3$ of sulfuric acid. Find the concentration of the acid in g/dm^3.
6. $25.0cm^3$ of a solution of sodium hydroxide was pipetted into a conical flask and titrated with 0.200 mol/dm^3 (0.2M) HCl. Using a methyl orange indicator it was found that 15.0cm3 of the acid was required to neutralise the alkali. Calculate the molarity of the sodium hydroxide and the concentration in g/dm^3.
7. 4.90g of pure sulfuric acid was dissolved in water, the total resulting volume was $200cm^3$, $20.7cm^3$ of this solution was found after titration to need $10.0cm^3$ of sodium hydroxide to be neutralised. What is the concentration of sodium hydroxide?

Answers

The periodic table

Element	Period	Group
Calcium	4	2
Beryllium	2	2
Nitrogen	2	5
Aluminium	3	3
Sulfur	3	6

Mass number and atomic number

Element	Mass number	Atomic number
5 B Boron 11	11	5
12 Mg Magnesium 24	24	12
24 Cr Chromium 52	52	24
11 Na Sodium 23	23	11
14 Si Silicon 28	28	14
Oxygen	16	8
Helium	4	2
Scandium	45	21
Phosphorous	31	15
Copper	64	29

The number of protons, neutrons and electrons

Element	Number of protons	Number of electrons	Number of neutrons
17 Cl Chlorine 35.5	17	17	18.5
35 Br Bromine 80	35	35	45
28 Ni Nickel 59	28	28	31
8 O Oxygen 16	8	8	8
53 I Iodine 127	53	53	74
Argon	18	18	22
Boron	5	5	6
Barium	56	56	81
Cobalt	27	27	32
Sulfur	16	16	16

Isotopes

Element	Number of protons	Number of electrons	Number of neutrons
Carbon-13	6	6	7
Oxygen-18	8	8	10
Nitrogen -16	7	7	9
Iron-55	26	26	29
Magnesium-26	12	12	14
Argon-41	18	18	23
Sulfur-34	16	16	18
Fluorine-17	9	9	8
Hydrogen-3	1	1	2
Calcium-38	20	20	18

Ions

	Atom		Ion		
Element	Number of protons	Number of electrons	Number of protons	Number of electrons	Charge
Sodium	11	11	11	10	Na^{+}
Magnesium	12	12	12	10	Mg^{2+}
Oxygen	8	8	8	10	O^{2-}
Fluorine	9	9	9	10	F^{-}
Chlorine	17	17	17	18	Cl^{-}
Lithium	3	3	3	2	Li^{+}
Calcium	20	20	20	18	Ca^{2+}
Potassium	19	19	19	18	K^{+}
Lithium	3	3	3	4	Li^{-}
Iodine	53	53	53	54	I^{-}

Elements and atoms

Compound	Number of elements	Number of atoms
H_2O	2	3
O_2	1	2
$CaCO_3$	3	5
NH_3	2	4
CH_4	2	5
H_2SO_4	3	7
HCl	2	2
HNO_3	3	5
CuO	2	2
SO_2	2	3

Brackets

Compound	Number of elements	Number of atoms
$Ca(OH)_2$	3	5
$Cu(NO_3)_2$	3	9
$Cr_2(SO_4)_3$	3	17
$Fe_2(SO_4)_3$	3	17

Conservation of mass

Magnesium	+	Oxygen	→	Magnesium oxide		
5g	+	0.1g	→	5.1g		
Sodium	+	Water	→	Sodium hydroxide	+	Hydrogen
2.1g	+	0.5g	→	2.3g	+	0.3g
Silver sulfate	+	Magnesium	→	Magnesium sulfate	+	Silver
14.65g	+	7.56g	→	13.98g	+	8.23g
Calcium	+	Hydrochloric acid	→	Calcium chloride	+	Hydrogen
17.0g	+	3.1g	→	19.2g	+	0.9g
Iron oxide	+	Carbon	→	Iron	+	Carbon dioxide
45.8g	+	7.7g	→	52.3g	+	1.2g

Balancing Equations-easy!

