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Chemistry core knowledge booklet

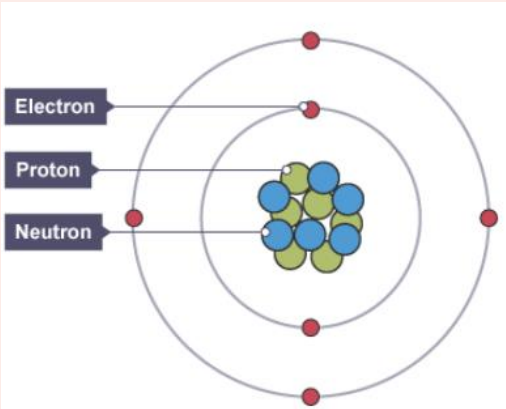
NAME_____

4.1 Atomic structure and the periodic table

Key words

atom	The smallest part of an element that can exist.
molecule	A collection of two or more atoms held together by chemical bonds.
ion	Electrically charged particle, formed when an atom or molecule gains or loses electrons.
element	A substance made of one type of atom only.
compound	A substance formed by the chemical union of two or more elements.

Key diagram – atom



Subatomic particle	Relative mass	Relative Charge
Proton	1	+1
Neutron	1	0
Electron	Very small	1

Key knowledge

All substances are made of atoms. Atoms of each element are represented by a chemical symbol. Atoms are very small, having a radius of about 0.1 nm (1 x 10-10 m). The radius of a nucleus is less than 1/10 000 of that of the atom (about 1 x 10-14 m). Almost all of the mass of an atom is in the nucleus.

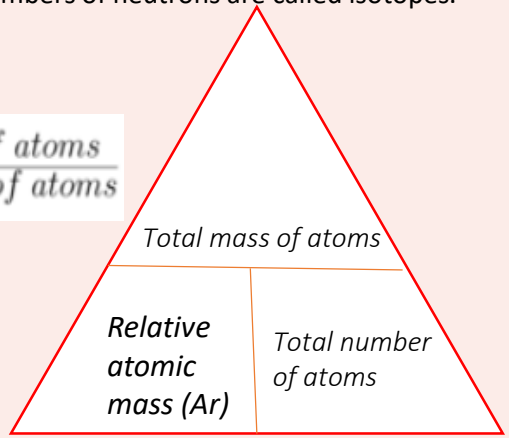
Compounds contain two or more elements chemically combined in fixed proportions and can be represented by formulae using the symbols of the atoms from which they were formed.

Chemical reactions always involve the formation of one or more new substances, and often involve a detectable energy change.

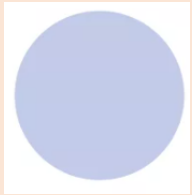
Required skill – Calculating relative atomic mass

Atoms of the same element must have the same number of protons, but they can have different numbers of neutrons. Atoms of the same element with different numbers of neutrons are called isotopes.

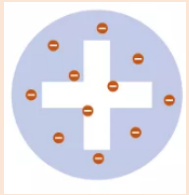
$$A_r = \frac{\text{total mass of atoms}}{\text{total number of atoms}}$$



Key story – The development of the model of the atom

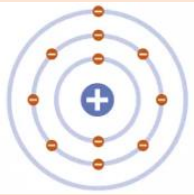


John Dalton
Solid Sphere
Recognised atom are identical for particular element.

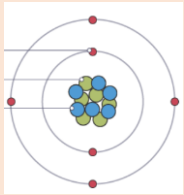


JJ Thompson
Plum Pudding Model
Recognised electrons as components of an atom.

Ernest Rutherford
Nuclear model
Recognised positive charge localised in the nucleus of atom.



Niels Bohr
Planetary model
Recognised that electron move in shells (energy levels)



James Chadwick
provided the evidence to show the existence of neutrons within the nucleus

1	What is an atom?	An atom is the smallest part of an element that can exist.
2	What is an element?	A substance made of only one type of atom
3	What is a compound?	A substance made of two or more different atoms chemically bonded together
4	What is a molecule?	A group of atoms chemically bonded together
5	How do you represent a chemical reaction?	A + B -> AB
6	State the three subatomic particles	Protons, neutrons, electrons
7	State the relative masses of the subatomic particles	Protons: 1, neutrons: 1, electrons: 0
8	State the relative charges of the subatomic particles	Protons: +1, neutrons: 0, electrons: -1
9	How are the subatomic particles arranged in an atom?	Protons and neutrons in the nucleus, electrons orbiting in shells
11	What is the plum pudding model of the atom?	A ball of positive charge with negative electrons into it
12	What did James Chadwick do?	Provided the evidence to show the existence of neutrons in nucleus.
13	What did the gold foil experiment show?	That atoms have dense nuclei with a positive charge
14	What is the difference between plum pudding model and the nuclear model of the atom?	The plum pudding model suggested that the atom is a ball of positive charge with negative electrons embedded in it. The nuclear model stated the mass of an atom was concentrated at the centre (nucleus) and that the nucleus was charged.
15	What is the atomic number of an atom?	The number of protons in an atom
16	What is the mass number of an atom?	The number of protons + the number of neutrons in an atom
17	How are the number of neutrons in an atom calculated?	Mass number - atomic number
18	How are the electrons arranged in atoms?	Orbiting the nucleus in shells
19	What is the maximum number of electrons that can go in the first shell?	2
20	What is the maximum number of electrons that can go in the second and third shells?	8

C1 Atomic structure and the periodic table

Key words

period	A horizontal row in the periodic table.
properties	The characteristics of something. In chemistry, chemical properties include the reactions a substance can take part in. Physical properties include colour and boiling point.
periodic table	A tabular representation of all known elements in order based on atomic number, eg all the noble gases are found on the right of the periodic table.
non-metal	Element that is a poor conductor of electricity and heat, and which forms negative ion.
metal	Shiny element that is a good conductor of electricity and heat, and which forms positive ion.

Key diagram – Periodic Table

The zig-zag line in this diagram separates the metals, on the left, from the non-metals, on the right.

Key knowledge

Elements are arranged in rows, called periods, in order of increasing atomic number.
Elements with similar properties are placed in vertical columns, called groups.
The table is called the periodic table because elements with similar properties occur at regular intervals.

The electronic structure of an element is linked to its position on the periodic table.

Electronic structure feature	Link to the periodic table
Number of shells	Period number
Number of electrons in outermost shell	Group number
Numbers added together	Atomic number

Required skills – Identifying trends in data

Group 0 (Noble gases)	**Group 1 (Alkali metals)**	**Group 7 (Halogens)**	**Transition metals**
8 electrons in their outer shell (except for helium)	1 electron in their outer shell.	7 electrons in the outer shell	Placed between groups 2 and 3 in the periodic table
They are unreactive	The reactivity of the elements increases going down the group. M + water → M hydroxide + hydrogen M + oxygen → M oxide M + chlorine → M chloride	The reactivity of the elements decreases down the group. M + chlorine → M chloride M + bromine → M bromide M + iodine → M iodide Halogen can displace each other in chemical reaction.	Form ions with different charges and coloured compounds. Used as catalyst. M + oxygen → M oxide M + chlorine → M chloride
Physical properties: • The boiling points of the noble gases are low • The boiling points increase going down the group.	Physical properties: • soft • relatively low melting points • low densities	Physical properties: • the melting point increases going down the group. • The boiling point increases going down the group.	Physical properties (compared to group 1): • higher melting points • higher densities • greater strength • greater hardness

Key story - The development of the periodic table

Early periodic tables were incomplete, since many elements were unknown and some elements were placed in groups with elements that were not similar to them based on the relative atomic mass.

Dmitri Mendeleev arranged the elements in order of increasing atomic weights. He also took into account the properties of the elements and their compounds. This meant that his table:

- had gaps in it (he predicted the properties of undiscovered elements)
- showed elements with similar chemical properties lined up in groups, even if it meant reversing their order.

21	How are elements arranged in the periodic table?	The elements are in order of atomic (proton) number and elements with similar properties are in groups.
22	How are elements arranged in the early periodic tables?	The elements were placed in strict order of atomic weights.
23	How did Mendeleev arrange his periodic table?	He ordered the elements based on atomic weights
24	What are groups in the periodic table?	The columns, numbered 1, 2, 3, 4, 5, 6, 7, 0
25	What does the group tell you about the electrons in an atom?	How many electrons in the outer shell. E.g. carbon is in group 4 so has 4 electrons in the outer shell
26	What are periods in the periodic table?	The rows in the periodic table
27	What can the period tell you about the electrons in an atom?	How many shells an atom has. E.g. carbon is in the second period so has two shells
28	Why did Mendeleev put some elements in groups?	Because they had similar chemical properties (e.g. they reacted violently with water)
29	Why did Mendeleev leave gaps in his periodic table?	For elements that had not been discovered yet

C1 Atomic structure and the periodic table

Key words

chromatography	Chromatography is used to separate different substances dissolved in a liquid.
crystallisation	The process of producing crystals from a solution by evaporating the solvent.
pure	a substance consists only of one element or one compound
dissolved	When a substance breaks up and mixes completely with a solvent to produce a solution.
soluble	Substance able to dissolve in solvent
solute	The dissolved substance in a solution.
solution	Mixture formed by a solute and a solvent

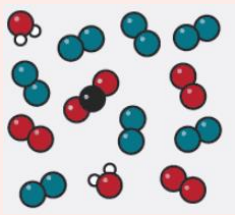
Key diagram

Element

Compound

Mixture of elements

Mixture of compounds



Mixture of elements and compounds

Key knowledge

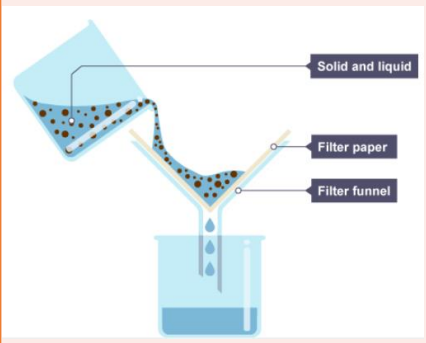
A mixture consists of two or more elements or compounds not chemically combined together. The chemical properties of each substance in the mixture are unchanged.

