National 5 Chemistry

Self-Evaluation

Name: ……………………………………………………………………………

Class: ………………

Teacher: ………………………………

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JAB chem

National 5 Chemistry
Unit 1.1 Reaction Rates

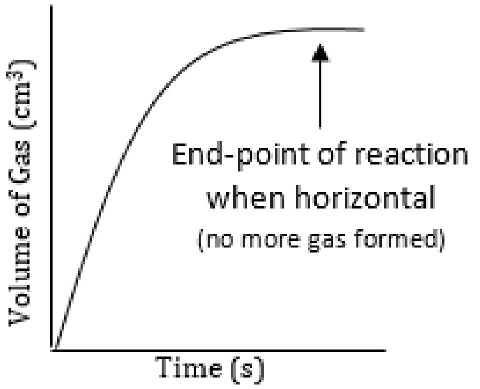
JAB chem

Lesson	Traffic Light		
	Red	Amber	Green

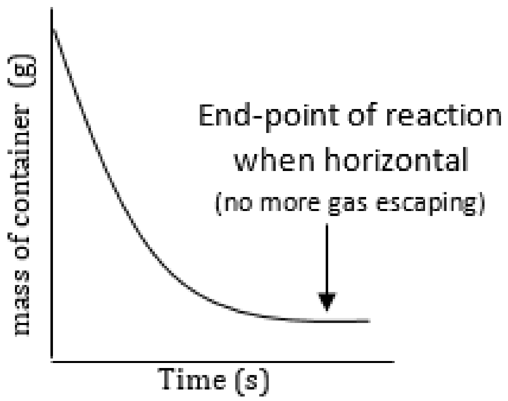
1

Progress of chemical reactions through changes in mass and volume can be measured.

quantity of product increases as reaction proceeds



quantity of reactant decreases as reaction proceeds

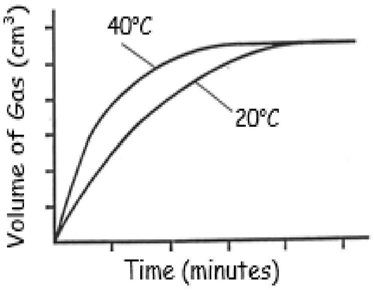


☹ 😐 ☺

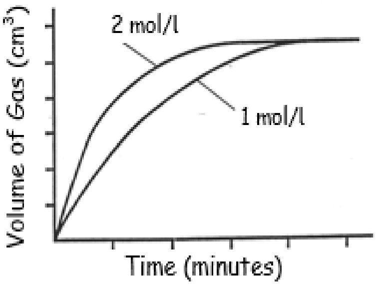
2a 2b 2c

Rates of reaction can be increased:

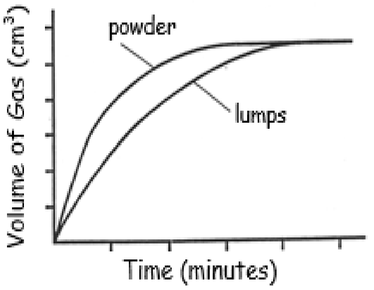
by increasing the temperature



by increasing the concentration of a reactant



by increasing surface area or decreasing particle size



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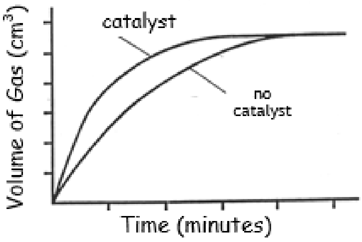
2d 3

Rates of reaction can be increased by adding a catalyst

- Catalysts speed up chemical reactions
- Catalysts can be recovered chemically unchanged at the end of the reaction.
  - Same mass of catalyst at start & end of experiment



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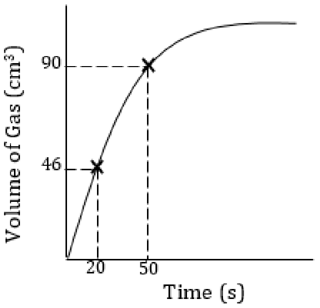
4

The average rate of a chemical reaction can be calculated from initial & final quantities and the time interval. The units of rate can also be worked out.

$$\text{Rate} = \frac{\Delta\text{quantity}}{\Delta\text{time}} = \frac{90 - 46}{50 - 20} = \frac{44}{30} = 1.47\ \text{cm}^3\ \text{s}^{-1}$$



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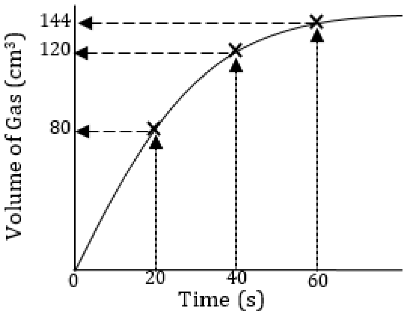
5

The rate of a reaction can be shown to decrease over time by calculating the average rate at different stages of the reaction.

Time Interval:	0-20s	20-40s	40-60s
Rate Equation:	$\text{Rate} = \frac{\Delta\text{quantity}}{\Delta\text{time}}$	$\text{Rate} = \frac{\Delta\text{quantity}}{\Delta\text{time}}$	$\text{Rate} = \frac{\Delta\text{quantity}}{\Delta\text{time}}$
Insert Numbers:	$\text{Rate} = \frac{80 - 0}{20 - 0}$	$\text{Rate} = \frac{120 - 80}{40 - 20}$	$\text{Rate} = \frac{144 - 120}{60 - 40}$
Subtraction:	$\text{Rate} = \frac{80}{20}$	$\text{Rate} = \frac{40}{20}$	$\text{Rate} = \frac{24}{20}$
Answer:	Rate = 4.0 $\text{cm}^3\ \text{s}^{-1}$	Rate = 2.0 $\text{cm}^3\ \text{s}^{-1}$	Rate = 1.2 $\text{cm}^3\ \text{s}^{-1}$



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National 5 Chemistry
Unit 1.2a Periodic Table and Atoms

Lesson | Traffic Light: Red | Amber | Green

6 7

The elements of the Periodic Table are arranged in order of increasing atomic number:

- Metal elements are on the left side and non-metals elements are found on the right side
- Groups (columns) on the Periodic Table contain elements with same number of outer electrons, indicated by the group number on the Periodic Table

☹ 😐 ☺

8

Elements within the same group have the same valency and have similar chemical properties as they have the same number of electrons in their outer electron shell.

Group Number	1	2	3	4	5	6	7	0
Valency	1	2	3	4	3	2	1	0

☹ 😐 ☺

9

The electron arrangement of the first 20 elements can be written.

1st Energy Level holds	2nd Energy Level holds	3rd Energy Level holds	4th Energy Level holds
2 electrons	8 electrons	8 electrons	8 electrons

Electrons Arrangements of the first 20 elements are found on page 6 of the data booklet

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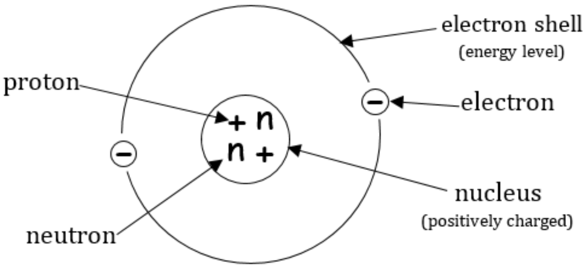
10

Every element is made up of very small particles called atoms.

- each atom has a nucleus contains protons and neutrons
- electrons move around the outside of the nucleus.



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11

Particle	Location	Charge	Mass
Proton	Nucleus	+1	1 amu
Neutron	Nucleus	Neutral	1 amu
Electron	Outside Nucleus	-1	Approx zero

☹ 😐 ☺

12

The **atomic number** of an element is equal to the number of protons.
Atoms are *neutral* because atoms have the same numbers of protons and electrons

☹ 😐 ☺

13

The **mass number** of an atom is equal to the number of protons plus neutrons

☹ 😐 ☺

14

Isotopes are atoms of the same element which have:

- the *same* atomic number but a *different* mass numbers
- the *same* number of protons but a *different* number of neutrons

Most elements have more than one isotope and an element is a mixture of the different isotopes

☹ 😐 ☺

15a

mass number → 23
atomic number → 11
$^{23}_{11}\text{Na}$ ← symbol

The number of protons, neutrons and electrons can be found from the atomic no. and mass no.

Number of protons = atomic number = 11
Number of neutrons = mass number – atomic number = 23 – 11 = 12
Number of electrons = number of protons (for neutral atoms only) = 11

☹ 😐 ☺

15b

mass number → 18
atomic number → 8
$^{18}_{8}\text{O}^{2-}$ ← charge ← symbol

The number of protons, neutrons and electrons can be found from the atomic no. and mass no.

Number of protons = atomic number = 8
Number of neutrons = mass number – atomic number = 18 – 8 = 10
Number of electrons = number of protons – charge = 8 – (-2) = 10

☹ 😐 ☺

16

Relative atomic mass is the average atomic mass of all the isotopes of an element

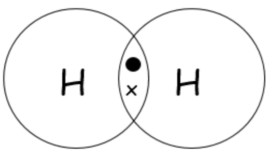
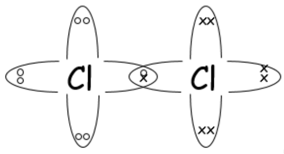
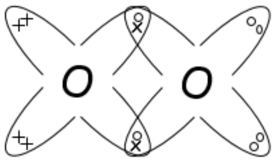
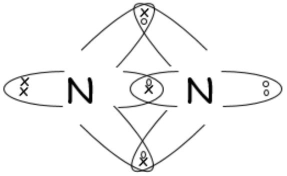
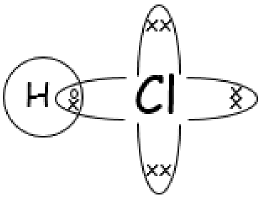
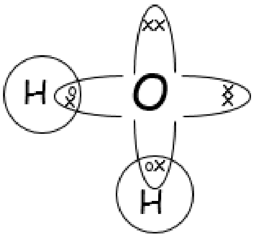
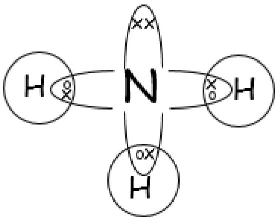
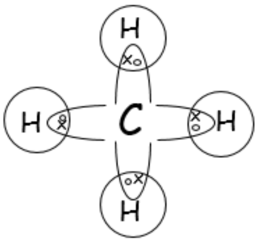
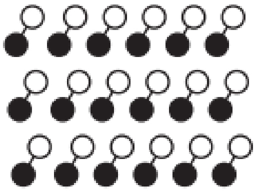
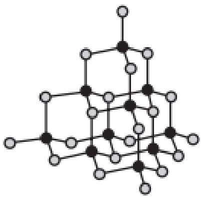
- RAM is rarely a whole number because it an average of different masses

e.g. The RAM of Chlorine is 35.5 (The two chlorine isotopes are ^{35}Cl and ^{37}Cl)
As RAM is closer to 35 than 37 there must be more ^{35}Cl atoms in sample than ^{37}Cl atoms

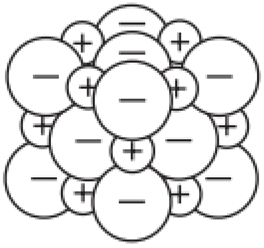
☹ 😐 ☺

<table>
<tr><td></td><td>JAB chem

National 5 Chemistry
Unit 1.2b Covalent Bonding

JAB chem</td><td>Lesson</td><td colspan="3">Traffic Light</td></tr>
<tr><td></td><td></td><td></td><td>Red</td><td>Amber</td><td>Green</td></tr>
<tr><td>17
18</td><td>A covalent bond forms when two positive nuclei are held together by their common attraction for a shared pair of electrons.
• Covalent bonds form between non-metal atoms.</td><td></td><td>☹</td><td>😐</td><td>☺</td></tr>
<tr><td>19
22</td><td>Outer electrons can be shared to form the covalent bond(s) in a molecule.
• More than one bond can be formed between atoms leading to double & triple covalent bonds.
<table>
<tr><td>Hydrogen molecule H_2</td><td>Hydrogen molecule Cl_2</td><td>Oxygen molecule O_2</td><td>Nitrogen molecule N_2</td></tr>
<tr><td> </td><td> </td><td> </td><td> </td></tr>
<tr><td>$H-H$</td><td>$Cl-Cl$</td><td>$O=O$</td><td>$N\equiv N$</td></tr>
</table></td><td></td><td>☹</td><td>😐</td><td>☺</td></tr>
<tr><td>20</td><td>7 elements exist as diatomic molecules through the formation of covalent bonds:
<table><tr><td>Diatomic Elements</td><td>H_2</td><td>N_2</td><td>O_2</td><td>F_2</td><td>Cl_2</td><td>Br_2</td><td>I_2</td></tr></table></td><td></td><td>☹</td><td>😐</td><td>☺</td></tr>
<tr><td>21</td><td>The shape of simple covalent molecules depends on the number of bonds and the orientation of these bonds around the central atom.
• The shape of molecules can be described as linear, angular, trigonal pyramidal or tetrahedral.
<table>
<tr><td>Hydrogen chloride
HCl</td><td>Water
H_2O</td><td>Ammonia
NH_3</td><td>Methane
CH_4</td></tr>
<tr><td> </td><td> </td><td> </td><td> </td></tr>
<tr><td>linear</td><td>angular</td><td>trigonal pyramidal</td><td>tetrahedral</td></tr>
</table></td><td></td><td>☹</td><td>😐</td><td>☺</td></tr>
<tr><td>23</td><td>Covalent substances can form either discrete molecular or giant network structures</td><td></td><td>☹</td><td>😐</td><td>☺</td></tr>
<tr><td>24</td><td>Covalent molecular substances:
• have strong covalent bonds within the molecules and only weak attractions between the molecules
• have low melting and boiling points as only weak forces of attraction between the molecules are broken when a substance changes state
• do not conduct electricity because they do not have charged particles which are free to move
</td><td></td><td>☹</td><td>😐</td><td>☺</td></tr>
<tr><td>25</td><td>Covalent molecular substances which are insoluble in water may dissolve in other solvents.</td><td></td><td>☹</td><td>😐</td><td>☺</td></tr>
<tr><td>26</td><td>Covalent network structures:
• have a network of strong covalent bonds within one giant structure
• have very high melting and boiling points because the network of strong covalent bonds is not easily broken
• do not dissolve
</td><td></td><td>☹</td><td>😐</td><td>☺</td></tr>
<tr><td>27</td><td>In general, covalent network substances do not conduct electricity. This is because they do not have charged particles which are free to move.</td><td></td><td>☹</td><td>😐</td><td>☺</td></tr>
</table>