1. $2H_2 + O_2 \rightarrow 2H_2O$
2. $H_2 + Cl_2 \rightarrow 2HCl$
3. $2Mg + O_2 \rightarrow 2MgO$
4. $N_2 + 3H_2 \rightarrow 2NH_3$
5. $2Zn + O_2 \rightarrow 2ZnO$
6. $N_2 + O_2 \rightarrow 2NO$
7. $2K + S \rightarrow K_2S$
8. $Mg + 2HCl \rightarrow MgCl_2 + H_2$
9. $2Na + 2H_2O \rightarrow 2NaOH + H_2$
10. $2Ca + O_2 \rightarrow 2CaO$
11. $Ca + 2HCl \rightarrow CaCl_2 + H_2$
12. $2Na + Cl_2 \rightarrow 2NaCl$
13. $2SO_2 + O_2 \rightarrow 2SO_3$
14. $2KOH + MgSO_4 \rightarrow Mg(OH)_2 + K_2SO_4$
15. $K_2O_2 + 2H_2O \rightarrow H_2O_2 + 2KOH$

16. $2Na + 2H_2O \rightarrow 2NaOH + H_2$
17. $3NaOH + H_3PO_4 \rightarrow Na_3PO_4 + 3H_2O$
18. $2K + 2H_2O \rightarrow 2KOH + H_2$
19. $Ag_2SO_4 + Mg \rightarrow MgSO_4 + 2Ag$
20. $4Al + 3O_2 \rightarrow 2Al_2O_3$

Balancing Equations-Medium!

1. $Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$
2. $N_2 + 3Cl_2 \rightarrow 2NCl_3$
3. $C + 2Cl_2 \rightarrow CCl_4$
4. $CaCl_2 + 2KOH \rightarrow Ca(OH)_2 + 2KCl$
5. $P_4 + 6Cl_2 \rightarrow 4PCl_3$
6. $C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$
7. $2Mg + CO_2 \rightarrow 2MgO + C$
8. $2H_2O_2 \rightarrow 2H_2O + O_2$
9. $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$
10. $Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$
11. $TiCl_4 + 2Mg \rightarrow 2MgCl_2 + Ti$
12. $2PH_3 + 3O_2 \rightarrow P_2O_3 + 3H_2O$
13. $2PH_5 + 5O_2 \rightarrow P_2O_5 + 5H_2O$
14. $CuCl_2 + 2NaOH \rightarrow Cu(OH)_2 + 2NaCl$
15. $2KI + Pb(NO_3)_2 \rightarrow 2KNO_3 + PbI_2$
16. $PCl_3 + 3H_2O \rightarrow P(OH)_3 + 3HCl$
17. $C_3H_8 + 5O_2 \rightarrow 5CO_2 + 4H_2O$
18. $2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$
19. $C_6H_{12}O_6 + 6O_2 \rightarrow 6H_2O + 6CO_2$
20. $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$

Balancing Equations- Hard!

1. $2Mg + 2HIO_3 \rightarrow 2Mg(IO_3) + H_2$
2. $BaCl_2 + Na_2SO_4 \rightarrow 2NaCl + BaSO_4$
3. $NaI + 3HOCl \rightarrow NaIO_3 + 3HCl$
4. $4Al + 3MnO_2 \rightarrow 2Al_2O_3 + 3Mn$
5. $Ba(OH)_2 + H_2SO_4 \rightarrow BaSO_4 + 2H_2O$
6. $K_2CO_3 + 2AgNO_3 \rightarrow 2KNO_3 + Ag_2CO_3$

7. $Sr(ClO_4)_2 + K_2SO_4 \rightarrow SrSO_4 + 2KClO_4$
8. $2Al + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2$
9. $2HNO_3 + 3H_2S \rightarrow 2NO + 3S + 4H_2O$
10. $Pb(NO_3)_2 + 2KCl \rightarrow PbCl_2 + 2KNO_3$
11. $MgCO_3 + 2HNO_3 \rightarrow Mg(NO_3)_2 + H_2O + CO_2$
12. $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$
13. $SO_2 + 2HNO_2 \rightarrow H_2SO_4 + 2NO$
14. $8HI + H_2SO_4 \rightarrow 4H_2O + H_2S + 4I_2$
15. $3HCl + Al(OH)_3 \rightarrow 3H_2O + AlCl_3$
16. $2NaOH + CuSO_4 \rightarrow Na_2SO_4 + Cu(OH)_2$
17. $2HF + Ba(NO_3)_2 \rightarrow 2HNO_3 + BaF_2$
18. $2NO_2 + 7H_2 \rightarrow 2NH_3 + 4H_2O$
19. $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$
20. $2HCl + 2FeCl_2 + H_2O_2 \rightarrow 2FeCl_3 + 2H_2O$