Mixtures can be separated by physical processes such as filtration, crystallisation, simple distillation, fractional distillation and chromatography. These physical processes do not involve chemical reactions and no new substances are mad

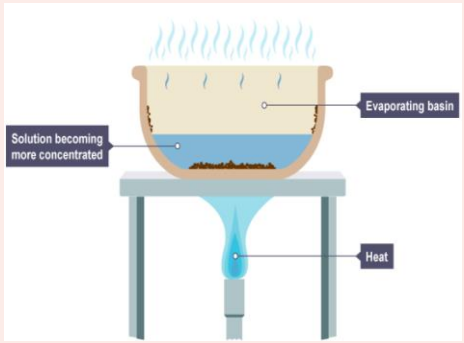
Pure substances have a sharp melting point but mixtures melt over a range of temperatures. This difference is most easily seen when the temperature of a liquid is measured as it cools and freezes.

Required Practical – Separation techniques

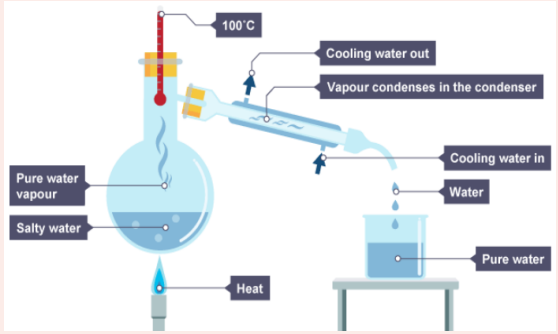
Filtration can be used to remove solid from liquid.



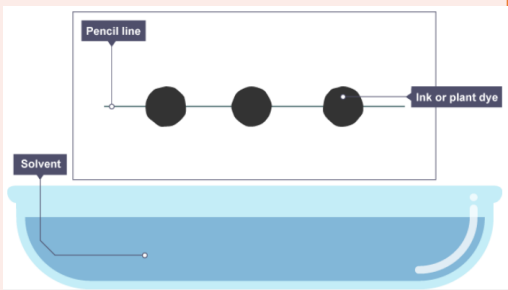
Evaporation is used to separate a soluble solid from a liquid.



Distillation is a process which uses evaporation and condensation in order to obtain a solvent from a solution.



Chromatography is a method for separating dissolved substances from one another.



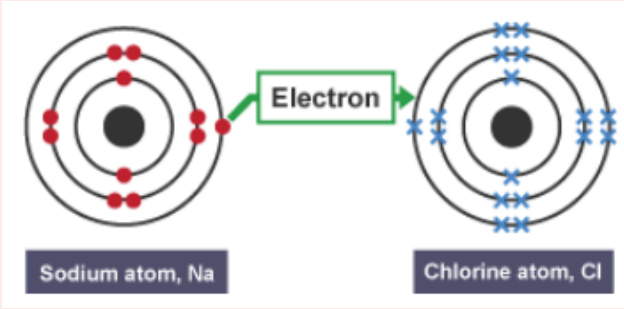
30	What does mixture consist of?	A mixture consists of two or more elements or compounds not chemically combined together.
31	How can mixture be seperated?	Mixtures can be separated by physical processes such as filtration, crystallisation, simple distillation, fractional distillation and chromatography.
32	What is chromatography?	Chromatography is a method for separating dissolved substances from one another.
33	What is evaporation?	Evaporation is used to separate a soluble solid from a liquid.
34	What is filtration?	Filtration can be used to remove solid from liquid.
35	What is distillation?	Distillation is a process which uses evaporation and condensation in order to obtain a solvent from a solution.
36	How can you test is a substance is pure?	Melting point and boiling point data can be used to distinguish pure substances from mixtures.
37	What is a pure substance in chemistry?	In chemistry, a pure substance is a single element or compound, not mixed with any other substance.

Ionic bonds

Key words

lattice	A regular grid-like arrangement of atoms in a material.
charge	Property of matter that causes a force when near another charge. Charge comes in two forms, positive and negative.
charged particles	Particles, usually ions or electrons, that carry electrical charges.
electron	Subatomic particle, with a negative charge and a negligible mass relative to protons and neutrons.
electrostatic force	A force of attraction between particles with opposite charges.
ion	Electrically charged particle, formed when an atom or molecule gains or loses electrons.

Key diagram



Key knowledge

Ionic compounds have regular structures (giant ionic lattices) in which there are strong electrostatic forces of attraction in all directions between oppositely charged ions. These compounds have high melting points and high boiling points because of the large amounts of energy needed to break the many strong bonds. When melted or dissolved in water, ionic compounds conduct electricity because the ions are free to move and so charge can flow.

Metal atoms lose electrons to become positively charged ions.

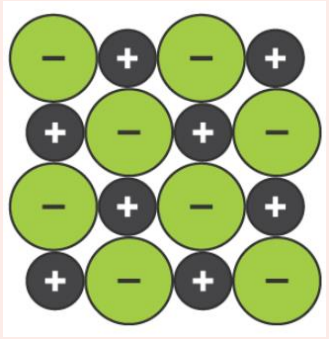
The ions produced by metals in Groups 1 and 2 have the electronic structure of a noble gas (Group 0) and a positive charge.

Non-metal atoms gain electrons to become negatively charged ions.

The ions produced by non-metals in Groups 6 and 7 have the electronic structure of a noble gas (Group 0) and a negative charge.

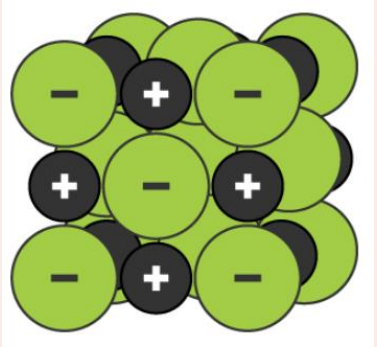
Key skill – Using models

A two-dimensional space-filling model



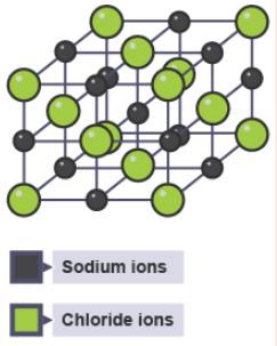
Shows the arrangement of ions in one layer, but it does not show how the next layer of ions is arranged

A three-dimensional space-filling model



Shows the arrangement of ions in a larger section of the crystal, but shows lots of free space between the ions, which there isn't.

A three-dimensional ball and stick model



Shows the arrangement of ions in a larger section of the crystal, but using sticks for bonds is misleading because the forces of attraction between ions actually act in all directions

38	List three types of chemical bonds.	Ionic, covalent and metalic.
39	What are the particles in ionic bonding?	Oppositely charge ions
40	What are the particles in covalent bonds?	Atoms that share electrons.
41	What are the particles in metalic bonding?	Atoms that share delocalised electrons.
42	When does ionic bond occurs?	Ionic bonding occurs in compounds formed from metals combined with non-metals.
43	When does covalent bonding occurs?	Covalent bonding occurs in most non-metallic elements and in compounds of non-metals.
44	When does metalic bonding occur?	Metallic bonding occurs in metallic elements and alloys.
45	What type of bond do metals form with non-metals?	Ionic
46	What happens to electrons when a metallic bond forms?	They are shared by large numbers of positive ions.
47	Which chemical bond form lumps or sheets made up of positive ions and delocalised electrons?	Metalic
48	Which chemical bond occur between metals and non-metals to form crystals?	Ionic
49	Which chemical bond occur between atoms with incomplete electron shells?	Ionic, Metalic and covalent.
50	What types of bonds are in molecule of water?	covalent
51	What types of bonds are in gold-copper alloy?	Metalic bonding
52	What type of bond is in Sodium Chloride?	Ionic bonding
53	What type of bonding is in carbon dioxide?	Covalent bonding
54	What are the two ways that atoms can join together?	By sharing electrons By transferring electrons
55	True or False: Ionic structures are large crystals formed by electrostatic attraction	TRUE
56	True or False: Both ionic and metallic structures have high melting points	TRUE
57	True or False: Metal structures conduct electricity only when melted.	FALSE
58	True or False: At room temperature, covalent structures are soli	FALSE
59	What happens to the electrons in an ionic bond?	They are transferred from a metal atom to a non-metal atom.
60	Why do atoms form positive ions when they lose electrons?	Because electrons are negatively charged

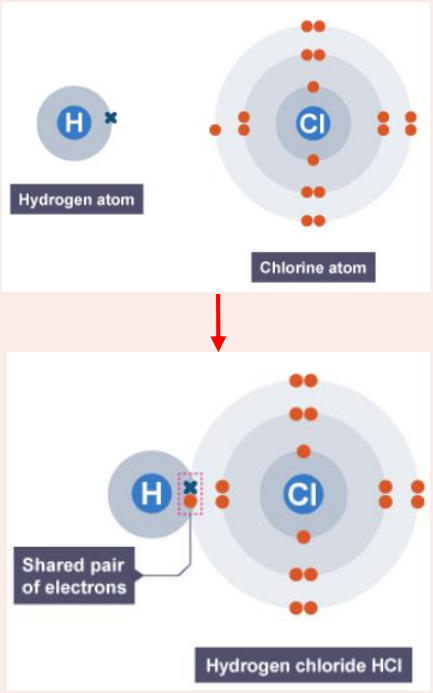
61	Magnesium requires two electrons to complete its outer shell. How many fluorine atoms need to bond to it to produce a stable ionic bond?	Two
62	How many electrons does Chlorine (2,8,7) need to loose o gain to achieve stable electron pattern.	Gain one electron
63	How many electrons does Neon (2,8) need to loose o gain to achieve stable electron pattern.	Neither gain nor lose
64	How many electrons does Sodium (2,8,1) need to loose o gain to achieve stable electron pattern.	Lose one electron
65	How many electrons does Oxygen (2,6) need to loose o gain to achieve stable electron pattern.	Gain two electrons
66	What happens to sodium when it reacts with oxygen?	Two sodium atoms each transfer one electron to complete the outer shell of one oxygen atom.
67	What is chemical formula of Potassium fluoride?	KF
68	What is chemical formula for Magnesium bromide?	$MgBr_2$
69	What is chemical fomula for Calcium fluoride?	CaF_2
70	What is chemical formula for Sodium oxide?	Na_2O
71	Ionic compounds are held together by _____ between oppositely charged ions.	electrostatic forces of attraction
72	True or False: Magnesium oxide has the formula MgO; each magnesium atom transfers two electrons to each oxygen atom.	TRUE
73	True or False: Magnesium sulfide has the formula MgS_2; each magnesium atom gives one electron to each sulfur atom.	FALSE
74	True or False: Magnesium chloride has the formula $MgCl_2$; each magnesium atom gives one electron to each chlorine atom.	TRUE
75	True or False: Magnesium fluoride has the formula MgF; each magnesium atom gives two electrons to a fluorine atom.	False
78	Does this set of euqation show ionic compounds fomration? $O + 2e^- \rightarrow O^{2-}$, $Mg - 2e^- \rightarrow Mg^{2+}$	Yes
77	Does this set of euqation show ionic compounds fomration? $O - 1e^- \rightarrow O^-$, $Na + 2e^- \rightarrow Na^{2-}$	No
78	Does this set of euqation show ionic compounds fomration? $Cl + e^- \rightarrow Cl^-$, $Na - e^- \rightarrow Na^+$	Yes
79	What is an ionic compound?	A giant structure of ions held together in a lattice by electrostatic forces
80	Why do ionic compounds have high melting and boiling points?	The electrostatic forces holding the ions together are very strong.
81	What is needed to allow electricity to flow through an ionic substance?	The ions are free to move and carry a charge
82	Why do ionic compounds only conduct electricity some of the time?	Ions are unable to move in solid ionic compounds. In solution ions are free to move through the liquid.