National 5 Chemistry
Unit 1.2c Ionic Bonding

		Lesson	Traffic Light		
			Red	Amber	Green
28	Ions are formed when atoms lose or gain electrons to obtain the stable electron arrangement of a noble gas.		☹	😐	☺
29 30	In general: Metal atoms lose electrons to form positive ions $\underset{2,8,1}{Na} \longrightarrow \underset{2,8}{Na^+} + e^-$ Non-metal atoms gain electrons to form negative ions $\underset{2,8,7}{Cl} + e^- \longrightarrow \underset{2,8,8}{Cl^-}$		☹	😐	☺
31	Ionic bonds are the electrostatic attraction between positive and negative ions.		☹	😐	☺
32	 Ionic compounds form lattice structures of oppositely charged ions with each positive ion surrounded by negative ions and each negative ion surrounded by positive ions.		☹	😐	☺
33	Ionic compounds have high melting and boiling points because strong ionic bonds must be broken in order to break up the lattice.		☹	😐	☺
34	Many ionic compounds are soluble in water. As they dissolve the lattice structure breaks up allowing water molecules to surround the separated ions.		☹	😐	☺
35	Ionic compounds conduct electricity only when molten or in solution as the lattice structure breaks up allowing the ions to be free to move.		☹	😐	☺
36	Conduction in ionic compounds can be explained by the movement of ions towards oppositely charged electrodes.		☹	😐	☺

Type of Bonding	Conduction as a Solid	Conduction as a Liquid	Conduction as a Solution
Metallic (Metals only)	✓	✓	metals do not dissolve in water
Covalent (Non-metals only)	×	×	×
Ionic (Metals + Non-metals)	×	✓	✓

National 5 Chemistry
Unit 1.3a Chemical Formulae

		Lesson	Traffic Light		
			Red	Amber	Green

37 Compound names are derived from the names of the elements from which they are formed.

Ending	Meaning	Example
-ide	2 elements in compound	Copper sulphide = copper + sulphur
-ate	2 elements in compound + oxygen	Copper sulphate = copper + sulphur + oxygen
-ite	2 elements in compound + oxygen	Sodium sulphite = sodium + sulphur + oxygen

☹ 😐 ☺

38 Chemical formulae can be written for two element compounds using valency rules and a Periodic Table.

- The valency of an element is worked out from the group number:

Group Number	1	2	3	4	5	6	7	0
Valency	1	2	3	4	3	2	1	0

- The formula of a simple 2-element compound is worked out by the cross-over rule:

Write down element symbols	Write down Valency below each element's symbol	Put in Cross-over Arrows	Follow arrows and cancel down if necessary to get formula
Si O	Si O 4 2	Si O ╳ 4 2	Si_2O_4 ↓ SiO_2

☹ 😐 ☺

39 Roman numerals in the name of a compound indicate the valency of an element.

Roman Numeral	I	II	III	IV	V	VI	VII
Valency	1	2	3	4	5	6	7

The cross over rule is followed as usual once the valency of the metal has been worked out from the roman numeral

☹ 😐 ☺

40 The chemical formula can also be determined from names with prefixes.

Compound	carbon **mono**xide	carbon **di**oxide	sulphur **tri**oxide	carbon **tetra**chloride
Formula	CO	CO_2	SO_3	CCl_4
Meaning	Mono = 1	Di = 2	Tri = 3	Tetra = 4

☹ 😐 ☺

41 The chemical formula of a covalent molecular substance gives the number of each type of atom present in a molecule.

- The formula of a covalent network gives the simplest ratio of each type of atom in the substance.

☹ 😐 ☺

42 Ions containing more than one type of atom are often referred to as group ions.

☹ 😐 ☺

43 Chemical formulae can be written for compounds containing group ions

- The valency of a group ion can be worked out from the charge of the ion

Write down element symbols	Write down Valency below each element's symbol	Put in Cross-over Arrows	Follow arrows and cancel down if necessary to get formula
Al SO_4^{2-}	Al SO_4^{2-} 3 2	Al SO_4^{2-} ╳ 3 2	$Al_2(SO_4)_3$

☹ 😐 ☺

44
45 Ionic formulae give the simplest ratio of each type of ion in the substance and can show the charges on each ion, if required.

- charges must be superscript and numbers of atoms/ions must be subscript

Work out the formula of the substance	Work out the ion formed by the metal	Work out the ion of the non-metal/group ion	Put the ion in brackets if there is more than one of that ion to get ionic formula
$Al_2(SO_4)_3$	Al^{3+}	SO_4^{2-}	$(Al^{3+})_2(SO_4^{2-})_3$

☹ 😐 ☺

National 5 Chemistry
Unit 1.3b Mole Calculations & Balanced Equations

Lesson | Traffic Light: Red | Amber | Green

46

Chemical equations, using formulae and state symbols, can be written and balanced.

Write down correct chemical formula of all reactants before the arrow and all products after the arrow.

$$Na_{(s)} + O_{2(g)} \longrightarrow Na_2O_{(s)}$$

There are 2 oxygen atoms on left hand side but only 1 oxygen atom on right hand side. As the formula of Na_2O cannot be changed, double the number of Na_2O molecules by adding the number 2 *in front* of the formula

$$Na_{(s)} + O_{2(g)} \longrightarrow 2Na_2O_{(s)}$$

There is 1 sodium atom on the LHS but 4 sodium atoms on the RHS. As the formulae of Na and Na_2O are set and cannot be changed, we must add the number 4 in front of the Na on the LHS to balance the number of Na atoms

$$4Na_{(s)} + O_{2(g)} \longrightarrow 2Na_2O_{(s)}$$

☹ 😐 ☺

47

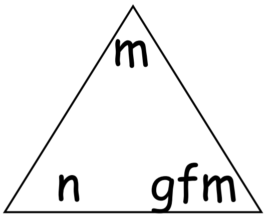
The mass of a mole of any substance, in grams, is equal to the gram formula mass and can be calculated using relative atomic masses. e.g. calculate the gfm of glucose $C_6H_{12}O_6$.

Write Element Symbol	Number of each atom from formula		Relative Atomic Mass (p7 data book)		Total
C	6	x	12	=	72
H	12	x	1	=	12
O	6	x	16	=	96
			gfm	=	180

☹ 😐 ☺

48a

Calculations can be performed using the relationship between the mass and the number of moles of a substance.



m = mass	n = no. of moles	GFM = gram formula mass
$m = n \times gfm$	$n = \frac{m}{gfm}$	$gfm = \frac{m}{n}$

☹ 😐 ☺

48b

Changing number of moles → number of grams

e.g. Calculate the number of moles in 3.6g of water.

Calculate the gfm of H_2O

H	2	x	1	=	2
O	1	x	16	=	16
			gfm	=	18g

then

$$\text{no. of mol} = \frac{\text{mass}}{\text{gfm}}$$

$$= \frac{3.6}{18}$$

$$= \mathbf{0.2mol}$$

☹ 😐 ☺

48c

Changing number of grams → number of moles

e.g. calculate the mass if 0.1 moles of CO_2

Calculate the gfm of CO_2

C	1	x	12	=	12
O	2	x	16	=	32
			gfm	=	44g

then

mass = no. of mol x gfm

= 0.1 x 44

= **4.4g**

☹ 😐 ☺

49

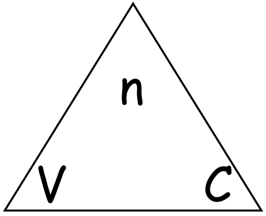
A solution is formed when a solute is dissolved in a solvent.

Name	Definition
solution	a mixture formed when a solute dissolves in a solvent
solute	The substance that is dissolved
solvent	The liquid that does the dissolving

☹ 😐 ☺

50

The number of moles of solute, volume of solution and concentration of solution can be calculated using the equation:



$$n = C \times V$$

no. of moles = **Concentration** x **volume**

(mol) (mol l^{-1}) (litres)

$$n = V \times C \qquad C = \frac{mol}{V} \qquad V = \frac{mol}{C}$$

☹ 😐 ☺

<table>
<tr>
<td>51</td>
<td>Given a balanced equation, the mass or number of moles of a substance can be calculated given the mass or number of moles of another substance in the reaction.
e.g. calculate the mass of carbon dioxide produced if 5g of calcium carbonate reacts with
gfm $CaCO_3$
Ca 1 x 40 = 40
C 1 x 12 = 12
O 3 x 16 = 46
gfm = 100g
gfm CO_2
C 1 x 12 = 12
O 2 x 16 = 32
gfm = 44g
$n= \frac{m}{gfm} = \frac{5}{100} = 0.05mol$
$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$
1mol 2mol 1mol 1mol 1mol
0.05mol 0.05mol
m = n x gfm
= 0.05 X 44
= 2.2g</td>
<td></td>
<td>☹</td>
<td>😐</td>
<td>☺</td>
</tr>
<tr>
<td>52</td>
<td>The percentage composition of an element in any compound can be calculated from the formula of the compound.
<table>
<tr><th>Calculate mass of 1 mole</th><th>Find mass of element</th><th>Percentage Fe in Fe_2O_3 calculation</th></tr>
<tr><td>Fe_2O_3 = (2x56) + (3x16)
= 112 + 48
= 160g</td><td>2 x Fe = (2x56)
= 112g</td><td>$\frac{112g}{160g}$ x 100 = 70%</td></tr>
</table></td>
<td></td>
<td>☹</td>
<td>😐</td>
<td>☺</td>
</tr>
</table>

National 5 Chemistry
Unit 1.4a pH

		Lesson	Traffic Light		
			Red	Amber	Green
53	The pH scale is a continuous range of numbers: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 ← Acidic solutions → (0–6) neutral (7) ← Alkaline solutions → (8–14) • the pH scale runs from 0 to 14 • it is possible to get pH values below 0 and above 14		☹	😐	☺
55 56	Water is neutral as it dissociates according to the equation: $H_2O_{(l)} \rightleftharpoons H^+_{(aq)} + OH^-_{(aq)}$ • dissociation produces equal concentrations of hydrogen H^+ ions & hydroxide OH^- ions. • At any time, only a few water molecules are dissociated into free ions. • The symbol $\rightleftharpoons$ indicates that a reaction is reversible and occurs in both directions.		☹	😐	☺
54 57 58	The acidity, alkalinity and neutral nature of a solution depends on H^+ and OH^- ions. • a <u>neutral</u> solution has equal concentrations of $H^+_{(aq)}$ and $OH^-_{(aq)}$ ions. • <u>acidic</u> solutions have a higher concentration of $H^+_{(aq)}$ ions than $OH^-_{(aq)}$ and have a pH below 7. • <u>alkaline</u> solutions have a higher concentration of $OH^-_{(aq)}$ ions than $H^+_{(aq)}$ ions and have a pH above 7.		☹	😐	☺
59 60	The pH of a acidic/alkaline solution heads towards pH=7 when diluted with water: • dilution of an acidic solution with water will decrease the concentration of $H^+_{(aq)}$ and the pH will increase towards 7. • dilution of an alkaline solution with water will decrease the concentration of $OH^-_{(aq)}$ and the pH will decrease towards 7.		☹	😐	☺
61	Soluble *non-metal* oxides dissolve in water forming acidic solutions e.g. CO_2, NO_2 and SO_2		☹	😐	☺
62	Soluble *metal* oxides dissolve in water to form alkaline solutions: metal oxide + water → metal hydroxide		☹	😐	☺
63	Metal oxides, metal hydroxides, metal carbonates & ammonia neutralise acids and are called bases. • only bases that dissolve in water form alkaline solutions • all bases neutralise acids and form water.		☹	😐	☺

National 5 Chemistry
Unit 1.4b Neutralisation Reactions

Lesson | Traffic Light: Red, Amber, Green

64 A neutralisation reaction is one in which a base reacts with an acid to form water.
- A salt is also formed in this reaction.

