

Contents

ATOMIC STRUCTURE AND THE PERIODIC TABLE

Atoms, elements and compounds	8
Mixtures and compounds	9
Scientific models of the atom	12
Atomic structure	13
Isotopes and relative atomic mass	15
The development of the periodic table and the noble gases	17
Electronic structure and the periodic table	19
Metals and non-metals	21
Group 1 – the alkali metals	22
Group 7 – the halogens	24
Displacement reactions in Group 7	26
The transition metals	28
Review it!	29

BONDING, STRUCTURE AND THE PROPERTIES OF MATTER

Bonding and structure	30
Ions and ionic bonding	32
The structure and properties of ionic compounds	34
Covalent bonds and simple molecules	36
Diamond, graphite and graphene	38
Fullerenes and polymers	40
Giant metallic structures and alloys	41
Nanoparticles	43
Review it!	44

QUANTITATIVE CHEMISTRY

Conservation of mass and balancing equations	45
Relative formula masses	47
The mole	49
Reacting masses and using moles to balance equations	51
Limiting reactant	53
Concentrations in solutions	54
Moles in solution	56
Moles and gas volumes	58
Percentage yield and atom economy	60
Review it!	61

CHEMICAL CHANGES

Metal oxides and the reactivity series	62
Extraction of metals and reduction	64
The reactions of acids	66
Practical: The preparation of a soluble salt	68
Oxidation and reduction in terms of electrons	70
The pH scale and neutralisation	71
Strong and weak acids	72
The basics of electrolysis and the electrolysis of molten ionic compounds	73
The electrolysis of aqueous solutions	75
The extraction of metals using electrolysis	77
Practical: Investigation of the electrolysis of aqueous solutions	78
Practical: Determining reacting volumes by titration	80
Review it!	82

ENERGY CHANGES

Exothermic and endothermic reactions	83
Practical: Investigation into the variables that affect temperature changes in chemical reactions	84
Reaction profiles	86

Topic 1

Topic 2

Topic 3

Topic 4

Topic 5

Topic 6

The energy changes of reactions	87
Chemical cells and fuel cells	89
Review it!	91

RATES OF REACTION AND EQUILIBRIUM

Ways to follow a chemical reaction	92
Calculating the rate of reaction	95
The effect of concentration on reaction rate and the effect of pressure on the rate of gaseous reactions	97
Rates of reaction - the effect of surface area	98
The effects of changing the temperature and adding a catalyst	99
Practical: Investigation into how changing the concentration affects the rate of reaction	101
Reversible reactions	103
The effect of changing conditions on equilibrium	105
Review it!	107

Topic 7

ORGANIC CHEMISTRY

Carbon compounds, hydrocarbons and alkanes	108
Crude oil, fractionation and petrochemicals	110
The structural formulae and reactions of alkenes	112
Cracking and alkenes	114
Alcohols	116
Carboxylic acids	118
Addition polymerisation	120
Condensation polymerisation	122
Amino acids and DNA	124
Review it!	125

Topic 8

CHEMICAL ANALYSIS

Pure substances and formulations	126
Practical: Chromatography	128
Testing for gases	130
Identifying metal ions using flame tests and flame emission spectroscopy	131
Identifying metal ions using sodium hydroxide solution	133
Testing for negative ions (anions) in salts	135
Practical: Identifying ions in an ionic compound	137
Review it!	139

Topic 9

CHEMISTRY OF THE ATMOSPHERE

The composition and evolution of the Earth's atmosphere	140
Global warming	142
The carbon footprint and its reduction	144
Atmospheric pollutants	146
Review it!	148

Topic 10

USING RESOURCES

Finite and renewable resources, sustainable development	149
Life cycle assessments (LCAs)	151
Alternative methods of copper extraction	153
Making potable water and waste water treatment	155
Ways of reducing the use of resources	157
Rusting	158
Alloys as useful materials	160
Ceramics, polymers and composites	162
The Haber process	164
Production and uses of NPK fertilisers	166
Practical: Analysis and purification of a water sample	167
Review it!	169

Glossary/Index	170
Answers	174

Practical: Determining reacting volumes by titration

DO IT!

Write or record on an MP3 file a short account of how you can carry out a titration. You should describe how the volumes are measured and the procedure used.

When acids are **neutralised** by alkalis there are no visible changes.

To see when the **neutralisation** is complete an **indicator** is added to the reaction mixture. The indicator **changes colour** when the correct volumes of acid and alkali have reacted.

Accurate volumes of acid and alkali are measured using a **burette** and a **pipette**. Volumes are expressed to 2 decimal places.