Covalent bonds

Key words

atom	The smallest part of an element that can exist.
charge	Property of matter that causes a force when near another charge. Charge comes in two forms, positive and negative.
charged particles	Particles, usually ions or electrons, that carry electrical charges.
electron	Subatomic particle, with a negative charge and a negligible mass relative to protons and neutrons.
stable	Atoms are stable if their outer shell contains its maximum number of electrons.
ion	Electrically charged particle, formed when an atom or molecule gains or loses electrons.

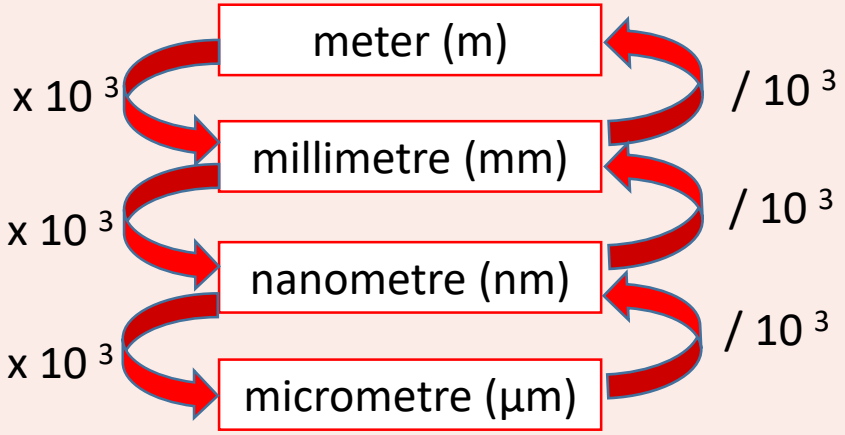
Key diagram



Key skill – calculating orders of magnitude

Each division or multiplication by ten is termed an **order of magnitude**. For example, there is **one** order of magnitude between the height of a four-year old child (1m) and the height of an apple tree (10 m).

The radius of an atom is measured in picometres (pm), 10^{-12} m.
The radius of a nucleus measured in femtometres (fm), 10^{-15} m.



Key knowledge

A covalent bond forms when two non-metal atoms share a pair of electrons.

Covalently bonded substances fall into two main types:
- simple molecules (few atoms)
- giant covalent structures

Substances that consist of small molecules are usually gases or liquids that have relatively low melting points and boiling points. These substances have only weak forces between the molecules (intermolecular forces). It is these intermolecular forces that are overcome, not the covalent bonds, when the substance melts or boils. The intermolecular forces increase with the size of the molecules, so larger molecules have higher melting and boiling points. These substances do not conduct electricity because the molecules do not have an overall electric charge.

In diamond, each carbon atom forms four covalent bonds with other carbon atoms in a giant covalent structure, so diamond is very hard, has a very high melting point and does not conduct electricity.
In graphite, each carbon atom forms three covalent bonds with three other carbon atoms, forming layers of hexagonal rings which have no covalent bonds between the layers.

Silica (or silicon dioxide), which is found in sand, has a similar structure to diamond, so its properties are similar to diamond.

One 'dot and cross' together represents a single bond, which is one bond pair of electrons. Two pairs of 'dots and crosses' side by side represent a double bond (as in O2). Three electron bond pairs is a triple bond (as in N2).

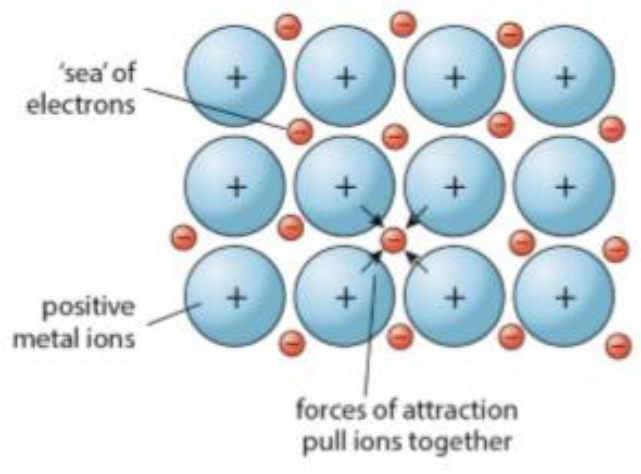
83	What is a covalent bond?	A chemical bond that involves the sharing of electron pairs between two or more non-metal atoms
84	How many pairs of electrons are shared in hydrogen chloride?	one
85	How many pairs of electrons are shared in methane?	four
86	How many pairs of electrons are shared in ammonia?	three
87	How many pairs of electrons are shared in water?	two
88	True or False: Substances consisting of small molecules are usually very dense.	FALSE
89	True or False: Substances consisting of small molecules are usually liquids or gases	TRUE
90	True or False: Substances consisting of small molecules are usually solids	FALSE
91	True or False: Substances consisting of small molecules are usually soluble in water.	FALSE
92	List two properties of substances that are made of small molecules?	Low melting and boiling point Never conduct electricity
93	Explain why sulfur dioxide has a higher boiling point than either carbon monoxide or carbon dioxide.	There are stronger intermolecular forces between its molecules Sulfur dioxide is a bigger substance than either carbon monoxide or carbon dioxide
94	Which factors influence the boiling point of substances made up of small molecule?	Size of the molecule Shape of the molecule
95	What type of bond holds monomers together in a polymer chain?	Strong covalent bonds
96	List two characteristics of polymers?	They form chains held together by covalent bonds. They are very large molecules.
97	True or False: Diamond is formed of flat layers, while graphite has a lattice structure.	FALSE
98	True or False: Graphite is heavier and denser than diamond.	FALSE
99	True or False: Graphite is formed from layered rings of carbon, diamond has a rigid lattice structure.	TRUE
100	True or False: Diamond has a lower melting point than graphite.	TRUE
101	Which giant covalent structures can conduct electricity?	Graphite, because its bonding and layered structure allows electrons to move
102	What is the typical property of diamond?	Very Hard
103	What is typical property of silicon dioxide?	White crystalline solid with a similar structure to diamond
104	What is typical property of graphite?	Soft, due to layers of atoms
105	How many bonds does each carbon atom have to other carbon atoms in diamond?	Four
106	What shape do the four carbon atoms in diamond have?	Tetrahedron
107	Why diamond does not conduct electricity?	No free electrons
108	Why diamond has high melting and boiling point?	Strong covalent bonds
109	Why diamond is very hard?	3D lattice structure of bonds
110	True or False: Diamond does not conduct electricity	TRUE
111	True or False: Diamond conducts thermal energy.	TRUE
112	True or False: Diamond conducts electricity.	FALSE
113	True or False: Diamond is a good insulator.	FALSE
114	List two common uses of diamond.	Jewellery Cutting tools
115	What is the structure of graphite?	Hexagonal rings stacked to form layers
116	How many carbon atoms is each carbon atom bonded to in graphite?	Three
117	Why is graphite good lubricant?	Weak bonds between the layers
118	Why does graphite conducts electricity?	Free electrons float between the layers
119	Why does graphite has high melting point?	Strong covalent bonds between atoms
120	Why is graphite a conductor of thermal energy?	Delocalised electrons can absorb heat
121	List two common uses of graphite	Pencil 'lead' Carbon microphones
122	Which substance is graphene similar to?	Graphite
123	What property of carbon nanotubes makes them ideal for reinforcing materials?	High tensile strength
124	What kind of structure does carbon nanotube has?	Cylindrical tube
125	What kind of structure does Graphene has?	Single atom-thick layer
126	What kind of structure does Diamond has?	3D Lattice
127	List two uses of fullerenes	Drug delivery Semi-conductors
128	What is metalic bonding?	Giant structures of positive ions and delocalised electrons arranged in a regular pattern

Metallic bonds

Key words

atom	The smallest part of an element that can exist.
charge	Property of matter that causes a force when near another charge. Charge comes in two forms, positive and negative.
charged particles	Particles, usually ions or electrons, that carry electrical charges.
electron	Subatomic particle, with a negative charge and a negligible mass relative to protons and neutrons.
electrostatic force	A force of attraction between particles with opposite charges.
delocalised	Electrons that are not associated with a particular atom.

Key diagram



Key knowledge

The metallic bond is the strong electrostatic force of attraction between the positive metal ions and the 'sea' of delocalised electrons.

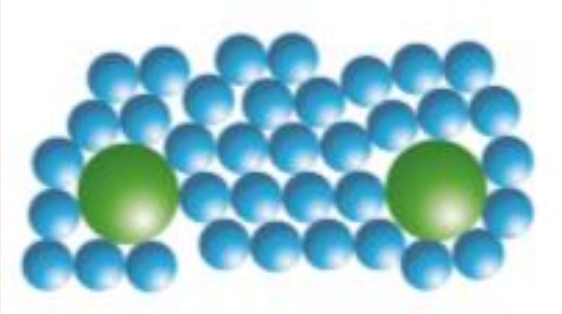
Metals have giant structures of atoms with strong metallic bonding. This means that most metals have high melting and boiling points.