☹ 😐 ☺

65a Hydrogen ions in acids react with oxide ions in metal oxides to form water

$$\text{acid} + \text{metal oxide} \longrightarrow \text{salt} + \text{water}$$

☹ 😐 ☺

65b Hydrogen ions in acids react with hydroxide ions in alkalis to form water.

$$\text{acid} + \underset{\text{(alkali)}}{\text{metal hydroxide}} \longrightarrow \text{salt} + \text{water}$$

☹ 😐 ☺

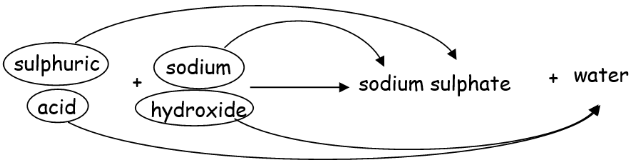
65c H^+ ions in acids react with carbonate ions in metal carbonates to form water and carbon dioxide.

$$\text{acid} + \text{metal carbonate} \longrightarrow \text{salt} + \text{water} + \text{carbon dioxide}$$

☹ 😐 ☺

66 Salts are formed in the reaction of acids with bases.
- *acids* supply the 2nd name of the salt:

Name of Acid	Hydrochloric acid	Sulphuric Acid	Nitric Acid
2nd Name of Salt	Chloride	Sulphate	Nitrate



☹ 😐 ☺

67 Spectator ions can be identified and the equations can be rewritten omitting these ions:

$$\text{sodium hydroxide} + \text{sulphuric acid} \rightarrow \text{sodium sulphate} + \text{Water}$$

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + H_2O$$

Rewrite to include all ions separately

$$2Na^+ + 2OH^- + 2H^+ + SO_4^{2-} \rightarrow 2Na^+ + SO_4^{2-} + 2H_2O$$

Cancel out any spectator ions which appear on both sides

$$\cancel{2Na^+} + 2OH^- + 2H^+ + \cancel{SO_4^{2-}} \rightarrow \cancel{2Na^+} + \cancel{SO_4^{2-}} + 2H_2O$$

Re-write equation omitting spectator ions

$$2OH^- + 2H^+ \rightarrow 2H_2O$$

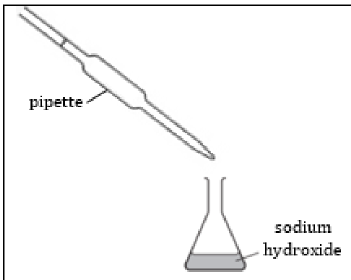
☹ 😐 ☺

68 For neutralisation reactions, equations can be written omitting spectator ions:

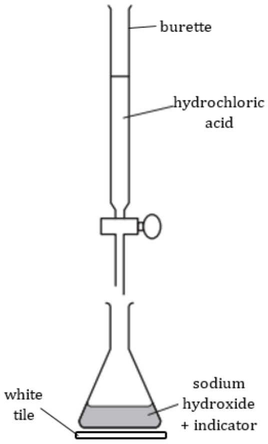
For metal oxides	$2H^+_{(aq)} + O^{2-}_{(aq)} \longrightarrow H_2O_{(l)}$
for metal hydroxides	$H^+_{(aq)} + OH^-_{(aq)} \longrightarrow H_2O_{(l)}$
for aqueous metal carbonates	$2H^+_{(aq)} + CO_3^{2-}{}_{(aq)} \longrightarrow H_2O_{(l)} + CO_{2(g)}$
for insoluble metal carbonates	$2H^+_{(aq)} + CO_3^{2-}{}_{(s)} \longrightarrow H_2O_{(l)} + CO_{2(g)}$

☹ 😐 ☺

69 In an acid-base titration, the concentration of the acid or base is determined by accurately measuring the volumes used in the neutralisation reaction.
- an indicator can be added to show the end-point of the reaction.



Pipettes are used to transfer exact quantities of solutions. The line towards the top of the pipette shows where the solution should be taken up to using a pipette filler for safety.



The burette is filled with hydrochloric acid of a known concentration and the volume of the hydrochloric acid in the burette is recorded (at the bottom of the meniscus). Hydrochloric acid is added from the burette into the flask until the colour in the flask changes. The final volume is recorded.
- The first titration is done in a way to work out the rough volume where the colour change takes place.
- Subsequent titrations involve the initial transfer of most of the volume from the rough titration is added initially then hydrochloric acid is added drop by drop until the colour changes
- The titration is repeated until at least two results are obtained within 0.2cm^3 of each other

The average volume is taken and then used to work out the number of moles of hydrochloric acid from the average volume and the already known concentration

☹ 😐 ☺

70

Given a balanced equation for the reaction occurring in any titration:

- the concentration of one reactant can be calculated given the concentration of the other reactant and the volumes of both solutions

e.g. A 50·0 cm^3 sample of contaminated water containing chromate ions was titrated and found to require 27·4 cm^3 of 0·0200 mol l^{-1} iron(II) sulphate solution to reach the end-point.
Calculate the chromate ion concentration, in mol l^{-1}, present in the sample of water.

no of mol Fe^{2+} = volume x concentration = 0.0274 x 0.02 = 5.48x10^{-4} mol

$$\underset{\substack{3\text{mol} \\ 5.48\text{x}10^{-4}\text{mol}}}{3Fe^{2+}} + \underset{\substack{1\text{mol} \\ 1.83\text{x}10^{-4}\text{mol}}}{CrO_4^{2-}} + 8H^+ \longrightarrow 3Fe^{3+} + Cr^{3+} + 4H_2O$$

$$\textbf{c}\text{oncentration} = \frac{\textbf{n}\text{o of mol}}{\textbf{v}\text{olume}} = \frac{1.83\text{x}10^{-4}\text{ mol}}{0.05\text{ litres}} = 3.65\text{x}10^{-3}\text{ mol l}^{-1}$$

- the volume of one reactant can be calculated given the volume of the other reactant and the concentrations of both solutions

e.g. calculate the volume of 0.1mol l^{-1} sodium hydroxide required to neutralise 25cm^3 of 0. 2mol l^{-1} sulphuric acid.

$$\begin{array}{ccccccccccc}
\multicolumn{5}{c}{\longleftarrow \text{Sulphuric acid} \longrightarrow} & & \multicolumn{5}{c}{\longleftarrow \text{Sodium hydroxide} \longrightarrow} \\
\underset{\text{volume}}{V} & \text{x} & \underset{\text{concentration}}{C} & \text{x} & \underset{\text{power}}{P} & = & \underset{\text{volume}}{V} & \text{x} & \underset{\text{concentration}}{C} & \text{x} & \underset{\text{power}}{P} \\
25 & \text{x} & 0.2 & \text{x} & 2 & = & V & \text{x} & 0.1 & \text{x} & 1 \\
 & & & & 10 & = & V & \text{x} & 0.1 & & \\
 & & & & {}^{10}/_{0.1} & = & V & & & & \\
 & & & & 100\text{cm}^3 & = & V & & & &
\end{array}$$

NB: Acids & Alkalis have a power based on the number of H^+ or OH^- ions in the formula:

Acid	Formula	Power
Hydrochloric acid	HCl	1
Sulphuric Acid	H_2SO_4	2
Nitric Acid	HNO_3	1

Alkali	Formula	Power
Sodium hydroxide	$NaOH$	1
Potassium hydroxide	KOH	1
Calcium hydroxide	$Ca(OH)_2$	2

☹ 😐 ☺

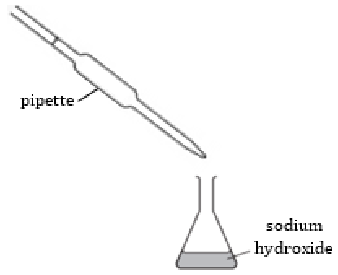
National 5 Chemistry
Unit 1.4c Preparation of Salts by Neutralisation

Lesson

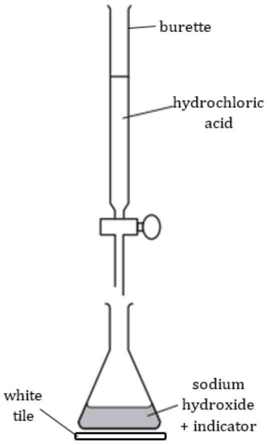
Traffic Light: Red Amber Green

74

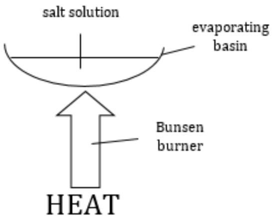
Titration can be used to produce a soluble salt. Once the volumes of acid and alkali have been noted, the reaction can be repeated without the indicator to produce an uncontaminated salt solution. The solution can then be evaporated to dryness.



A pipette and pipette filler is used to transfer an exact quantity of sodium hydroxide to a conical flask.



Hydrochloric acid is transferred from a burette to the conical flask until the exact moment where the colour of the indicator changes. Have recorded both the starting and final volumes of hydrochloric acid, the titration can be repeated exactly without indicator to obtain a pure sample of the salt solution formed.
The salt solution can then be evaporated to obtained a pure sample of the salt being produced.



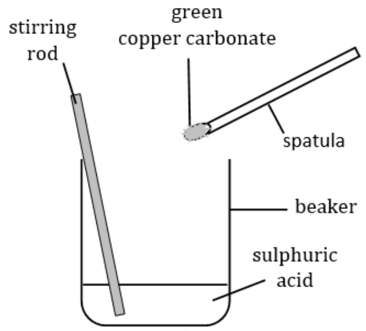
☹ 😐 ☺

75
76

Insoluble metal carbonates and insoluble metal oxides can be used to produce soluble salts.

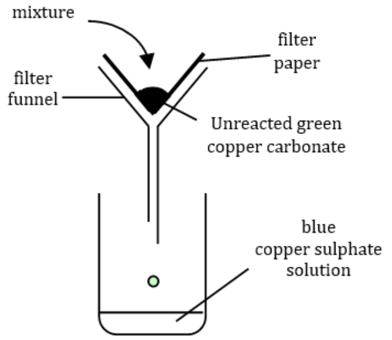
- excess base is added to the appropriate acid, the mixture is filtered and the filtrate evaporated to dryness.

1. <u>Neutralisation</u>



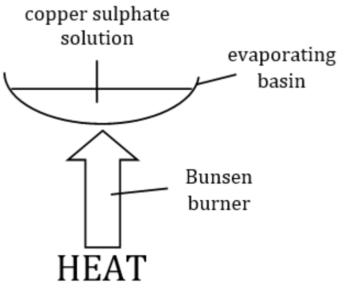
○ Insoluble metal carbonate (or metal oxide) is used to neutralise the acid.
○ When all acid has been neutralised, some excess carbonate or oxide will lie on the bottom of the beaker

2. <u>Filtration</u>



○ Excess metal carbonate (or metal oxide) is removed from the solution by fitration
○ The *residue* in the filter paper is unreacted metal carbonate (or metal oxide)
○ The filtrate in beaker is the solution of salt you are making

3. <u>Evaporation</u>

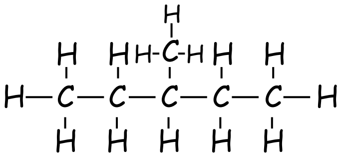
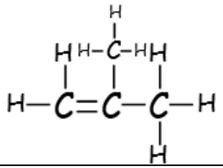
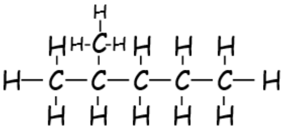
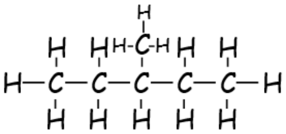
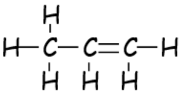
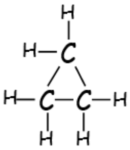
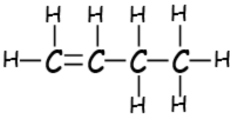
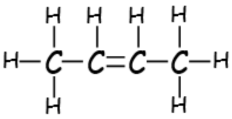
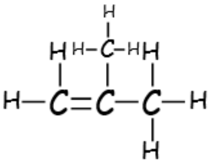
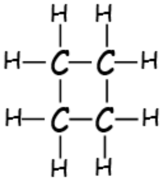
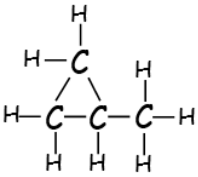