Relative atomic mass

Compound	Relative mass
H_2O	(2x1) + (1x16) = 18
O_2	(2x16) = 32
$CaCO_3$	(1x40) + (1x12) + (3x16) =100
NH_3	(1x14) + (3x1) = 17
CH_4	(1x12) + (4x1) = 16
H_2SO_4	(2x1) + (1x32) + (4x16) = 98
HCl	(1x1) + (1x35.5) = 36.5
HNO_3	(1x1) + (1x14) + (3x16) = 63
CuO	(1x63.5) + (1x16) = 79.5
$Ca(OH)_2$	(1x40) + (2x16) + (2x1) = 74
$Cu(NO_3)_2$	(1x63.5) + (2x14) + (6x16) = 187.5
$Cr_2(SO_4)_3$	(2x52) + (3x32) + (12x16) = 392
$Fe_2(SO_4)_3$	(2x56) + (3x32) + (12x16) = 400

Calculating relative atomic mass

1. 35.50
2. 80.00
3. 55.85
4. 40.02
5. 40% 191, 60% 193

Moles

Compound	Relative mass	Mass in grams	Moles
N_2	28	28	1
CO_2	44	22	0.5
CaO	56	112	2
Fe_2O_3	160	40	0.25
PCl_3	137.5	27.5	0.2
$Mg(OH)_2$	58	116	2
$KHSO_4$	136	102	0.75
Na_2SO_4	142	326.6	2.3
H_3AsO_4	142	95.14	0.67
$Cu(NO_3)_2$	188	292.5	1.56

1. 0.1 moles
2. 174g
3. 129.5g
4. 14g
5. 0.15 moles

Percentage yield

1. 75%
2. 62%
3. 66%
4. 83%
5. 80%
6. 86%
7. 85%
8. 90%

Atom economy

1. 56%
2. 48%
3. 56%
4. 56%
5. Hydration 100%, fermentation 51%

Half equations

Reaction	Oxidation or Reduction	Anode or Cathode
$Cu^{2+} + 2e^- \rightarrow Cu$	Reduction	Cathode
$2F^- - 2e^- \rightarrow F_2$	Oxidation	Anode
$Na^+ + e^- \rightarrow Na$	Reduction	Cathode
$2O^{2-} \rightarrow O_2 + 4e^-$	Oxidation	Anode
$Al^{3+} + 3e^- \rightarrow Al$	Reduction	Cathode
$Li^+ + e^- \rightarrow Li$	Reduction	Cathode
$2Cl^- \rightarrow Cl_2 + 2e^-$	Oxidation	Anode
$2H^+ + 2e^- \rightarrow H_2$	Reduction	Cathode
$S^{2-} - 2e^- \rightarrow S$	Oxidation	Anode
$Mg^{2+} + 2e^- \rightarrow Mg$	Reduction	Cathode

Reacting masses

1. 49.8g
2. 36.1g
3. 48.9g
4. 264.9g
5. 136g
6. 26.3g
7. 57g
8. 52.8g
9. 12.7g
10. 11g

Avogadro and gas volumes

Compound	M_r	Mass in grams	Number of moles	Number of particles	Gas volume (dm^3)
KOH	56	56	1	6.02×10^{23}	24
CO_2	44	22	0.5	3.01×10^{23}	12
NaOH	40	80	2	1.02×10^{24}	48
$CaCO_3$	100	50	0.5	3.01×10^{23}	12
PCl_3	137.5	34.375	0.25	1.51×10^{23}	6
SF_6	146	14.6	0.1	6.02×10^{22}	2.4
MgO	40	40	1	6.02×10^{23}	24
C_2H_6	28	28	1	6.02×10^{23}	24
NH_3	17	4.25	0.25	1.51×10^{23}	6
$P(OH)_3$	82	6.83	0.083	5.02×10^{22}	2

Endothermic and exothermic reactions

1. -486kJ/mol^{-1}
2. +103 kJ/mol^{-1}
3. -184 kJ/mol^{-1}
4. -730 kJ/mol^{-1}
5. -81 kJ/mol^{-1}

Titration calculations

1. 4.8mol
2. 0.6mol
3. 0.005mol
4. 1.5 mol/dm^3
5. 33.3 mol/dm^3 not reoccurring-this does not exist in science!!
6. 0.22dm^3

1. 24g
2. 588g
3. 0.3g
4. 63g

1. 0.12 mol/dm^3
2. 0.278 mol/dm^3
3. 0.045 mol/dm^3
4. 0.342 mol/dm^3
5. 4.08 g/dm^3
6. 4.8 g/dm^3
7. 1.035 mol/dm^3