In pure metals, atoms are arranged in layers, which allows metals to be bent and shaped. Pure metals are too soft for many uses and so are mixed with other metals to make alloys which are harder.

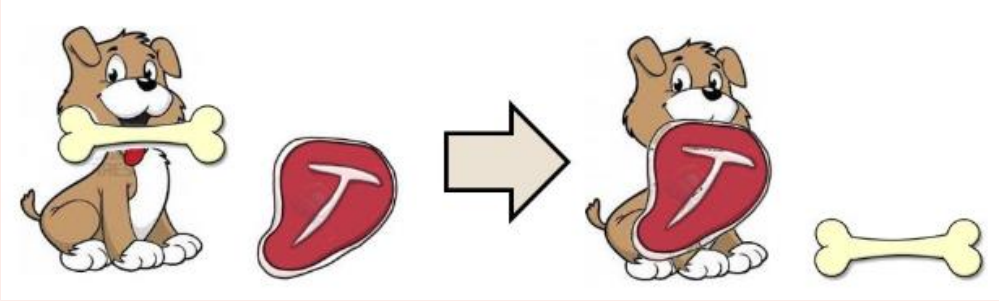
Metals are good conductors of electricity because the delocalised electrons in the metal carry electrical charge through the metal. Metals are good conductors of thermal energy because energy is transferred by the delocalised electrons.

Key process – Using models

In an alloy, there are atoms of different sizes. The smaller or bigger atoms distort the layers of atoms in the pure metal. This means that a greater force is required for the layers to slide over each other. The alloy is harder and stronger than the pure metal.



Displacement reactions involve a metal and a compound of a different metal. In a displacement reaction a more reactive metal will displace a less reactive metal from its compounds



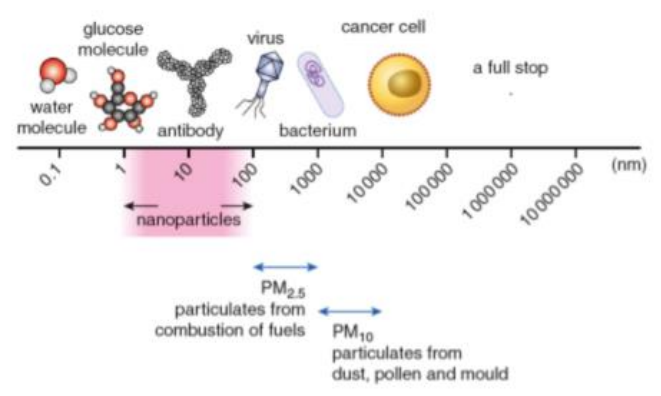
129	Why are metallic bonds so strong?	Positive ions are in a sea of delocalised electrons.
130	List two characteristics of metalic bonds.	Close-packed ions Delocalised electrons
131	How does heating break metallic bonds?	Heating transfers energy to positive metal ions, causing them to move around more rapidly and, eventually, the material to melt. Heating transfers energy to electrons, causing the material to melt.
132	What are smart alloys?	Alloys that return to their original shape when heated
133	Why are copper, gold, iron and aluminium often combined to form alloys?	Because alone they are too soft for many uses
134	What does bronze contain?	Copper and tin
135	What does Solder contain?	Tin and lead
136	What does steel contain?	Iron and carbon
137	Why is steel better for building bridges than iron?	Combining different sized atoms makes steel harder than iron or carbon. Iron reacts with oxygen to form rust.
138	List two characteristics of alloy.	Often harder than metals Lower melting and boiling points
139	Why are metals good conductors of electricity?	Metals are good conductors of electricity because the delocalised electrons
140	Why are metals a good conductors of thermal energy?	Metals are good conductors of electricity because the delocalised electrons

Nanoparticles

Key words

atom	The smallest part of an element that can exist.
nanotubes	Long cylindrical molecules made from carbon atoms joined together by covalent bonds.
nanoparticles	Tiny particles which are between 1 and 100 nanometres (nm) in size.
nanoscience	The study of structures between 1 and 100 nanometres (nm) in size.
electrostatic force	A force of attraction between particles with opposite charges.
ion	Electrically charged particle, formed when an atom or molecule gains or loses electrons.

Key diagram



Key knowledge

Nanoscience refers to structures that are 1–100 nm in size, of the order of a few hundred atoms.

Nanoparticles are between 1 and 100 nm in size. Each nanoparticle contains only a few hundred atoms.

When materials are present as nanoparticles, this can change the properties of the materials. Silver nanoparticles in clothes or deodorants stop bacteria growing in our sweat. Titanium dioxide nanoparticles in sunscreens protect us from ultraviolet light. Bigger particles could do the same, but they would leave a white coating on our skin. Many medical drugs are designed to work on one type of cell only. Nanoparticles can act like miniature envelopes to carry the drugs safely to the right cells.

Graphene is a two-dimensional compound as it is only one atom thick. It is made up of hexagonal rings of carbon atoms connected to one another by strong covalent bonds. Graphene is thermally stable. Graphene is an electrical conductor Graphene is the strongest material ever found, It is not only strong but elastic too and it can absorb white light

Fullerenes are molecules of carbon atoms with hollow shapes. The structure of fullerenes is based on hexagonal rings of carbon atoms but they may also contain rings with five or seven carbon atoms.
Fullerenes can be used for drug delivery into the body, as lubricants, and as catalysts. They can act as hollow cages to trap other molecules.

Carbon nanotubes are cylindrical fullerenes. Some of their special properties are: high tensile strength high electrical conductivity high thermal conductivity. They are useful: as semi-conductors in electrical circuits as catalysts for reinforcing materials, such as in tennis rackets.

Key skill – Calculating Surface area to volume ratio

 10 cm	 1 cm
Surface area 1 side = 10 x 10 = 100 cm^2 6 sides = 6 x 100 = 600 cm^2	**Surface area** 1 side = 1 x 1 = 1 cm^2 6 sides = 6 x 1 = 6 cm^2
Volume Volume = 10 x 10 x 10 = 1000 cm^3	**Volume** volume = 1 x 1 x 1 = 1 cm^3
Surface area : Volume ratio 600:1000 6:10 0.6:1	**Surface area : Volume ratio** 6:1

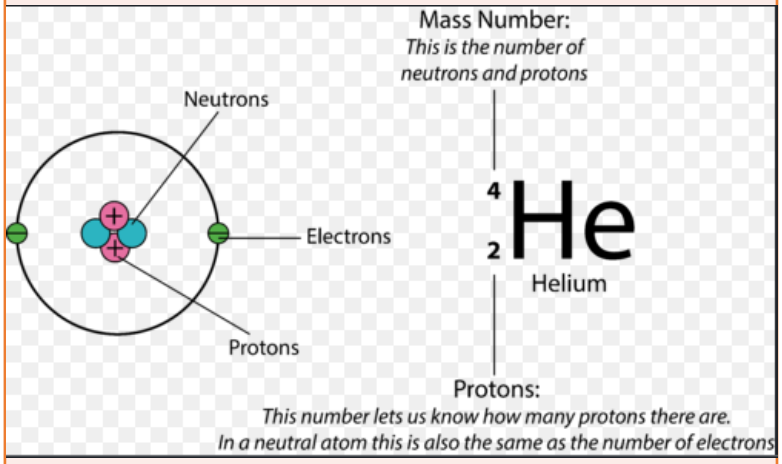
141	Which substance is graphene similar to?	Graphite
142	What property of carbon nanotubes makes them ideal for reinforcing materials?	High tensile strength
143	What kind of structure does carbon nanotube has?	Cylindrical tube
144	What kind of structure does Graphene has?	Single atom-thick layer
145	What kind of structure does Diamond has?	3D Lattice
146	List two uses of fullerenes	Drug delivery Semi-conductors

Chemical quantities and calculations (Combined)

Key words

Avogadro's constant	6.0×10^{23} number of particles
mass	The amount of matter an object contains. Mass is measured in kilograms (kg) or grams (g).
relative formula mass	The relative formula mass (Mr) of a compound is calculated by adding together the relative atomic masses (Ar) of the atoms present in a compound.
mass number	The number of protons and neutrons found in the nucleus of an atom.
relative atomic mass	. The mean relative mass of the atoms of the different isotopes in an element. It is the number of times heavier an atom is than one-twelfth of a carbon-12 atom.

Key diagram



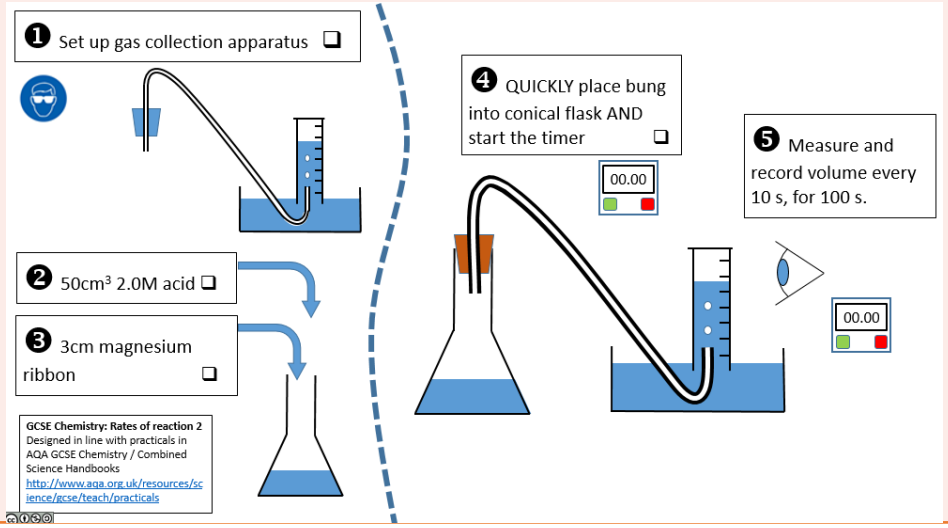
Key knowledge

The law of conservation of mass states that no atoms are lost or made during a chemical reaction so the mass of the products equals the mass of the reactants.