○ The salt solution can be returned to the solid salt by evaporating the water

☹ 😐 ☺

<table>
<tr><th></th><th>

National 5 Chemistry
Unit 2.1 Naming and Drawing Hydrocarbons

</th><th>Lesson</th><th colspan="3">Traffic Light</th></tr>
<tr><th></th><th></th><th></th><th>Red</th><th>Amber</th><th>Green</th></tr>
<tr><td>1</td><td>A homologous series is a family of compounds with
• same general formula
• similar chemical properties.</td><td></td><td>☹</td><td>😐</td><td>☺</td></tr>
<tr><td>2</td><td>Patterns are often seen in the physical properties of the members of a homologous series.
• Physical properties include melting points, boiling points, solubility
Melting & boiling points increase as the size of molecule increases for any homologous series
• These changes in physical properties are due the strength of the intermolecular forces between the molecules.
• As size of molecule increases, the strength of the intermolecular forces increases</td><td></td><td>☹</td><td>😐</td><td>☺</td></tr>
<tr><td>3</td><td>Hydrocarbons are compounds containing only hydrogen and carbon atoms
• alkanes, alkenes and cycloalkanes are examples of homologous series</td><td></td><td>☹</td><td>😐</td><td>☺</td></tr>
<tr><td>4</td><td>Compounds containing only carbon–carbon single bonds are described as saturated.
• Alkanes and cycloalkanes are saturated hydrocarbons
Compounds containing at least one carbon–carbon double bond are described as unsaturated.
• Alkenes are unsaturated hydrocarbons</td><td></td><td>☹</td><td>😐</td><td>☺</td></tr>
<tr><td>5</td><td>It is possible to distinguish an unsaturated compound from a saturated compound using bromine solution.
• Unsaturated compounds decolourise bromine solution quickly e.g. alkenes
• Saturated compounds do not decolourise bromine solution quickly e.g. alkanes and cycloalkanes</td><td></td><td>☹</td><td>😐</td><td>☺</td></tr>
<tr><td>6a</td><td>The structure of any molecule can be drawn as a full or a shortened structural formula.
<table>
<tr><td>Full Structural Formula</td><td></td><td></td></tr>
<tr><td>Shortened Structural Formula</td><td>$CH_3CH_2CH(CH_3)CH_2CH_3$</td><td>$CH_2{=}C(CH_3)CH_3$</td></tr>
</table></td><td></td><td>☹</td><td>😐</td><td>☺</td></tr>
<tr><td>6b</td><td>Isomers are compounds with:
• same molecular formula but different structural formulae

2-methylpentane C_6H_{14}

3-methylpentane C_6H_{14}
• may belong to different homologous series e.g. alkenes and cycloalkanes

propene C_3H_6

cyclopropane C_3H_6
• usually have different physical properties e.g. alkenes decolourise bromine solution</td><td></td><td>☹</td><td>😐</td><td>☺</td></tr>
<tr><td>7</td><td>Given a structural formula for a compound, an isomer can be drawn.
Isomers can be drawn for a given molecular formula.
<table>
<tr><th>C_4H_8</th><th>C_4H_8</th><th>C_4H_8</th><th>C_4H_8</th><th>C_4H_8</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>but-1-ene</td><td>but-2-ene</td><td>2-methylpropene</td><td>cyclobutane</td><td>methylcyclopropane</td></tr>
</table></td><td></td><td>☹</td><td>😐</td><td>☺</td></tr>
</table>

National 5 Chemistry
Unit 2.1b Alkanes

Lesson | Traffic Light: Red, Amber, Green

8

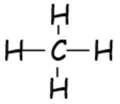
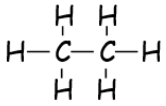
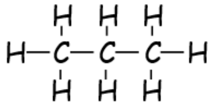
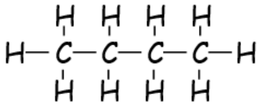
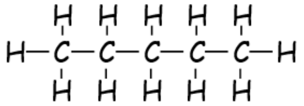
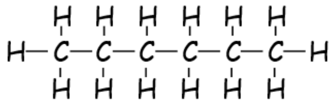
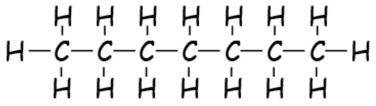
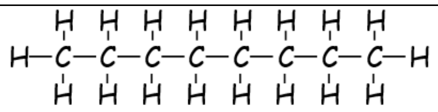
Alkanes are a homologous series of saturated hydrocarbons (saturated means single bonds only)

- are commonly used as fuels
- are insoluble in water
- can be represented by the general formula C_nH_{2n+2}

☹ 😐 ☺

9a
10a

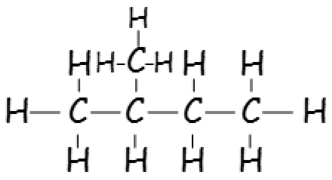
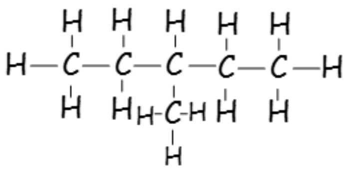
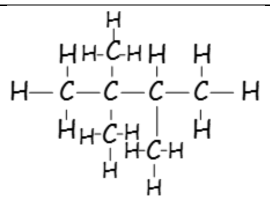
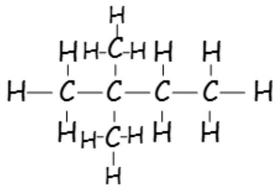
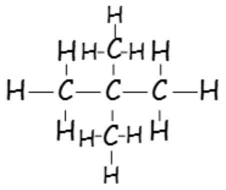
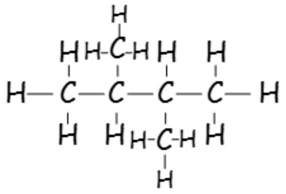
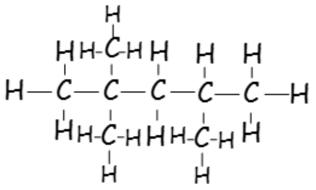
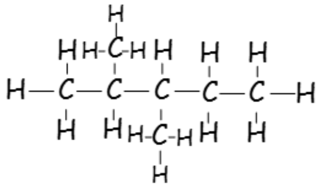
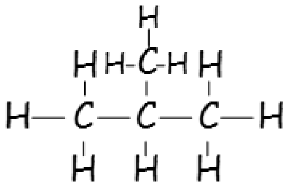
Alkanes with straight chains have the following structure:

Alkane	Molecular Formula	Shortened Formula	Structural Formula
Methane	CH_4	CH_4	
Ethane	C_2H_6	CH_3CH_3	
Propane	C_3H_8	$CH_3CH_2CH_3$	
Butane	C_4H_{10}	$CH_3CH_2CH_2CH_3$	
Pentane	C_5H_{12}	$CH_3CH_2CH_2CH_2CH_3$	
Hexane	C_6H_{14}	$CH_3CH_2CH_2CH_2CH_2CH_3$	
Heptane	C_7H_{16}	$CH_3CH_2CH_2CH_2CH_2CH_2CH_3$	
Octane	C_8H_{18}	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_3$	

☹ 😐 ☺

9b
10b

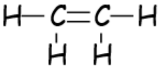
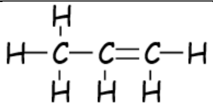
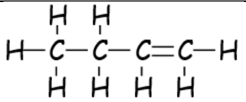
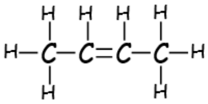
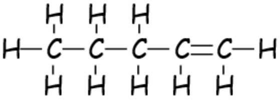
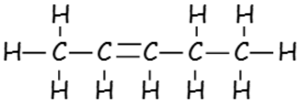
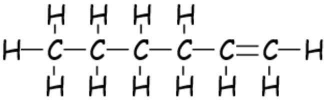
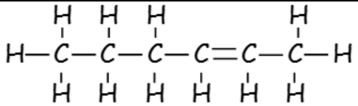
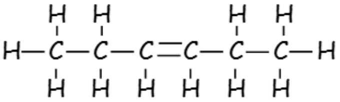
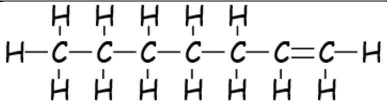
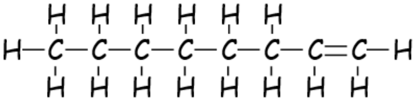
Alkanes can also have a branched chain structure. Some examples include:

 2-methylbutane	 3-methylpentane	 2,2,3-trimethylbutane
 2,2-dimethylbutane	 2,2-dimethylpropane	 2,3-dimethylbutane
 2,2,4-trimethylpentane	 2,3-dimethylpentane	 2-methylpropane

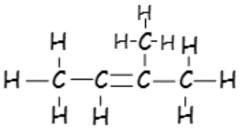
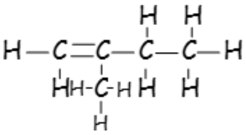
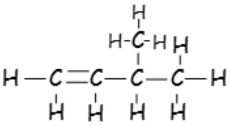
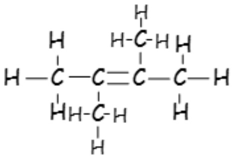
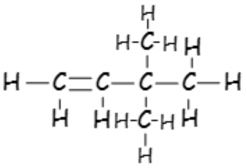
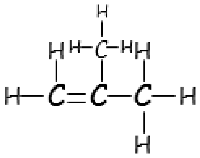
☹ 😐 ☺

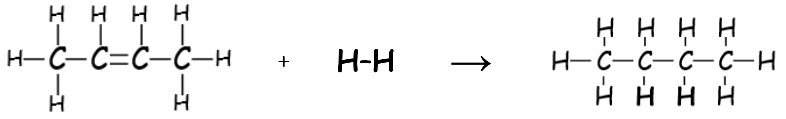
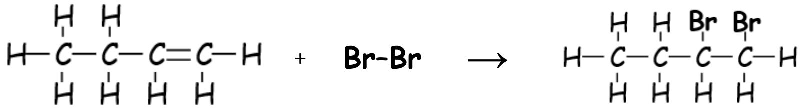
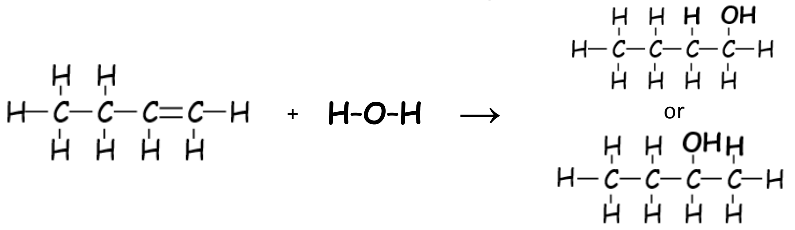
National 5 Chemistry
Unit 2.1c Alkenes

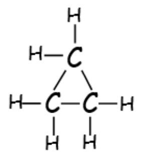
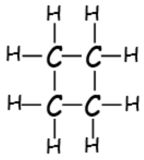
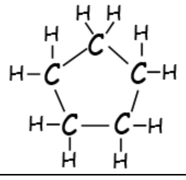
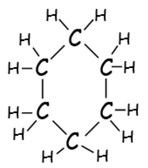
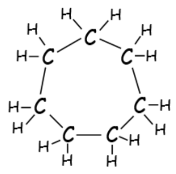
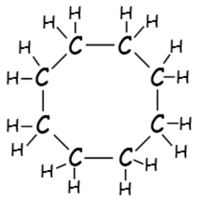
Lesson		Red	Amber	Green
11	Alkenes are a homologous series of unsaturated hydrocarbons (unsaturated = at least one double bond) • are used to make polymers and alcohols • are insoluble in water • contain the C=C double bond functional group • can be represented by the general formula C_nH_{2n}	☹	😐	☺
12a 13a	Straight-chain alkenes can be drawn. The position of the double bond must be indicated in the name for alkenes with four or more carbons in the main chain.	☹	😐	☺

Alkane	Molecular Formula	Shortened Formula	Structural Formula
Ethene	C_2H_4	$CH_2=CH_2$	
Propene	C_3H_6	$CH_3CH=CH_2$	
But-1-ene	C_4H_8	$CH_3CH_2CH=CH_2$	
But-2-ene	C_4H_8	$CH_3CH=CHCH_3$	
Pent-1-ene	C_5H_{10}	$CH_3CH_2CH_2CH=CH_2$	
Pent-2-ene	C_5H_{10}	$CH_2CH=CHCH_2CH_3$	
Hex-1-ene	C_6H_{12}	$CH_3CH_2CH_2CH_2CH=CH_2$	
Hex-2-ene	C_6H_{12}	$CH_3CH_2CH_2CH=CHCH_3$	
Hex-3-ene	C_6H_{12}	$CH_3CH_2CH=CHCH_2CH_3$	
Hept-1-ene	C_7H_{14}	$CH_3CH_2CH_2CH_2CH_2CH=CH_2$	
Oct-1-ene	C_8H_{16}	$CH_3CH_2CH_2CH_2CH_2CH_2CH=CH_2$	

Lesson		Red	Amber	Green
12b 13b	Alkenes with branches can be drawn:	☹	😐	☺

 2-methylbut-2-ene	 2-methylbut-1-ene	 3-methylbut-1-ene
 2,3-dimethylbut-2-ene	 3,3-dimethylbut-1-ene	 methylpropene

	National 5 Chemistry Unit 2.1c Alkenes	Lesson	Traffic Light		
			Red	Red	Red
14a 15a	Alkenes undergo addition reactions with hydrogen forming alkanes, known as hydrogenation.  $C_4H_8 + H_2 \longrightarrow C_4H_{10}$		☹	😐	☺
14b 15b	Alkenes undergo addition reactions with halogens forming dihaloalkanes  $C_4H_8 + Br_2 \longrightarrow C_4H_8Br_2$		☹	😐	☺
14c 15c	Alkenes undergo addition reactions with water forming alcohols, known as hydration.  $C_4H_8 + H_2O \longrightarrow C_4H_9OH$		☹	😐	☺

	National 5 Chemistry Unit 2.1d Cycloalkanes	Lesson	Traffic Light		
			Red	Amber	Green
16	Cycloalkanes: • are a homologous series of saturated, cyclic hydrocarbons • are used as fuels and solvents • are insoluble in water can be represented by the general formula C_nH_{2n}		☹	😐	☺
17 18	Cycloalkanes have the following structure: cyclopropane C_3H_6  cyclobutane C_4H_8  cyclopentane C_5H_{10}  cyclohexane C_6H_{12}  cycloheptane C_7H_{14}  cyclooctane C_8H_{16} 		☹	😐	☺

National 5 Chemistry
Unit 2.2a Alcohols

Lesson | Traffic Light: Red ☹ | Amber 😐 | Green ☺

19 Alcohols are used as fuels as they are highly flammable and burn with very clean flames ☹ 😐 ☺

20 Alcohols are often used as solvents ☹ 😐 ☺

- alcohol is the main constituent of methylated spirits (meths), a useful solvent

21 Methanol, ethanol and propanol are miscible with water, thereafter the solubility decreases as size increases ☹ 😐 ☺

- miscible means that the alcohols mix with water and do not separate.