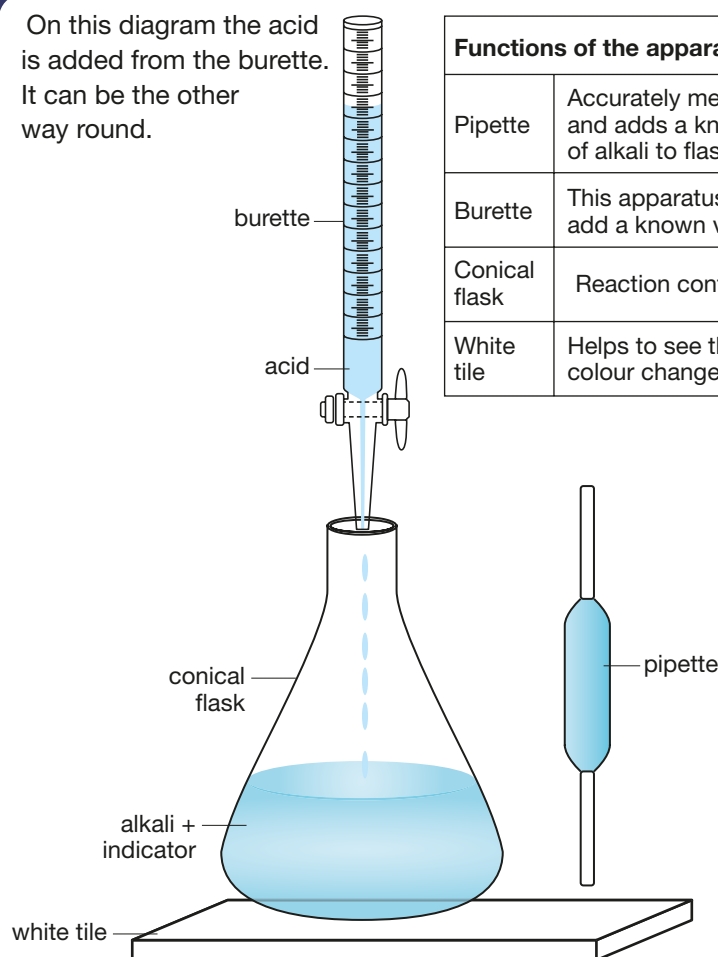


SNAP IT!

On this diagram the acid is added from the burette. It can be the other way round.

Functions of the apparatus.

Pipette	Accurately measures out and adds a known volume of alkali to flask.
Burette	This apparatus is used to add a known volume of acid.
Conical flask	Reaction container
White tile	Helps to see the indicator colour change



NAIL IT!

The burette can be read to the nearest 0.05 cm^3 so the results are expressed to 2 decimal places. Please note that zero is recorded as 0.00 not 0 because the burette reads to 0.05 cm^3 so results are recorded to 2 decimal places.

MATHS SKILLS

You may have to read a table of data and use simple mathematical operations such as subtraction and finding the mean of a set of results. Results are expressed to 2 decimal places.

WORKIT!

Given below is a table of results from a titration experiment where an acid is added from the burette to 25.00 cm³ of an alkali.

There are two results that are within 0.10 cm³ of each other and the average of these is used as the reading.

What is the average titration result for this experiment?

Reading	Rough titration	Accurate titration 1	Accurate titration 2	Accurate titration 3
Final reading/cm ³	19.00	37.20	18.50	37.10
Initial reading/cm ³	0.00	19.00	0.00	18.50
Titre/cm ³	19.00	18.20	18.50	18.60

The average accurate titre = $(18.50 + 18.60) / 2 = 18.55 \text{ cm}^3$

Practical Skills**Titration procedure**

The point at which the indicator changes colour is the **end-point**. The volume of acid needed to reach the end-point is called the **titre**.

For each **titration** a known volume of alkali is added to the **conical flask** using the pipette, followed by a couple of drops of indicator.

The first titration is a **rough titration** – the acid is added from the burette 1 cm³ at a time until the end-point. This gives an estimate of the volume of acid required in the reaction.

Using the **rough titration** reading, acid is run into alkali until 1.00 cm³ before the end-point for the rough titration and then add the solution drop-by-drop to give an **accurate** titre.

This is repeated until you get two results which are within 0.10 cm³ of each other.

After the rough titration it is good practice to start the next titration where you stopped last time. This means that in the example above we start at 19.00 cm³ and not at 0.00. This saves time and materials.

Note that the recording of results is a very important part of titrations. You need a column for your rough titration and columns for each accurate titration.

CHECKIT!

- Name the main apparatus used for a titration.
- What is a rough titration?
- How can you tell when enough acid has been added to the alkali?
- In a titration experiment four accurate results were obtained: 24.20 cm³, 24.50 cm³, 24.60 cm³ and 25.80 cm³.
 - Which results are rejected?
 - What is the average titre for the experiment?