In a balanced chemical equation, the sum of the relative formula masses of the reactants in the quantities shown equals the sum of the relative formula masses of the products in the quantities shown.

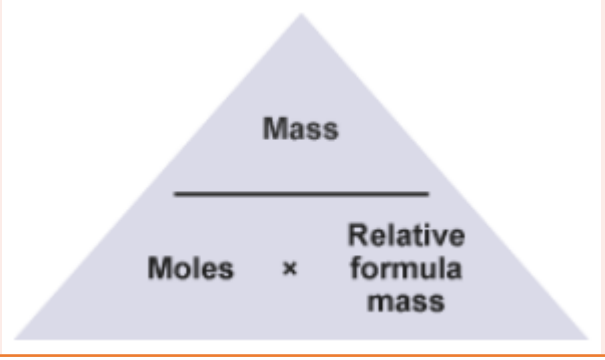
Many chemical reactions take place in solutions. The concentration of a solution can be measured in mass per given volume of solution, eg grams per dm3 (g/dm3).

Practical - investigation of mass changes using various apparatus.



Key process - Calculation

number of moles = mass ÷ relative formula mass



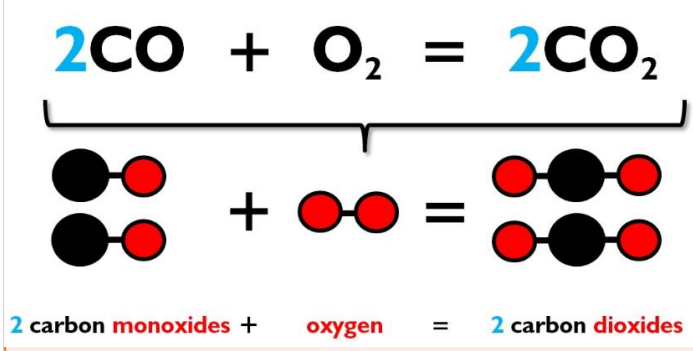
147	What is the relative electrical charge of proton?	1
148	What is the relative electrical charge of neutron?	0
149	what is the relative electrical charge of electron?	-1
150	What is the overall electrical charge of an atom?	neutral
151	In an atom, the number of electrons is _____ to the number of protons in the nucleus.	equal
152	What is atomic number?	The number of protons
153	All atoms of a particular element have the _____number of protons.	same
154	Atoms of different elements have _____ numbers of protons.	different
155	What is the radius of an atom?	0.1 nm (1 x 10-10 m)
156	What is the radius of the nucleus?	1/10 000 of that of the atom (about 1 x 10-14 m).
157	What is the relative mass of proton?	1
158	What is the relative mass of neutron?	1
159	What is the relative mass of electron?	very small
160	List the three subatomic particles.	proton, electron and neutron
161	List the particle in the nucleus.	Protons and neutrons
162	What is mass number?	The sum of the protons and neutrons in an atom is its mass number.
163	What are isotops?	Atoms of the same element with different numbers of neutrons.
164	What is relative atomic mass of an element ?	An average value that takes account of the abundance of the isotopes of the element
165	The law of _____ of mass states that no atoms are lost or made during a chemical reaction.	conservation
166	How many atoms of sulfur are represented by the following formula: $Al_2(SO_4)_3$	3
167	What is the number of atoms in Ag?	1
168	What is the number of atoms in $CaCl_2$?	3
169	What is the number of atoms in PCl_5?	6
170	What is the number of atoms in Fe_2O_3?	5
171	What is the missing number? $2Na + 2H_2O \rightarrow$ ____$NaOH + H_2$	2
172	What is the missing number? $C_3H_8 +$ ____$O_2 \rightarrow 3CO_2 + 4H_2O$	5
173	What is the missing number? ____$Al + 3O_2 \rightarrow 2Al_2O_3$	4
174	What is the missing number? $N_2 +$ ____$H_2 \rightarrow 2NH_3$	2
175	The relative formula mass (Mr) of a compound is the _____ of the atoms in the numbers shown in the formula.	sum of the relative atomic masses
176	What is relative formula mass for MgO ?	40
177	What is relative formula mass for NaF ?	42
178	What is relative formula mass for NaNO3. Atomic masses: Na=23 N=14 O=16	85
	Calculate the relative formula mass of Ca(OH)2. Ar Ca = 40 Ar O = 16 Ar H = 1	74
	2 g of solid reactant is heated to give a gas and a solid product. Would the mass of solid product be more or less than 2g?	less than 2g
	A student wishes to carry out the reaction between calcium carbonate and hydrochloric acid. What method could the student use to measure the mass of carbon dioxide gas given off in the reaction?	Carry out the reaction in a flask, on a balance or collect the gas in a srynge
	$MgCO_3 + 2HCl \rightarrow MgCl_2 + H_2O + CO_2$ Which compounds contains 5 atoms?	Magnesium carbonate
	$MgCO_3 + 2HCl \rightarrow MgCl_2 + H_2O + CO_2$. Which is a A liquid product?	H_2O
	$MgCO_3 + 2HCl \rightarrow MgCl_2 + H_2O + CO_2$ Which is a gas produced in the reaction?	Carbon dioxide
	When a metal reacts with oxygen the mass of the oxide produced is _____ than the mass of the metal.	greater
	In thermal decompositions of metal carbonates _____is produced and escapes into the atmosphere leaving the metal oxide as the only solid product.	carbon dioxide

Chemical quantities and calculations (Higher Tier)

Key words

mole	The amount of substance that contains the same number of particles as there are atoms in 12 g of carbon-12
Molar volume of gases	The mole of any gas has a volume of 24 dm3 or 24,000 cm3 at room temperature and pressure.
concentration of a solution	The amount in moles of solute or the mass in grams of solute in a given volume of solution can be calculated from its concentration in mol/dm^3.
percentage yield	The percent ratio of actual yield to the theoretical yield
atom economy	.

Key diagram- Reaction profile



Key knowledge

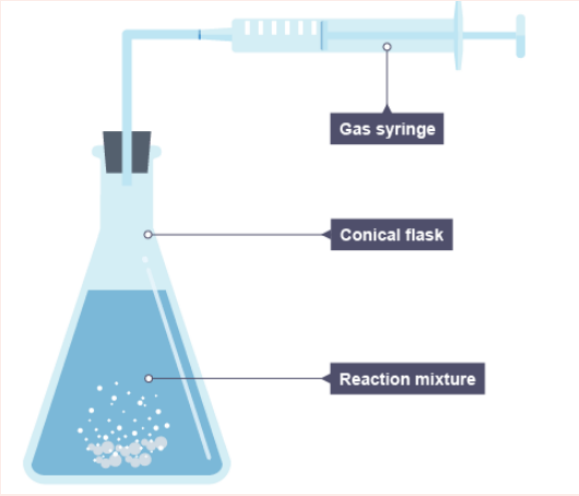
The masses of reactants and products can be calculated from balanced symbol equations. Chemical equations can be interpreted in terms of moles. For example: Mg +2HCl MgCl2+ H2 shows that one mole of magnesium reacts with two moles of hydrochloric acid to produce one mole of magnesium chloride and one mole of hydrogen gas.

The balancing numbers in a symbol equation can be calculated from the masses of reactants and products by converting the masses in grams to amounts in moles and converting the numbers of moles to simple whole number ratios.

The amount of a product obtained is known as the yield. When compared with the maximum theoretical amount as a percentage, it is called the percentage yield.

The atom economy (atom utilisation) is a measure of the amount of starting materials that end up as useful products.

Practical - investigation of mass changes using various apparatus.



Key process - Calculation

Equal amounts in moles of gases occupy the same volume under the same conditions of temperature and pressure. The volume of one mole of any gas at room temperature and pressure (20oC and 1 atmosphere pressure) is 24 dm3. The volumes of gaseous reactants and products can be calculated from the balanced equation for the reaction (Chemistry only)

$$\text{percentage yield} = \frac{\text{mass of product actually made}}{\text{maximum theoretical mass of product}} \times 100$$

$$\text{atom economy} = \frac{\text{total } M_r \text{ of the desired product}}{\text{total } M_r \text{ of all reactants}} \times 100$$