Alcohol	Methanol	Ethanol	Propanol	Butanol	Pentanol	Hexanol	Heptanol	Octanol
No of Carbons	1	2	3	4	5	6	7	8
Solubility	Very soluble in water		→					insoluble

22 As increase in the size of an alcohol increases the melting & boiling points ☹ 😐 ☺

- this is caused by the increasing strength of the intermolecular forces.

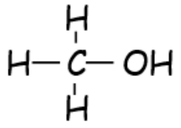
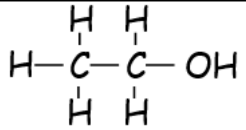
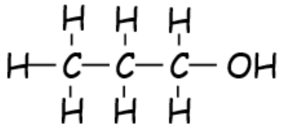
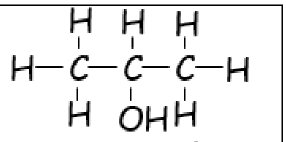
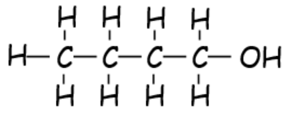
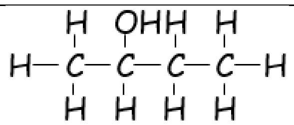
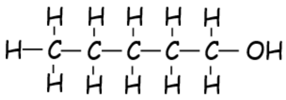
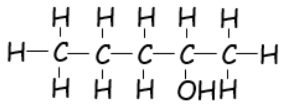
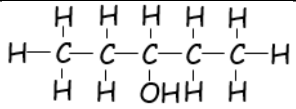
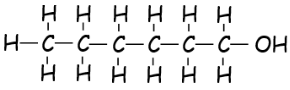
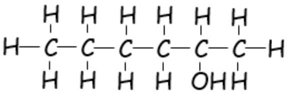
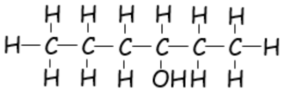
Alcohol	Methanol	Ethanol	Propanol	Butanol	Pentanol	Hexanol	Heptanol	Octanol
No of Carbons	1	2	3	4	5	6	7	8
Melting Point	low			→				high
Boiling Point	low			→				High
Strength of intermolecular forces	weaker			→				stronger

23 An alcohol is a molecule containing a hydroxyl –OH functional group. ☹ 😐 ☺

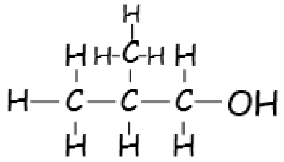
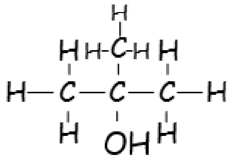
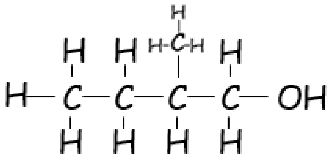
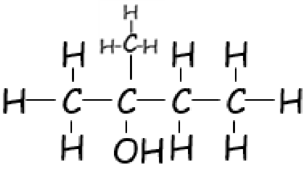
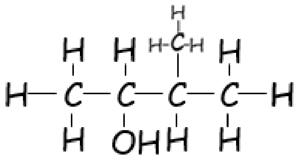
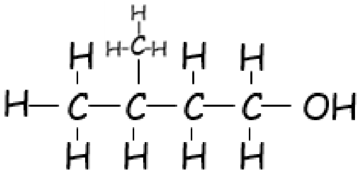
24 Saturated, straight-chain alcohols have the general formula $C_nH_{2n+1}OH$ ☹ 😐 ☺

- saturated alcohols do not contain C═C double bonds

25a 26a Straight-chain alcohols are named indicating the position of the hydroxyl –OH group can be drawn and named: ☹ 😐 ☺

 methanol	 ethanol	 propan-1-ol	 propan-2-ol
 butan-1-ol	 butan-2-ol	 pentan-1-ol	 pentan-2-ol
 pentan-3-ol	 hexan-1-ol	 hexan-2-ol	 hexan-3-ol

25b 26b Alcohols with branched chains can be drawn: ☹ 😐 ☺

 2-methylpropan-1-ol	 2-methylpropan-2-ol	 2-methylbutan-1-ol
 2-methylbutan-2-ol	 3-methylbutan-2-ol	 3-methylbutan-1-ol

National 5 Chemistry
Unit 2.2b Carboxylic Acids

Lesson | Traffic Light: Red Amber Green

27 Carboxylic acids are used in the preparation of preservatives, soaps and medicines. Vinegar is a solution of ethanoic acid, with molecular formula CH_3COOH. Vinegar is used in household cleaning products as it is a non-toxic acid so can be used safely in household situations. ☹ 😐 ☺

28 Methanoic, ethanoic, propanoic and butanoic acid are miscible in water, thereafter the solubility decreases as size increases. ☹ 😐 ☺

- miscible means that the carboxylic acids mix with water and do not separate.

Carboxylic Acid	Methanoic	Ethanoic	Propanoic	Butanoic	Pentanoic	Hexanoic	Heptanoic	Octanoic
No of Carbons	1	2	3	4	5	6	7	8
Solubility	Very soluble in water →							insoluble

29 As increase in the size of an carboxylic acid increases the melting & boiling points ☹ 😐 ☺

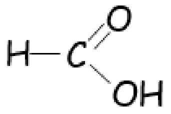
- this is caused by the increasing strength of the intermolecular forces.

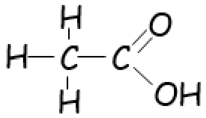
Carboxylic Acid	Methanoic	Ethanoic	Propanoic	Butanoic	Pentanoic	Hexanoic	Heptanoic	Octanoic
No of Carbons	1	2	3	4	5	6	7	8
Melting Point	low →							high
Boiling Point	low →							High
Strength of intermolecular forces	weaker →							stronger

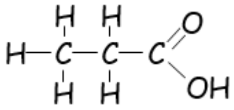
30 Carboxylic acids can be identified by the carboxyl –COOH functional group. ☹ 😐 ☺

31 Carboxylic acids have the general formula $C_nH_{2n+1}COOH$. ☹ 😐 ☺

32
33 Straight-chain carboxylic acids can be drawn and named: ☹ 😐 ☺


methanoic acid


ethanoic acid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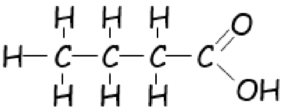
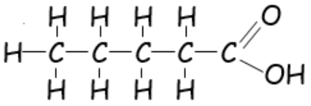
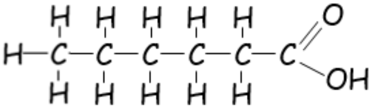
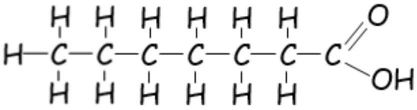
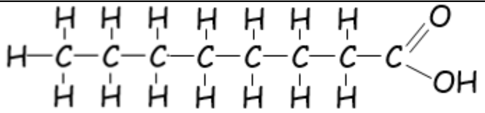

butananoic acid


pentanoic acid


hexanoic acid

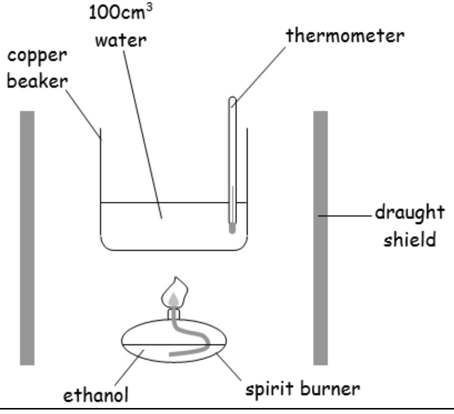

heptanoic acid


octanoic acid

34 Solutions of carboxylic acids have a pH less than 7 (like other acids) ☹ 😐 ☺

- can react with metals, metal oxides, hydroxides and carbonates to form salts.
  - salts formed from straight-chain carboxylic acids can be named.

methanoic acid + magnesium → magnesium methanoate + hydrogen
ethanoic acid + sodium oxide → sodium ethanoate + water
propanoic acid + potassium hydroxide → potassium propanoate + water
butanoic acid + lithium carbonate → lithium butanoate + water + CO_2

	National 5 Chemistry Unit 2.3 Energy From Fuels	Lesson	Traffic Light		
			Red	Amber	Green
35	A reaction or process that releases heat energy is described as exothermic. A reaction or process that takes in heat energy is described as endothermic. Reactions with energy changes can raise or lower the temperature of the surroundings: • **Exothermic** reactions release energy to the surroundings (raising the temperature) • **Endothermic** reactions take in energy from the surroundings (lowering the temperature)		☹	😐	☺
36	In combustion, a substance reacts with oxygen releasing energy.		☹	😐	☺
37	Hydrocarbons and alcohols burn completely in a plentiful supply of oxygen to produce carbon dioxide and water. Equations can be written for the complete combustion of hydrocarbons and alcohols: $\begin{array}{ccccccc} \text{methane} & + & \text{oxygen} & \longrightarrow & \text{carbon dioxide} & + & \text{water} \\ CH_4 & + & 2O_2 & \longrightarrow & CO_2 & + & 2H_2O \\ \text{ethene} & + & \text{oxygen} & \longrightarrow & \text{carbon dioxide} & + & \text{water} \\ C_2H_4 & + & 3O_2 & \longrightarrow & 2CO_2 & + & 2H_2O \\ \text{cyclobutane} & + & \text{oxygen} & \longrightarrow & \text{carbon dioxide} & + & \text{water} \\ C_4H_8 & + & 6O_2 & \longrightarrow & 4CO_2 & + & 4H_2O \\ \text{ethanol} & + & \text{oxygen} & \longrightarrow & \text{carbon dioxide} & + & \text{water} \\ C_2H_5OH & + & 3O_2 & \longrightarrow & 2CO_2 & + & 3H_2O \end{array}$		☹	😐	☺
38	Fuels burn releasing different quantities of energy.		☹	😐	☺
39a	The quantity of heat energy burning alcohols releases can be calculated experimentally using:  		☹	😐	☺
39b	The quantity of heat energy released can be calculated using the equation $E_h = cm\Delta T$ $\begin{array}{ccccccccc} E_h & = & c & \times & m & \times & \Delta T \\ \text{Heat Energy} & & \text{Specific Heat Capacity} & & \text{Mass} & & \text{Change in temperature} \\ (\text{kJ}) & & (\text{kJ kg}^{-1}\,{}^{o}\text{C}^{-1}) & & (\text{kg}) & & ({}^{o}\text{C}) \end{array}$				
40	The quantities E_h, c, m or ΔT can be calculated, in the correct units, given relevant data. The enthalpy changes can be calculated using $E_h = c \times m \times \Delta T$. e.g. Calculate the energy released by burning ethanol heated up 200cm³ of water by 6°C. $E_h = c \times m \times \Delta T$ $= 4.18 \times 0.2 \times 6$ $= 5.016$ kJ c = specific heat capacity = 4.18 kJ $kg^{-1}\,{}^{o}C^{-1}$ m = mass of water being heated up (worked out by converting volume of water into mass) (NB 1000cm³ water = 1kg of water) e.g. Burning an alcohol released 13.3kJ of energy as it raised the temperature of sodium chloride solution from 15°C to 49°C. The mass of the sodium chloride solution was 100g. Calculate the specific heat capacity of this solution of sodium chloride solution. $E_h = c \times m \times \Delta T \quad \therefore\ c = \dfrac{E_h}{m \times \Delta T} = \dfrac{13.3\text{ kJ}}{0.1\text{kg} \times 34^{o}\text{C}} = \dfrac{13.3}{3.4} = 3.91\text{ kJ kg}^{-1}\,{}^{o}\text{C}^{-1}$ • Calculations can involve heating substances other than water and the value of c will change to reflect the specific heat capacity of the new substance heating up.		☹	😐	☺

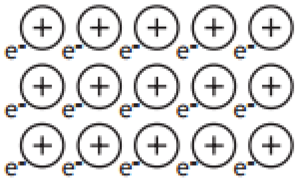
National 5 Chemistry
Unit 3.1a Metallic Bonding

Lesson | Traffic Light: Red | Amber | Green

1

Metallic bonding is the electrostatic force of attraction between positively charged ions and delocalised electrons.

- Positively charged ions consist of the nucleus and the inner shell of electrons
- The outer electrons are the delocalised electrons



☹ 😐 ☺

2

Metallic elements are conductors of electricity because they contain delocalised electrons

- Electrons are free to move across the metal by jumping from outer shell to outer shell

☹ 😐 ☺

National 5 Chemistry
Unit 3.1b Reaction of Metals

Lesson | Traffic Light: Red | Amber | Green

3a

The reaction of metals with oxygen can be written as:

metal + oxygen → metal oxide

Iron + Oxygen → Iron (III) oxide

$$4Fe + 3O_2 \longrightarrow 2Fe_2O_3$$

☹ 😐 ☺

3b

The reaction of metals with water can be written as:

metal + water → metal hydroxide + hydrogen

magnesium + water → magnesium hydroxide + hydrogen

$$Mg + 2H_2O \longrightarrow Mg(OH)_2 + H_2$$

☹ 😐 ☺

3c

The reaction of metals with dilute acids can be written as:

metal + acid → salt + hydrogen

aluminium + hydrochloric acid → aluminium chloride + hydrogen

$$2Al + 6HCl \longrightarrow 2AlCl_3 + 3H_2$$

☹ 😐 ☺

4

Metals can be arranged in order of reactivity by comparing the rates at which they react.

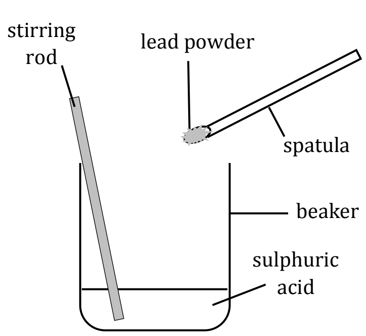
Metal	Potassium	Sodium	Lithium	Calcium	Magnesium	Aluminium	Zinc	Iron	Tin	Lead	Copper	Mercury	Silver	Gold	Platinum
Reaction With Oxygen	**Burn In Oxygen to Form Metal Oxide**								**Slowly React With Oxygen**			**No Reaction With Oxygen**			
Reaction With Water	**Fast Reaction With Water**				**Slow Reaction With Water Faster Reaction With Steam**						**No Reaction with Water or Steam**				
Reaction With Dilute Acids	**Violent Reaction With Acids**				**React With Acids**				**Slow Reaction**		**No Reaction With Acids**				

☹ 😐 ☺

5

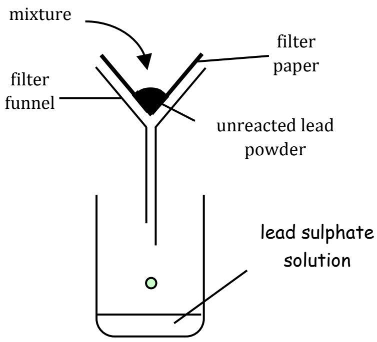
Metals can be used to produce soluble salts. Excess metal is added to the appropriate acid, the mixture is filtered and the filtrate evaporated to dryness.

1. Reaction with Acid



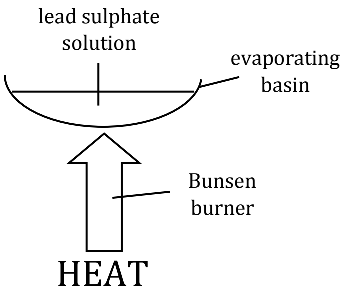
- metal reacts with dilute acid
- When all acid has been reacted, excess metal will lie on the bottom of the beaker

2. Filtration



- excess metal is removed by fitration
- *residue* in the filter paper is unreacted metal
- filtrate in beaker is solution of salt you are making

3. Evaporation



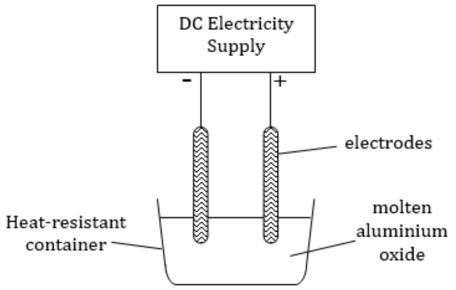
- The salt solution can be returned to the solid salt by evaporating the water

☹ 😐 ☺

National 5 Chemistry
Unit 3.1c Redox

		Lesson	Traffic Light		
			Red	Amber	Green
6a 8a	Reduction is a gain of electrons by a *reactant* in any chemical reaction: $Cu^{2+} + 2e^- \rightarrow Cu$ • a compound reacting to form a metal element is an example of reduction • reduction reactions have electrons before the arrow		☹	😐	☺
6b 8b	Oxidation is a loss of electrons by a *reactant* in any chemical reaction: $Mg \rightarrow Mg^{2+} + 2e^-$ • a metal element reacting to form a compound is an example of oxidation • oxidation reactions have electrons after the arrow		☹	😐	☺
7	In a redox reaction, reduction and oxidation take place at the same time.		☹	😐	☺
9	Ion-electron equations can be combined to produce redox equations. Oxidation Reaction: $Mg \rightarrow Mg^{2+} + 2e^-$ Reduction Reaction: $Cu^{2+} + 2e^- \rightarrow Cu$ Redox Reaction: $Mg + Cu^{2+} \rightarrow Mg^{2+} + Cu$		☹	😐	☺

National 5 Chemistry
Unit 3.1d Extraction of Metals

		Lesson	Traffic Light		
			Red	Amber	Green
10	During the extraction of metals, metal ions are reduced forming metal atoms.		☹	😐	☺
11a 12a	The least reactive metals are obtained by heating metals compounds alone e.g. silver, gold, platinum and mercury silver (I) oxide → silver + oxygen $2Ag_2O \rightarrow 4Ag + O_2$		☹	😐	☺
11b 12b	Metals with medium reactivity are obtained by heating metal compounds with carbon or carbon monoxide e.g. copper, lead, tin, iron and zinc Copper (II) oxide + carbon → copper + carbon dioxide $2CuO + C \rightarrow 2Cu + CO_2$ iron (III) oxide + carbon monoxide → iron + carbon dioxide $2Fe_2O_3 + 3CO \rightarrow 4Fe + 3CO_2$		☹	😐	☺
11c 12c	The most reactive metals must be obtained by molten electrolysis of metal compounds e.g. potassium, sodium, lithium, calcium, magnesium and aluminium aluminium oxide → aluminium + oxygen $2Al_2O_3 \rightarrow 4Al + 3O_2$		☹	😐	☺
13 14	Electrolysis is the decomposition of an ionic compound into its elements using electricity • a d.c. supply must be used if the products of electrolysis are to be identified. 		☹	😐	☺
15	Positive metal ions gain electrons at the negative electrode (reduction) e.g. $Cu^{2+} + 2e^- \rightarrow Cu$ Negative non-metal ions lose electrons at the positive electrode (oxidation) e.g. $2Cl^- \rightarrow Cl_2 + 2e^-$		☹	😐	☺

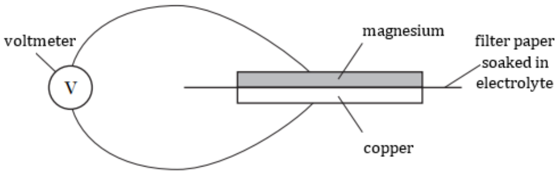
National 5 Chemistry
Unit 3.1e Electrochemical Cells

Lesson | Traffic Light: Red | Amber | Green

16 Electrically conducting solutions containing ions are known as electrolytes.
- Movement of ions in the electrolyte completes the circuit

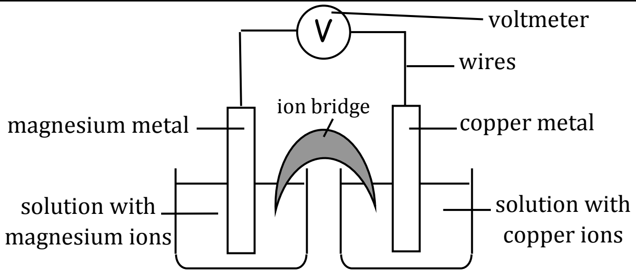
☹ 😐 ☺

17 A simple cell can be made by placing two metals in an electrolyte.
- Electrons move through the voltmeter from the metal higher up the electrochemical series to the metal lower in the series
- Ions move in the electrolyte to balance up this movement of charge



☹ 😐 ☺

18 Electricity can be produced in a cell by connecting two different metals in solutions of their metal ions. Electrons flow in the external circuit from the metal higher in the electrochemical series to the one lower in the electrochemical series.
- Electrons flow from Magnesium to copper in this circuit



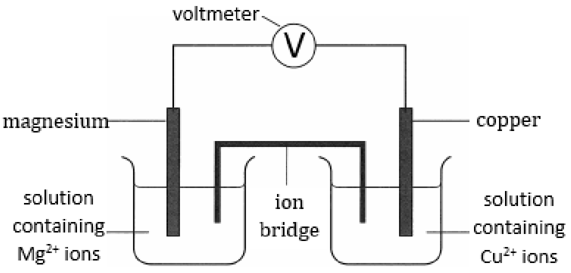
☹ 😐 ☺

19 20 21 Different pairs of metals produce different voltages. These voltages can be used to arrange the elements into an electrochemical series (p10 of data booklet)
- the further apart elements are in the electrochemical series, the greater the voltage produced when they are used to make an electrochemical cell.
- electrons flow in the external circuit from the species higher in the electrochemical series to the one lower in the electrochemical series.

☹ 😐 ☺

22a 23a For an electrochemical cell ion-electron equations can be written for:
- the oxidation reaction
- the reduction reaction
- the overall redox reactions

The direction of flow of electrons can also be worked out in an electrochemical cell.



At Magnesium Electrode: (oxidation)

$Mg_{(s)} \rightarrow Mg^{2+}{}_{(aq)} + 2e^-$

At Copper Electrode: (reduction)

$Cu^{2+}{}_{(aq)} + 2e^- \rightarrow Cu_{(s)}$

Overall Redox Reaction

$Mg_{(s)} + Cu^{2+}{}_{(aq)} \rightarrow Mg^{2+}{}_{(aq)} + Cu_{(s)}$

Electrons leave Magnesium (on left) as magnesium atoms form magnesium ions

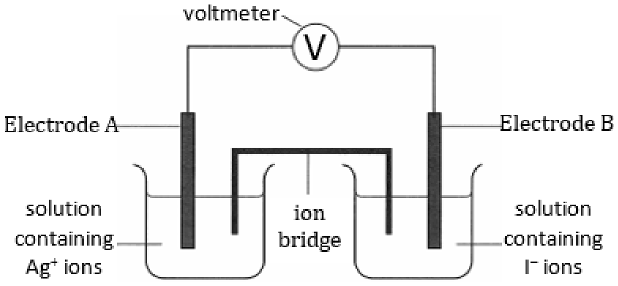
Electrons travel through the wires and Voltmeter

Electrons arrive at copper electrode (on right) and join with copper ions to form copper atoms

Electrons travel through wires from left to right

☹ 😐 ☺

22b 23b Some electrochemical cells involve non-metals as one of their reactions:



At Electrode A:

$Ag^+{}_{(aq)} + e^- \rightarrow Ag_{(s)}$

At Electrode B:

$2I^-{}_{(aq)} \rightarrow I_{2(s)} + 2e^-$

Overall Redox Reaction

$Ag^+{}_{(aq)} + 2I^-{}_{(aq)} \rightarrow Ag_{(s)} + I_{2(s)}$

Electrons leave Electrode B as I^- ions form I_2 molecules ions

Electrons travel through the wires and Voltmeter

Electrons arrive at electrode A and join with Ag^+ ions to form Ag atoms

Electrons travel through wires from right to left

National 5 Chemistry
Unit 3.2 Plastics

Lesson | Traffic Light: Red Amber Green

24 25 26

Plastics are examples of materials known as polymers.

- Polymers are long chain molecules formed by joining together a large number of small molecules called monomers.
- Addition polymerisation is the name given to a chemical reaction in which unsaturated monomers are joined, forming a polymer.

Name	Definition
monomer	Small molecules which join together to form polymers
polymer	The long chain molecule made by the joining up of monomers
polymerisation	The process where monomers join together to form polymers

☹ 😐 ☺

27

The name of the addition polymer is related to the name of the monomer:

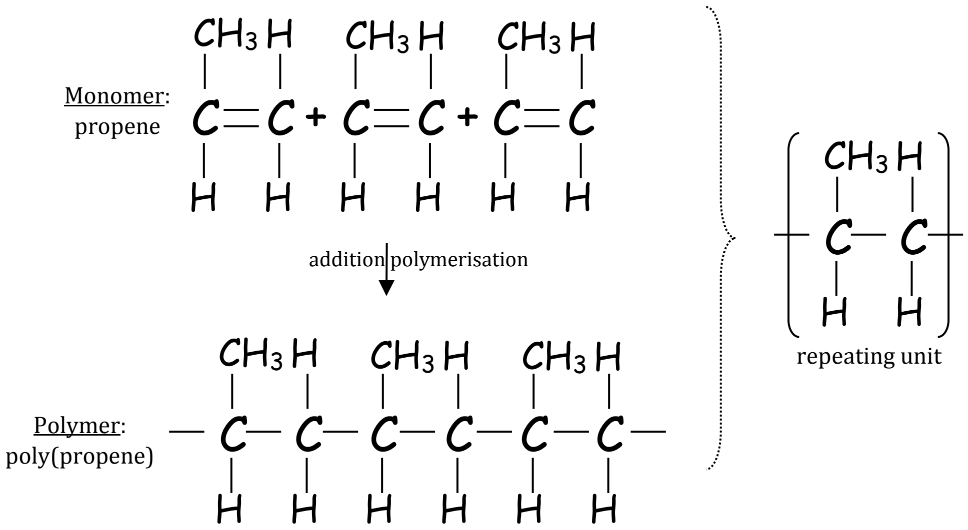
Monomer	ethene	styrene	propene	chloroethene
Polymer	poly(ethene)	poly(styrene)	poly(propene)	poly(chloroethene)

☹ 😐 ☺

28 29 30

The structure of a polymer can be drawn given either the structure of the monomer or the repeating unit

- A repeating unit is the shortest section of polymer chain which, if repeated, would yield the complete polymer chain (except for the end-groups)
- From the structure of a polymer, the monomer or repeating unit can be drawn.