179	True or False: There are 3.01×10^{22} molecules in half a mole of water.	FALSE
180	True or False: There are 6.02×10^{23} molecules in one mole of oxygen.	TRUE
181	Look at this equation: $2Na + 2HCl \rightarrow 2NaCl + H_2$ What is the simplest whole number ratio of sodium reacted to hydrogen produced?	2:1
182	Look at this equation: $2K + 2H_2O \rightarrow 2KOH + H_2$ If 19.5 g of potassium reacts according to the above equation, what mass of hydrogen will be produced?	0.5 g
183	What is relative formula mass of $Ca(OH)_2$?	74
184	What is relative formula mass of $LiNO_3$?	69
185	What is relative formula mass of $MgSO_4$?	120
186	What is relative formula mass of Na_2CO ?	106
187	Look at this equation: $2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$. How many moles of butane are there?	2
189	Look at this equation: $2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$. How many moles of carbon dioxide are there?	8
190	Look at this equation: $2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$. How many moles of oxygen are there?	13
191	Look at this equation: $2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$. How many moles of water are there?	10
192	Look at this equation: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ If 16 g of methane reacts as shown in the equation, what masses of carbon dioxide will be produced?	44 g
193	Look at this equation: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ If 16 g of methane reacts as shown in the equation, what masses of water will be produced?	36 g
194	Look at this equation: $3Mg + 8HNO_3 \rightarrow 3Mg(NO_3)_2 + 2NO + 4H_2O$ 48 g of magnesium reacts according to the equation. What is the number of moles of NO produced?	1.33 mol
	Look at this equation: $3Mg + 8HNO_3 \rightarrow 3Mg(NO_3)_2 + 2NO + 4H_2O$ 48 g of magnesium reacts according to the equation. What is the number of moles of water produced? ?	2.67mol
195	Look at this equation: $3Mg + 8HNO_3 \rightarrow 3Mg(NO_3)_2 + 2NO + 4H_2O$ 48 g of magnesium reacts according to the equation. What is the mass of water produced?	48.06g
196	How many moles are in 48 g carbon?	4 moles
197	How many moles are in 50 g O_2?	1.56 moles
198	How many moles are in 26.5 g copper oxide?	0.33 moles
199	How many moles are in 28 g potassium hydroxide?	0.5 moles
200	Look at this equation: $2Na + 2HCl \rightarrow 2NaCl + H_2$ 10 g of sodium is reacted with hydrochloric acid according to the equation. How many moles of hydrogen are produced?	0.218 mol
201	Look at this equation: $2Na + 2HCl \rightarrow 2NaCl + H_2$ 10 g of sodium is reacted with hydrochloric acid according to the equation. How many moles of sodium chloride are produced?	0.435 mol
202	Look at this equation: $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$ Five moles of propane are burned in oxygen. How many moles of carbon dioxide are produced?	15 mol
203	Look at this equation: $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$ Five moles of propane are burned in oxygen. How many moles of water are produced?	20 mol
204	A solution contains 52 g of salt dissolved in 200 cm^3 of water. What is the concentration of the solution?	260 g/dm^3
205	A solution has a concentration of 34 g/dm^3. What mass of solute was added to 250 cm^3 to make this solution?	8.5g
206	What is the concentration if 1000 g of substance is dissolved in 100 cm^3?	10 g/cm^3
207	What is the concentration if 20 mg of substance is dissolved in 1000 cm^3	0.2 g/dm^3
208	What is the concentration if 10 g of substance is dissolved in 1 dm^3	10 g/dm^3
209	What is the concentration of 4.5 g of substnace is dissolved in 3000 cm^3?	1.5 g/dm^3
210	29 g of calcium chloride was produced in a reaction which was expected to generate 40 g of calcium chloride. What is the percentage yield of calcium chloride?	73%
211	The percentage yield of magnesium oxide produced in a reaction is 62%. The actual yield was 9 g. What is the theoretical yield of magnesium oxide for this reaction?	14.5 g
212	What is actual yield?	mass if the product made
213	What is theoretical yield?	The mass of product expected to be made
214	What is the yield of reaction if no products are lost?	100%
215	True or False: 0% yield means that no product has been lost.	FALSE
216	How many moles are in 36 dm^3 argon?	1.5 moles

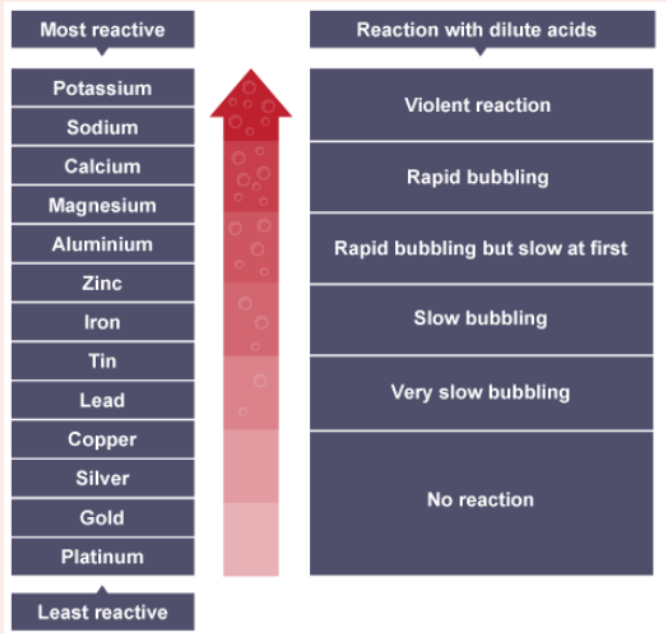
216	A re243action has a desired product with an Mr of 460. The reactants have an Mr of 670. What is the atom economy of the reaction?	69%
217	Sodium244 reacts with water to produce sodium hydroxide and hydrogen. If sodium hydroxide is the desired product, what is the atom economy o245f the reaction?	98%
218	What is atom economy?	A way of measuring the conversion of reactants to desired product
219	What is the value of the atom of economy in this reaction $S + O_2 \rightarrow SO_2$?	100%
220	What is the value of atom economy in this reaction nitrogen + hydrogen → ammonia?	100%
221	True or False: The lower the atom economy, the more wasteful the reaction	TRUE
222	True or False: A reaction with two products is more wasteful than a reaction with one product.	TRUE
223	True or False: To calculate atom economy, you need to use the atomic numbers of elements.	FALSE
224	True or False: If hydrogen is the desired product, the atom economy is 25%: $CH_4 + H_2O \rightarrow 3H_2 + CO$.	FALSE
225	A student is performing a titration. The initial reading on the burette is 10 cm^3. The final reading on the burette is 32 cm^3. How much acid did the student use?	22 cm^3
226	What is the concnetration of 0.4 moles of substance in 100 cm^3 of solution?	4 mol/dm^3
227	What is the concnetration of 0.8 moles of substance in 0.25 dm^3 of solution?	3.20 mol/dm^3
228	What is the concnetration of 1 mole of substnace in 500 cm^3 of solution?	2 mol/dm^3
229	What is the concnetration of 0.75 moles of substance in 1.5 dm^3 of solution?	0.50 mol/dm^3
230	Calculate the number of moles in a 500.0 cm^3 solution with concnetration of 1.5 mol/dm^3.	0.75 mol
231	Calculate the number of moles in a 50.0 cm^3 solution with concnetration of 0.75 mol/dm^3 .	0.0375 moles
232	Calculate the number of moles in a25.0 cm^3 solution with concnetration of 0.40 mol/dm^3.	0.01 moles
233	Calculate the number of moles in a 1 dm^3 solution with concnetration of 0.20 mol/dm^3.	0.20 moles
234	At room temperature and pressure (rtp), what volume does 14 g of nitrogen gas occupy?	12 dm^3
235	A sample of argon gas occupies a volume of 150 cm^3. How many moles are in this sample?	0.00625
236	How much volume 0.125 moles of nitrogen gas occupy?	3dm^3
237	How much volume 0.5 moles of hydrogen gas occupy?	12 dm^3
238	How much volume 1 mole of chlorine gas occupy?	24 dm^3
239	How much volume 0.0833 moles of oxygen gas occupy?	2 dm^3
240	How many moles are in 12 dm^3 carbon dioxide?	0.5 moles
241	How many moles are in 480 cm^3 helium?	0.02 moles
242	How many moles are in 18 dm^3 fluorine?	0.75 moles
243	What is a percentage yield?	A way of comparing the actual yield to the theoretical yield
244	True or False: If the amounts of reactants are calculated correctly, there will always be 100% product.	FALSE

Metals and reactivity series

Key words

displace	Take the place of another substance in a chemical reaction.
extracting	When something is taken away from or out of something else.
reactivity series	A list of elements in order of their reactivity
reactive	The tendency of a substance to undergo a chemical reaction.
oxidation	The gain of oxygen, or loss of electrons by a substance during chemical reaction

Key diagram



Key knowledge

When metals react with other substances the metal atoms form positive ions. The reactivity of a metal is related to its tendency to form positive ions.

Metals react with oxygen to produce metal oxides. The reactions are oxidation reactions because the metals gain oxygen.

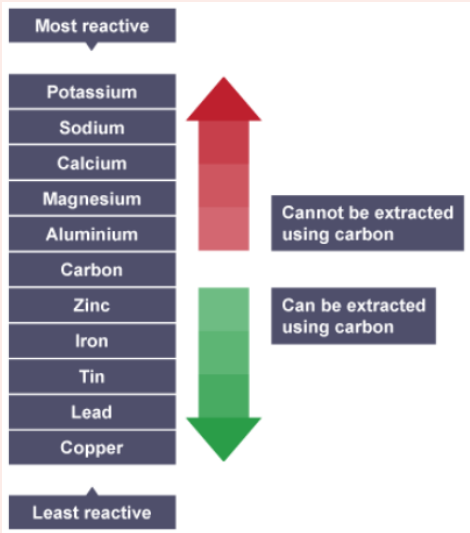
The non-metals hydrogen and carbon are often included in the reactivity series.

A more reactive metal can displace a less reactive metal from a compound.

Metals less reactive than carbon can be extracted from their oxides by reduction with carbon. Reduction involves the loss of oxygen.

Acids react with some metals to produce salts and hydrogen. These are **redox reactions**

Key process



Displacement reaction

magnesium + copper sulfate → magnesium sulfate + copper

$$Mg + CuSO_4 \rightarrow MgSO_4 + Cu$$

Extraction of metals from metal oxide

Carbon is a non-metal but it is more reactive than some metals. This means that some metals can be extracted from their metal oxides using carbon.