☹ 😐 ☺

	National 5 Chemistry Unit 3.3 Fertilisers	Lesson	Traffic Light		
			Red	Amber	Green
31 32	Growing plants require nutrients, including compounds containing nitrogen, phosphorus or potassium • fertilisers are substances which restore to the soil elements essential for healthy plant growth		☹	😐	☺
33	Ammonia and nitric acid are important compounds used to produce soluble, nitrogen-containing salts that can be used as fertilisers. • fertilisers must be soluble if they are to be absorbed by plants through their roots		☹	😐	☺
34	Ammonia is a pungent, clear, colourless gas • ammonia dissolves in water to produce an alkaline solution • ammonium hydroxide solution is formed although the balance is more molecule of ammonia than ions of ammonium and hydroxide ammonia + water → ammonium ion + hydroxide ion $NH_{3(aq)} + H_2O_{(l)} \rightarrow NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$		☹	😐	☺
35	Ammonia solutions react with acids to form soluble salts ammonia solution + acid → ammonium salt + water ammonia solution + hydrochloric acid → ammonium chloride + water $NH_4OH_{(aq)} + HCl_{(aq)} \rightarrow NH_4Cl_{(aq)} + H_2O_{(l)}$		☹	😐	☺
36	The Haber Process is the industrial process where ammonia is made for production of fertilisers $N_{2(g)} + 3H_{2(g)} \xrightarrow[\text{catalyst}]{\text{iron}} 2NH_{3(g)}$ Nitrogen + Hydrogen → Ammonia		☹	😐	☺
37	At low temperatures the forward reaction is too slow to be economical • if the temperature is increased, the rate of reaction increases • however as the temperature increases, the backward reaction becomes increases • 100% ammonia is never produced as the rate of breakdown of ammonia eventually equals the rate of formation of ammonia • an iron catalyst is used to increase reaction rate		☹	😐	☺
38 39	The Ostwald process uses ammonia, oxygen and water to produce nitric acid. • ammonia is the starting material for the commercial production of nitric acid. • a platinum catalyst is used in this process. $4NH_3 + 7O_2 \xrightarrow[\text{catalyst}]{\text{platinum}} 4NO_2 + 6H_2O$ ammonia + oxygen → nitrogen dioxide + water nitrogen dioxide $\xrightarrow{\text{water}}$ Nitric acid		☹	😐	☺

National 5 Chemistry
Unit 3.4 Nuclear Chemistry

Lesson | Traffic Light: Red, Amber, Green

40 Radioactive decay involves changes in the nuclei of atoms. Unstable nuclei (radioisotopes) can become more stable nuclei by giving out alpha, beta or gamma radiation. ☹ 😐 ☺

41, 44a, 46a **Alpha particles** (α) are helium nuclei

- alpha particles have a mass number = 4 and an atomic number = 2
- alpha particles have a double positive charge as they have no electrons
- deflected by an electric field towards the negatively charged plate
- stopped by piece of paper and travel only a few centimetres

${}^{4}_{2}He$

Alpha decay of ^{210}Po can be written as: $${}^{210}_{84}Po \rightarrow {}^{206}_{82}Pb + {}^{4}_{2}He$$

☹ 😐 ☺

42, 44b, 46b **Beta particles** (β) are electrons ejected from a nucleus

- beta particles have a mass number = 0 and an atomic number = -1
- beta particles have a negative charge
- deflected by an electric field towards a positively charge plate
- stopped by thin sheet of aluminium and travel over a metre in air

${}^{0}_{-1}e$

Beta decay of ^{99}Mo can be written as: $${}^{99}_{42}Mo \rightarrow {}^{99}_{43}Tc + {}^{0}_{-1}e$$

☹ 😐 ☺

43 **Gamma rays** (γ) are electromagnetic waves emitted from within the nucleus of an atom.

- Gamma radiation is able to travel great distances in air.
- They can be stopped by barriers made of materials such as lead or concrete.
- Gamma rays are not deflected by an electric field.

☹ 😐 ☺

45 In nuclear equations alpha, beta, protons and neutrons are written as:

Alpha particle	Beta Particle	Proton	Neutron
${}^{4}_{2}He$	${}^{0}_{-1}e$	${}^{1}_{1}p$	${}^{1}_{0}n$

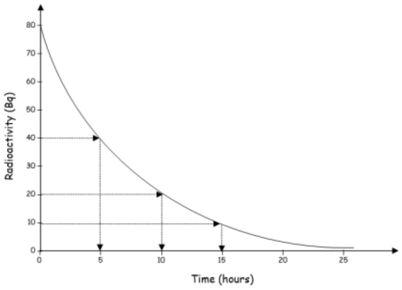
☹ 😐 ☺

47 Half-life is the time for half of the nuclei of a particular isotope to decay. ☹ 😐 ☺

48 The half-life of an isotope is a constant. Half-life is unaffected by temperature, chemical conditions (compound form or element) or physical conditions (solid, liquid, gas or solution). Radioactive isotopes can be used to date materials e.g. carbon dating of ^{14}C. ☹ 😐 ☺

49 The half-life of an isotope can be determined from a graph showing a decay curve.

- Find a halving of the quantity on the y-axis e.g. 100% to 50% or 2g to 1g
- Measure the time taken for the halving to take place on the x-axis



☹ 😐 ☺

50 The quantity/proportion of radioisotope, half-life or time elapsed from the other variables:

Calculate the half-life of the radioisotope if it takes 45 days for 2g of radioisotope to decay into 0.1g or the radioisotope.

Mass (g)	No of Half Lives
3.2	0
1.6	1
0.8	2
0.4	3
0.2	4
0.1	5

5 x $t_{½}$ = 45day ∴ $t_{½}$ = **9days**

How long did it take for 80g of a radioisotope with a half-life of 17 days 0.625g of radioisotope?

Mass (g)	Time Taken (days)
80	0
40	17
20	34
10	51
5	68
2.5	85
1.25	102
0.625	**119 days**

A radioisotope has a half-life of 3hours. How much of 64g of the radioisotope will remain after 15 hours?

Time (hrs)	Mass (g)	Proportion
0	64	1
3	32	$^{1}/_{2}$
6	16	$^{1}/_{4}$
9	8	$^{1}/_{8}$
12	4	$^{1}/_{16}$
15	**2g**	$^{1}/_{32}$

☹ 😐 ☺

51, 52 Radioisotopes have a range of uses in medicine and in industry.

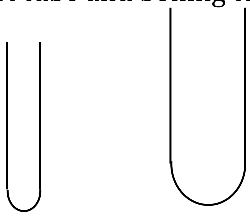
- Radioisotopes can be used to release gamma radiation to kill cancer cells
- Radioisotopes used must take account of type of radiation released and half-life
  - Gamma radiation is too penetrating to be used as medicines in the body
  - Medicines with very long half-lives are unsuitable for use in the body.

☹ 😐 ☺

National 5 Chemistry
Unit 3.5a Common Chemical Apparatus

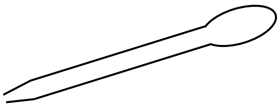
The following types of apparatus are used in chemistry:

test tube and boiling tube



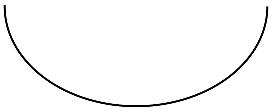
Test tubes and boiling tubes are uses for heating chemicals. There are made of pyrex glass which is heat resistant.

dropper



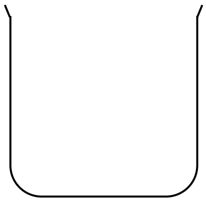
When making up a solution in a standard flask the last few drops of deionised water are added using a dropper when making up the volume in the flask up to the mark.

evaporating basin



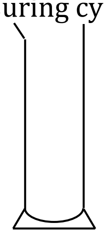
Heat-resistant dish used for the evaporation of water from solutions leaving a salt in the dish when dry.

beaker



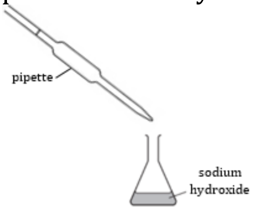
Used for holding quantities of liquid but not as accurate as a measuring cylinder

measuring cylinder



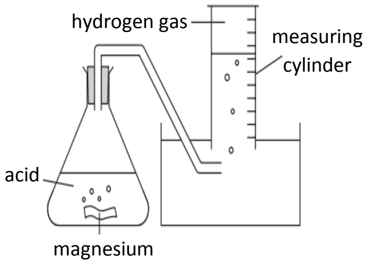
Used for measuring volumes of liquid. More accurate than a beaker but less accurate than a pipette.

pipette with safety filler



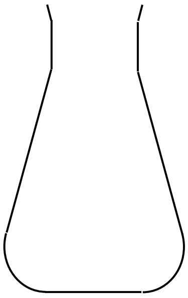
Accurate method of measuring volumes of solution. Pipette fillers are used to safely draw solution up pipette using suction.

delivery tube



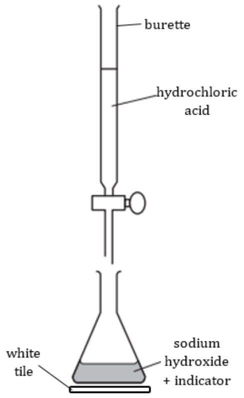
When drawing this apparatus in cross-section it is important to note that the delivery tube must not be blocked and is open to allow gas through to be collected over the water in the trough.

conical flask



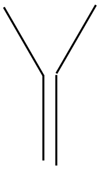
Conical flasks are used in titrations because their shape allows the swirling/mixing of the chemicals inside the flask more easily without spillage.

burette



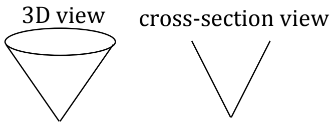
The burette allows accurate volumes of solution to be measured during a titration. Accurate titrations are carried out where the colour change in the flask is carried out to a accuracy of a single drop from the burette.

funnel



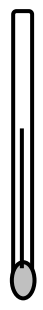
Used to transfer chemicals safely. Can be used with filter paper for filtration.

filter paper



Fold filter paper twice and open up one of the outer sections into a cone

thermometer



Used to measure temperature. Make sure end of thermometer is still in the substance you measuring temperature of.

Lesson	Red	Amber	Green
53	☹	😐	☺

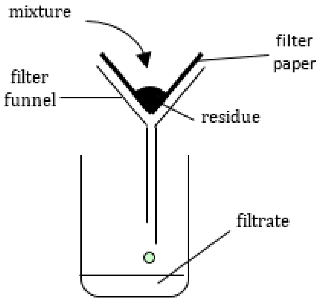
National 5 Chemistry
Unit 3.5b General Practical Techniques

Lesson | Traffic Light: Red | Amber | Green

54a

Simple filtration uses filter paper and a funnel to separate the residue from the filtrate.

- **Residue** collects in the filter paper as it is an insoluble solid
- **Filtrate** is a solution which goes through the filter paper and collects in the *vessel* (e.g. beaker) below the filter funnel



☹ 😐 ☺

54b

A balance can be used to measure the mass of chemicals

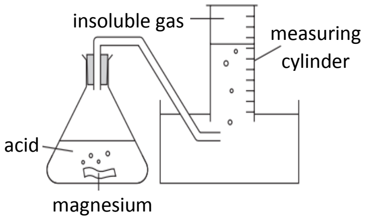
- place a clean beaker or weighing bottle on a balance and measure its mass
- add chemicals to the beaker and measure the new mass
- difference between the readings is the mass of the substance

☹ 😐 ☺

54c

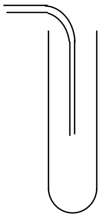
Methods of gas collection depend on the solubility of the gas and the density of the gas

Collection Over Water



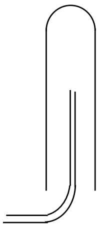
For (relatively) insoluble gases e.g. H_2, O_2, N_2, He, Ne, Ar, Kr, Xe, Rn

Downwards Displacement of Air



For gases more dense in air e.g. CO_2

Upward Displacement of Air



For gases less dense than air e.g. NH_3, He, H_2

☹ 😐 ☺

54d

Bunsen burners and electric hotplates can be used for heating apparatus in experiments

- electric hotplates should be used when substances being heated up are volatile and flammable.

☹ 😐 ☺

54e

Soluble salts can be made by neutralisation of the appropriate acid with:

metals	metal oxides	metal hydroxides	metal carbonates
(see Unit 3 LO5 for method)	(see Unit 1 LO75+76 for method)	(see Unit 1 LO74 for method)	(see Unit 1 LO75+76 for method)

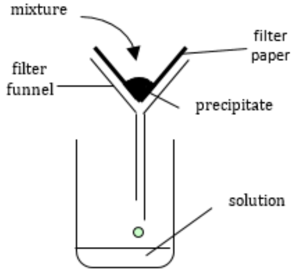
☹ 😐 ☺

54f

Precipitation is the reaction of two solutions to form an insoluble product called a precipitate:

- Insoluble salts are best made by precipitation
- Insoluble salts can be collected by filtration of insoluble solid from mixture

potassium iodide	+	lead nitrate	→	lead iodide	+	potassium nitrate
colourless solution		colourless solution		yellow solid		colourless solution



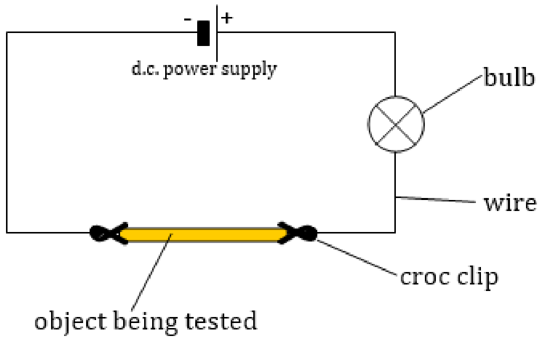
☹ 😐 ☺

54g

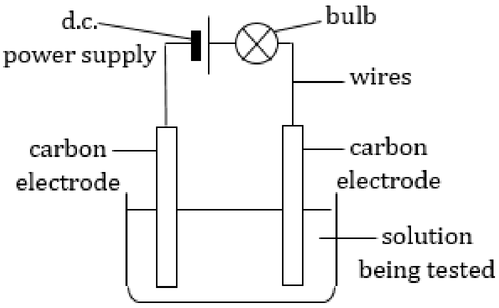
The electrical conductivity of solids and solutions can be tested using the following:

- substance is a conductor if the bulb lights

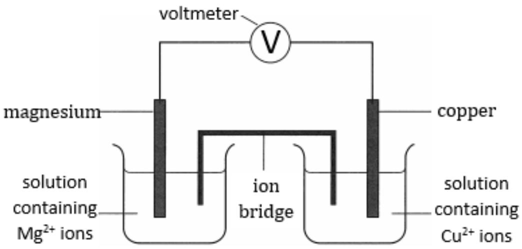
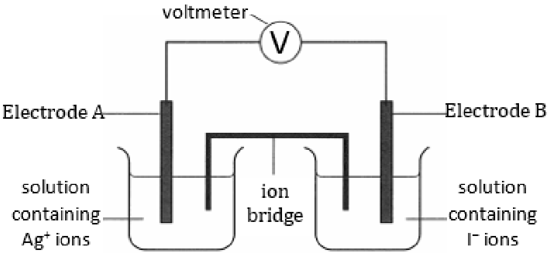
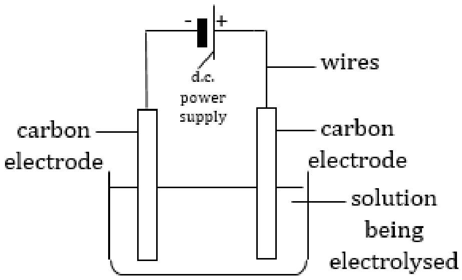
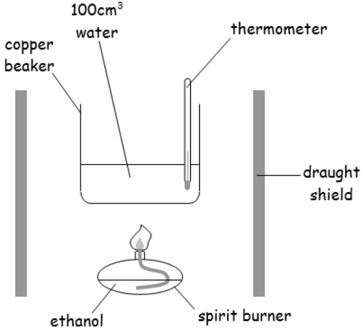
testing electrical conductivity of solids



testing electrical conductivity of solution



☹ 😐 ☺

54h	Electrochemical Cells can be set up using a salt bridge/ion bridge. Metal electrodes can be used:  Voltage is produced as the following chemical reaction proceeds: At Magnesium Electrode: $Mg_{(s)} \rightarrow Mg^{2+}_{(aq)} + 2e^-$ At Copper Electrode: $Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)}$ Carbon Electrodes can be used:  Voltage is produced as the following chemical reaction proceeds: At Carbon Electrode A: $2Ag^+_{(aq)} + 2e^- \rightarrow 2Ag_{(s)}$ At Carbon Electrode B: $2I^-_{(aq)} \rightarrow I_{2(s)} + 2e^-$		☹	😐	☺
54i	Electrolysis of solutions will break down an ionic compound back to the elements. A d.c. power supply must be used. - positive metal ions move to the negative electrode and form metal atoms $Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)}$ - negative non-metal ions move to the positive electrode and form non-metal atoms $2Cl^-_{(aq)} \rightarrow Cl_{2(g)} + 2e^-$  		☹	😐	☺
54j	Heat Energy E_h can be worked out from the following experiment and calculation:  Specific heat capacity **c** = 4.18 kJ kg^{-1} °C Volume of water = 100cm^3 ∴ Mass of water **m** = 0.1kg Starting temperature = 22°C Final Temperature = 33°C ∴ Change in temperature **ΔT** = 11°C $E_h = \mathbf{c} \times \mathbf{m} \times \mathbf{\Delta T}$ $= 4.18 \times 0.1 \times 11$ $= 4.598$ kJ		☹	😐	☺

Testing the electrical conductivity of solids

National 5 Chemistry
Unit 3.5c Analytical Methods

Lesson | Traffic Light: Red | Amber | Green

55 Titration is used to accurately determine the volumes of solution required to reach the end-point of a chemical reaction.

- an indicator changing colour will show when the end-point has been reached.
- a rough titration is used to work out the approximate volume of the end point
- accurate titrations are then set up using exactly the same chemicals and quantities,
  - the majority of the titre volume is added at first, thoroughly mixed and then the last few drops are added one at a time to allow the most accurate reading of the volume of the reactant in the burette
  - colour change should be achieved by the addition of one drop from the burette
- titre volumes within 0·2 cm^3 are considered concordant (accurate)
- the accurate titres achieved are then averaged for use in a calculation.

☹ 😐 ☺

56 A standard solution is a solution with an accurately known concentration.

- made up in a standard flask, also known as a volumetric flask.
- a mass of a solid is measured on a balance
- the solid is fully dissolved in a beaker with deionised water
- the solution in the beaker is transferred into a standard flask using a funnel
- the beaker is rinsed using deionised water from a wash bottle into the flask
- the funnel is rinsed inside and out with deionised water into the flask.
- the standard flask is filled up to the mark (the bottom of the curved meniscus on the line on the flask) with the last few drops of deionised water added using a dropper.
- The flask is mixed thoroughly before use.

☹ 😐 ☺

57 Metals ions in a sample can be identified using a flame test.

- Solutions of metals will give different colours when placed into a flame

Element	Barium	Calcium	Copper	Lithium	Potassium	Sodium	Strontium
Ion	Ba^{2+}	Ca^{2+}	Cu^{2+}	Li^+	K^+	Na^+	Sr^{2+}
Flame Colour	green	orange-red	blue-green	red	lilac	yellow	red

☹ 😐 ☺

58 Oxygen, hydrogen and carbon dioxide gases can be identified by:

Name of Gas	Oxygen	Hydrogen	Carbon Dioxide
Test for Gas	Relights a Glowing Splint	Burns with a Pop	Turns Limewater Milky

☹ 😐 ☺

59 Precipitation is the reaction of two solutions to form an insoluble salt called a precipitate.

☹ 😐 ☺

60 Information on the solubility of compounds can be used to predict when a precipitate will form. The formation of a precipitate can be used to identify the presence of a particular ion.

Writing down the names of the reactants		Swap the names over		Check p8 of data book for solubility of products	
Potassium Iodide	Lead Nitrate	Potassium Nitrate	Lead Iodide	Potassium Nitrate is soluble ↓ Dissolved in solution	Lead Iodide is insoluble ↓ Precipitate on bottom

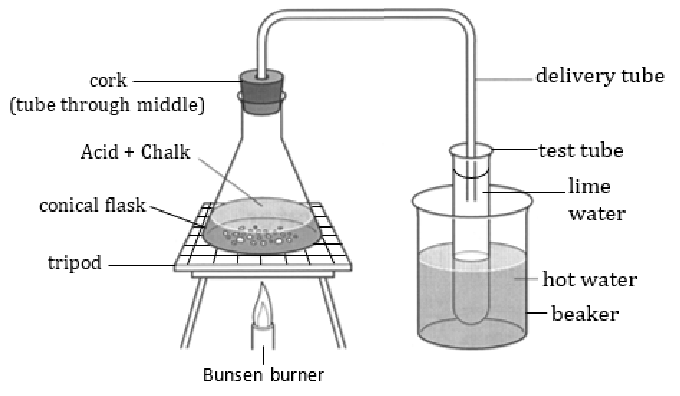
☹ 😐 ☺

National 5 Chemistry
Unit 3.5d Reporting Experimental Work

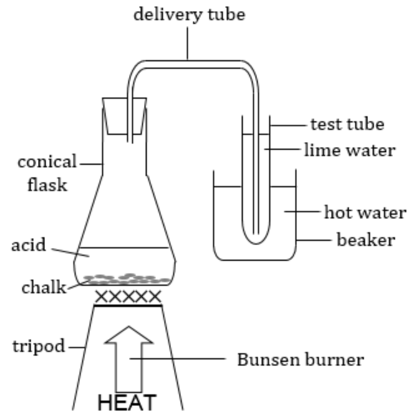
Lesson | Traffic Light: Red | Amber | Green

61 Labelled, sectional diagrams can be drawn for common chemical apparatus. ☹ 😐 ☺

3D diagram:



Cross-sectional diagram:



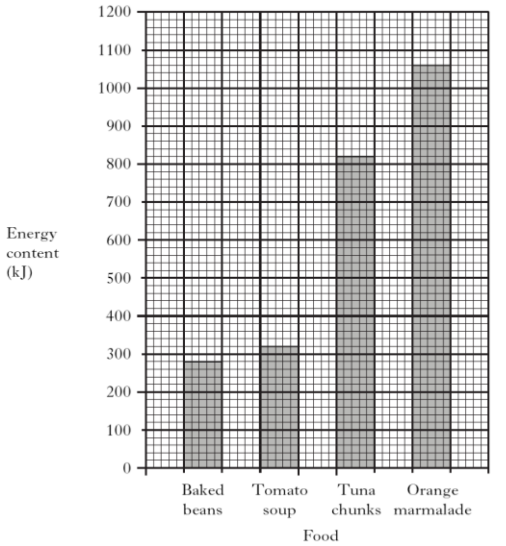
62 Data can be presented in tabular form with appropriate headings and units of measurement. ☹ 😐 ☺

- Each column of the table must have suitable headings (and units if appropriate)
- Units must be included in the title and not in the table entries (and certainly not in both)

63 Data can be presented as a bar, line or scatter graph with suitable scale(s) and labels. ☹ 😐 ☺

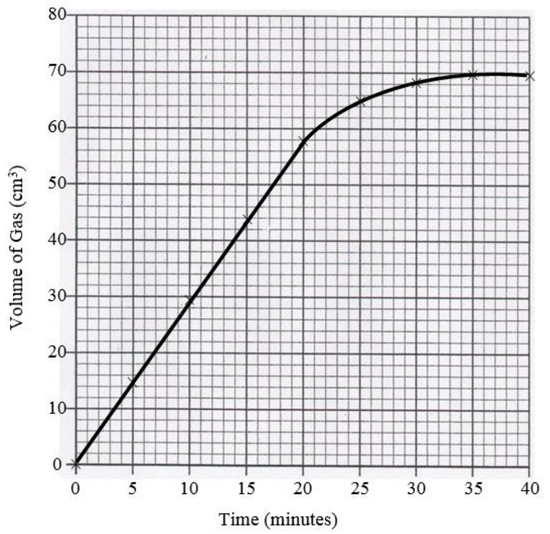
Bar graphs can be drawn from tables:

Food	Energy Content (kJ)
Baked Beans	280
Tomato Soup	320
Tuna Chunks	820
Orange Marmalade	1060



Line Graphs can be drawn from tables:

Time (minutes)	Volume of Gas (cm^3)
0	0
5	14
10	28
15	44
20	58
25	65
30	68
35	70
40	70



64 A line of best fit (straight or curved) can be used to represent the trend observed in experimental data. ☹ 😐 ☺

- Best fit line is drawn rather than "joining the dots"

65 Average values can be calculated from data (average is also known as mean): ☹ 😐 ☺

The average titre in a titration is calculated from the accurate titre values and the rough titration is excluded from the average.

Titration	Start Volume (cm^3)	Final Volume (cm^3)	Change in Volume (cm^3)
1	0.1	15.9	15.8
2	15.9	30.6	14.7
3	30.6	45.5	14.9

$$\text{Average Volume} = \frac{14.7 + 14.9}{2} = \frac{29.6}{2} = 14.8\text{cm}^3$$

<table>
<tr>
<td>66</td>
<td>Given a description of an experimental procedure and/or experimental results, an improvement to the experimental method can be suggested and justified.

e.g. improving method of measuring E_h
<table>
<tr><td>Water must be stirred thoroughly to ensure even temperature across water</td><td>Beaker must be clamped into the flame instead of using a tripod over the spirit burner</td><td>Heat loss can be reduced by use of a draught shield</td></tr>
<tr><td>Metal beakers should be used instead of glass beakers as they conduct heat better</td><td>Air could be replaced by oxygen to reduce incomplete combustion</td><td></td></tr>
</table>

e.g.</td>
<td></td>
<td>☹</td>
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