metal oxide + carbon → metal + carbon dioxide

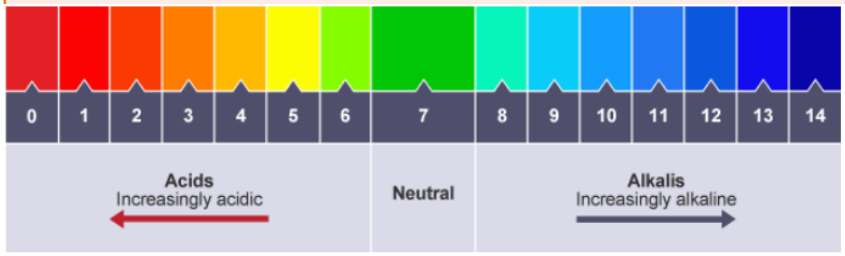
245	True or false? Tin oxide will react with copper because tin is higher in the reactivity series than copper.	FALSE
246	What is the product:magnesium oxide + copper →	magnesium oxide + copper (no reaction)
247	What is the product:hydrogen + copper oxide →	copper + water
248	What is the product:sodium + silver oxide →	sodium oxide + silver
249	What is the product:carbon + iron oxide →	iron + carbon dioxide
250	True or false: The most reactive metals form positive ions easily	TRUE
251	True or false: The most reactive metals are found on the right hand side of the periodic table	FALSE
252	True or false: The most reactive metals react vigorously with water	TRUE
253	True or false: The most reactive metals form negative ions easily.	FALSE
254	True or false: When lithium displaces copper oxide no reaction takes place	FALSE
255	True or false: When lithium displaces copper oxide copper transfers electrons to lithium	FALSE
256	True or false: When lithium displaces copper oxide lithium oxide and copper are formed.	TRUE
257	True or false: When lithium displaces copper oxide thium transfers electrons to copper	TRUE
258	The elements in Group 7 of the periodic table are known as the _____.	halogens
259	Why halogend have similar chemical reactions?	Because they all have seven electrons in their outer shell
260	Are halogens metals or non-metals?	Non-metals
261	The halogens consist of molecules made of _____ of atoms.	pairs
262	In Group 7, the further down the group an element is the _____ its relative molecular mass, melting point and boiling point.	higher
263	In Group 7, the reactivity of the elements _____going down the group	decreases
264	A more reactive halogen can _____ a less reactive halogen from an aqueous solution of its salt.	displace
265	Why does the melting and boiling point increase going down the group 7?	the molecules become larger the intermolecular forces become stronger more energy is needed to overcome these forces
266	What is the colour of Chlorine?	Pale green
267	What is the colour of Bromine?	Brown
268	What is the colour of Iodine?	Purple-black
269	What state is Chlorine at room temperature?	Ges
270	What state is Bromine at room temperature?	Liquid
271	What state is Iodine at room temperature?	Solid
272	sodium + chlorine → _____	sodium chloride
273	2Na(s) + Cl2(g) → 2_____(s)	NaCl
274	Write a balanced equation for the reaction of potassium with bromine to produce solid potassium bromide, KBr. Include state symbols.	2K(s) + Br2(l) → 2KBr(s)
275	Write a balanced equation for the reaction of iron with chlorine to produce solid iron(III) chloride, FeCl3. Include state symbols.	2Fe(s) + 3Cl2(g) → 2FeCl3(s)
276	Which non-metals are part of reactivity series of metals?	hydrogen and carbon
277	Metals less reactive than carbon can be extracted from their oxides by _____.	reduction with carbon
278	True or false? A half equation shows you what happens, in terms of electron transfer, to one species in the reaction.	TRUE
279	What would the half equation for aluminium ions converting to aluminium require?	Each aluminium ion gains three electrons.
280	What is the removal of oxygen known as in chemistry?	reduction
281	What is addition of oxygen known in chemisrtry?	oxydation
282	How can aluminium be extracted?	electrolysis
283	How can iron be extracted?	extracted with carbon
284	True or false: Copper oxide is reacted with carbon. Copper is reduced.	TRUE
285	True or false: Copper oxide is reacted with carbon. Copper is oxidised.	FALSE
286	True or false: Copper oxide is reacted with carbon. Carbon dioxide is produced	TRUE
287	True or false: Copper oxide is reacted with carbon. Carbon is oxidised.	TRUE
288	What type of reaction is t the reaction between lead oxide and carbon, where carbon has previously been heated in oxygen.	displacement reaction
289	What is reduced in the reaction between lead oxide and carbon, where carbon has previously been heated in oxygen?	Lead oxide
290	Acids react with some metals to produce _____.	salts and hydrogen
291	True or false? Hydrogen gas would be formed upon reaction of nitric acid with copper metal.	TRUE
292	When reacting a metal with an acid, what two things would you expect to observe?	Dissolving of the metal as it reacts Bubbling
293	Why is the reaction between iron and sulfuric acid a redox reaction?	Iron loses electrons and hydrogen gains electrons

Acid and Alkali

Key words

acid	Substance producing more hydrogen ions than hydroxide ions when dissolved in water.
alkali	Substance producing more hydroxide ions than hydrogen ions when dissolved in water.
dissociation	The breaking up of a molecule into ions when dissolved in water.
universal indicator	A chemical solution that produces many different colour changes corresponding to different pH levels.

Key diagram



Indicator	Acidic	Neutral	Alkaline
Litmus paper	Red	Purple	Blue
Methyl orange	Red	Yellow	Yellow
Phenolphthalein	Colourless	Colourless	Pink

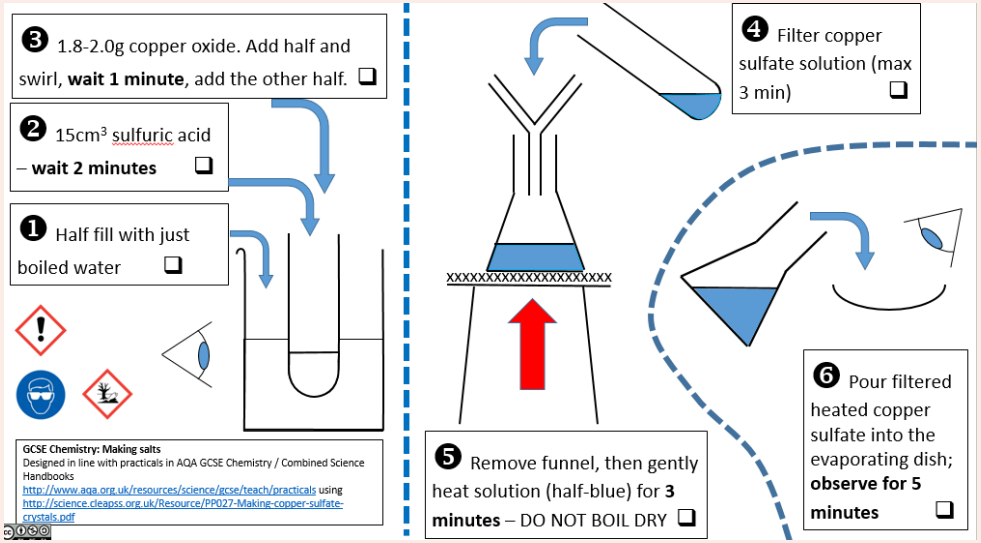
Key knowledge

Acids are neutralised by alkalis (eg soluble metal hydroxides) and bases (eg insoluble metal hydroxides and metal oxides) to produce salts and water, and by metal carbonates to produce salts, water and carbon dioxide.

Hydrochloric acid (HCl) produces chlorides
Nitric acid (HNO_3) produces nitrates
Sulfuric acid (H_2SO_4) produces sulfates.

Soluble salts can be made from acids by reacting them with solid insoluble substances, such as metals, metal oxides, hydroxides or carbonates. The solid is added to the acid until no more reacts and the excess solid is filtered off to produce a solution of the salt. Salt solutions can be crystallised to produce solid salts.

Required practical



Key process

An acid-alkali neutralisation is the reaction between hydrogen ions and hydroxide ions, forming water.

hydrochloric acid reacts with sodium hydroxide solution

↓

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

294	List 32three types of chemical bonds.	Ionic, covalent and metalic.
295	What are the particles in ionic bonding?	Oppositely charge ions
296	What are the particles in covalent bonds?	Atoms that share electrons.
297	What are the particles in metalic bonding?	Atoms that share delocalised electrons.
298	When does ionic bond occurs?	Ionic bonding occurs in compounds formed from metals combined with non-metals.
299	When does covalent bonding occurs?	Covalent bonding occurs in most non-metallic elements and in compounds of non-metals.
300	When does metalic bonding occur?	Metallic bonding occurs in metallic elements and alloys.
301	What type of bond do metals form with non-metals?	Ionic
302	What happens to electrons when a metallic bond forms?	They are shared by large numbers of positive ions.
303	Which chemical bond form lumps or sheets made up of positive ions and delocalised electrons?	Metalic
304	Which chemical bond occur between metals and non-metals to form crystals?	Ionic
305	Which chemical bond occur between atoms with incomplete electron shells?	Ionic, Metalic and covalent.
306	What types of bonds are in molecule of water?	covalent
307	What types of bonds are in gold-copper alloy?	Metalic bonding
308	What type of bond is in Sodium Chloride?	Ionic bonding
309	What type of bonding is in carbon dioxide?	Covalent bonding
310	What are the two ways that atoms can join together?	By sharing electrons By transferring electrons
311	True or False: Ionic structures are large crystals formed by electrostatic attraction	TRUE
312	True or False: Metal structures conduct electricity only when melted.	FALSE
313	What happens to the electrons in an ionic bond?	They are transferred from a metal atom to a non-metal atom.
314	Why do atoms form positive ions when they lose electrons?	Because electrons are negatively charged
315	Magnesium requires two electrons to complete its outer shell. How many fluorine atoms need to bond to it to produce a stable ionic bond?	Two
316	How many electrons does Chlorine (2,8,7) need to loose o gain to achieve stable electron pattern.	Gain one electron
317	How many electrons does Neon (2,8) need to loose o gain to achieve stable electron pattern.	Neither gain nor lose
318	How many electrons does Sodium (2,8,1) need to loose o gain to achieve stable electron pattern.	Lose one electron
319	How many electrons does Oxygen (2,6) need to loose o gain to achieve stable electron pattern.	Gain two electrons
320	Acids produce _____ in aqueous solutions	hydrogen ions (H+)
321	Aqueous solutions of alkalis contain _____.	hydroxide ions (OH–)
322	The pH scale, from ___ to ____, is a measure of the acidity or alkalinity of a solution	0 to 14
323	The pH scale, from 0 to 14, is a measure of the _____ or _____ of a solution	acidity or alkalinity
324	A solution with pH 7 is _____	neutral
	Aqueous solutions of acids have pH values of less than _____	7

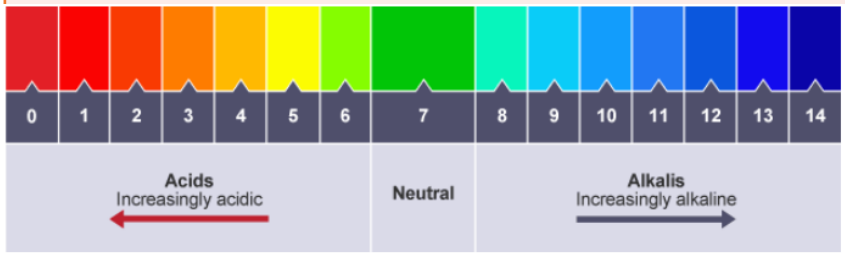
	aqueous solutions of alkalis have pH values greater than ____.	7
	Write the half equation for neutralisation.	$H^+ + OH^- \rightarrow H_2O$
	What are the products when potassium hydroxide reacts with hydrochloric acid?	Potassium chloride and water
	True or false? Both metal oxides and metal carbonates act as bases.	TRUE
	What are the products of acid and bse reaction?	produces only water and a salt
	True of False: Base reacts with alkalis?	FALSE
	True or False: Bases react with acids.	TRUE
	True of False: Most bases are insoluble.	TRUE
	True or False: Soluble bases are alkalis	TRUE
	An equal concentration of nitric acid and sodium hydroxide are added to a test tube with universal indicator. What final colour would be observed?	green
	True or false? Acids are substances that turn universal indicator blue.	FALSE
	What are the aqueous ions of barrium hydroxide	$Ba^{2+} + OH^-$
	What are the aqueous ions of Phosphoric acid	$H^+ + PO_4^{3-}$
	What are the aqueous ions of Hydrobromic acid	$H^+ + Br^-$
	What are the aqueous ions of Lithium hydroxide	$Li^+ + OH^-$
	True or False: Acids release hydrogen and hydroxide in aqueous solution	FALSE
	True or False: Acids neutralise bases	TRUE
	True or False: Acids turn litmus paper red	TRUE
	True or False: Acids release hydrogen ions in aqueous solution	TRUE
	True or false? The term soluble means that a substance cannot dissolve in a solvent.	FALSE
	True or false? To make a soluble salt by crystallisation from solution, the first step is to add an excess of acid to a metal oxide.	FALSE
	What is the salt produced when magnesium oxide reacts with nitric acid	$Mg(NO_3)_2$
	What is the salt produced when zinc carbonate + hydrochloric acid	$ZnCl_2$
	What is the salt produced when sodium hydroxide + hydrochloric acid	NaCl
	What is the salt produced when iron + sulfuric acid	$FeSO_4$
	How do we get solid salt from a salt solution?	crystalisation
	what is produced in of the reaction of calcium hydroxide with nitric acid?	Calcium nitrate Water
	Metals react with oxygen to produce _____.	metal oxides

Acid and Alkali – Higher Tier

Key words

acid	Substance producing more hydrogen ions than hydroxide ions when dissolved in water.
alkali	Substance producing more hydroxide ions than hydrogen ions when dissolved in water.
dissociation	The breaking up of a molecule into ions when dissolved in water.
universal indicator	A chemical solution that produces many different colour changes corresponding to different pH levels.

Key diagram



Indicator	Acidic	Neutral	Alkaline
Litmus paper	Red	Purple	Blue
Methyl orange	Red	Yellow	Yellow
Phenolphthalein	Colourless	Colourless	Pink

Key knowledge

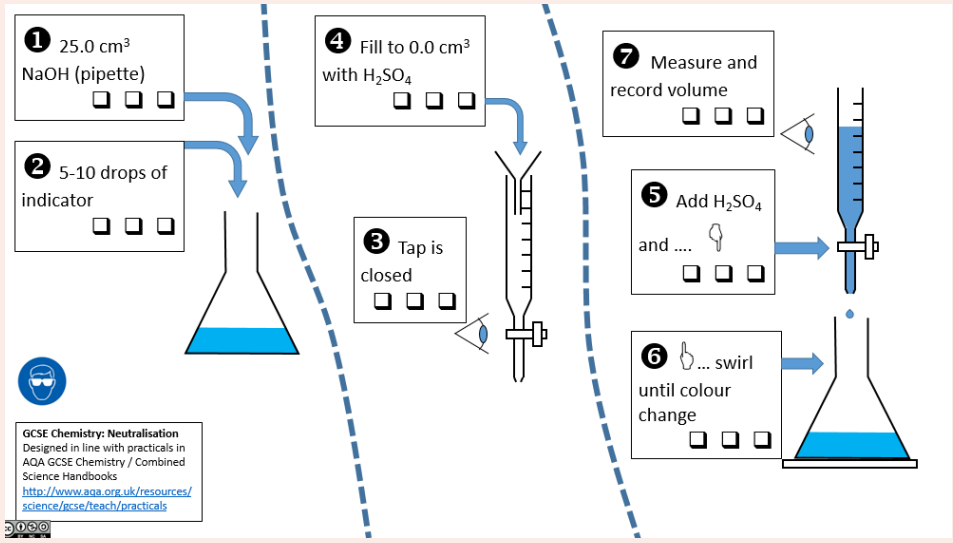
A strong acid is completely ionised in aqueous solution. Examples of strong acids are hydrochloric, nitric and sulphuric acids.

A weak acid is only partially ionised in aqueous solution. Examples of weak acids are ethanoic, citric and carbonic acids.

For a given concentration of aqueous solutions, the stronger an acid, the lower the pH.

As the pH decreases by one unit, the hydrogen ion concentration of the solution increases by a factor of 10.

Required practical



Key process

An acid-alkali neutralisation is the reaction between hydrogen ions and hydroxide ions, forming water.

hydrochloric acid reacts with sodium hydroxide solution

↓

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

↓

$H^+(aq) + Cl^-(aq) + Na^+(aq) + OH^-(aq) \rightarrow Na^+(aq) + Cl^-(aq) + H_2O(l)$

↓

$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

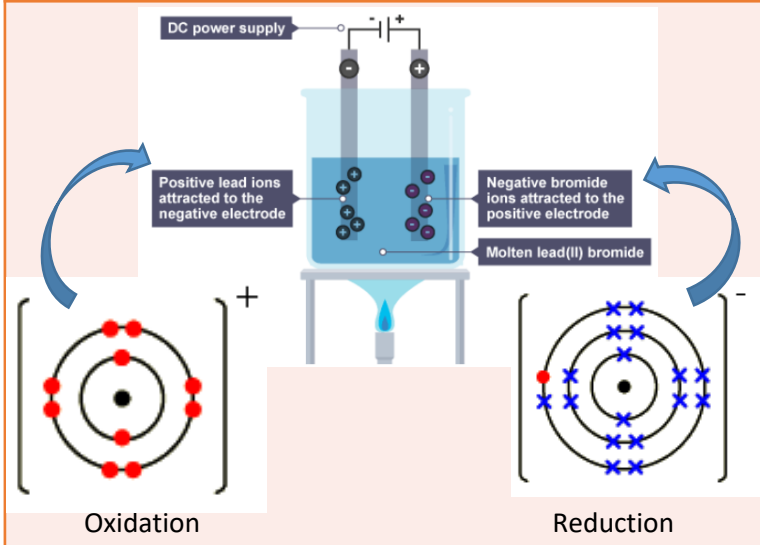
325	Which element do metals react with in the ground that then has to be removed, after the ore is extracted in a process called purification?	oxygen
326	Sodium oxide, when added to water, turns universal indicator purple, which other metal would react similarly?	Lithium oxide
327	What is the product of: $Rb_2O + H_2O \rightarrow$	rubidium hydroxide
328	What is the product of: $Li_2O + H_2O \rightarrow$	lithium hydroxide
329	What is the product of: K + O2 →	potassium oxide
330	What is the product of: $Na_2O + H_2O \rightarrow$	sodium hydroxide
331	Describe what happens when potassium and oxygen react in reards to oxydation and reduction.	The potassium is oxidised. The oxygen is reduced.
332	True or False: When sodium is added to water there would be no reaction	FALSE
333	True or False: When sodium is added to water the product is sodium hydroxide.	TRUE
334	True or False: When sodium is added to water the solution would be very acidic.	FALSE
335	True or False: When sodium is added to water The formula of the product would be NaOH.	TRUE
336	Examples of strong acids are:	hydrochloric, nitric and sulfuric acids.
337	Examples of weak acids are:	ethanoic, citric and carbonic acids.
338	As the pH decreases by one unit, the hydrogen ion concentration of the solution increases by a factor of ___.	10
339	True or false? Solutions of weak acids are always highly acidic.	FALSE
340	An increase of pH from 6 to 7 results in a solution with ____	ten times fewer hydrogen ions
341	A strong acid is _____ionised in aqueous solution.	completely
342	A weak acid is only _____ ionised in aqueous solution.	partially

Electrolysis

Key words

electrode	A conductor used to establish electrical contact with a circuit.
electrolyte	A substance which, when molten or in solution, will conduct an electric current.
molten	A term used to describe a liquid substance (eg rock, glass or metal) formed by heating a solid.
cathode	The electrode attached to the negative terminal of a battery
anode	The electrode attached to the positive terminal of a battery.
charged particles	Particles, usually ions or electrons, that carry electrical charges.

Key diagram



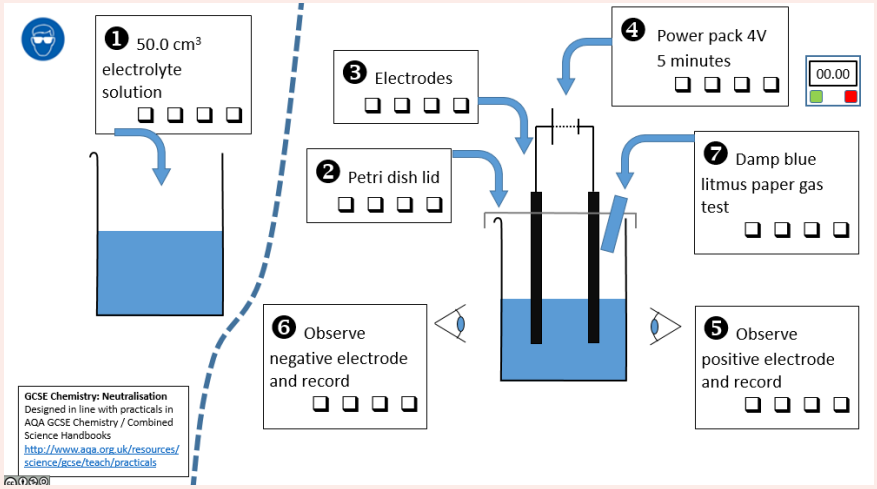
Key knowledge

When an ionic compound is melted or dissolved in water, the ions are free to move about within the liquid or solution. These liquids and solutions are able to conduct electricity and are called electrolytes.

Metals can be extracted from molten compounds using electrolysis. Electrolysis is used if the metal is too reactive to be extracted by reduction with carbon or if the metal reacts with carbon.

The ions discharged when an aqueous solution is electrolysed using inert electrodes depend on the relative reactivity of the elements involved. At the negative electrode (cathode), hydrogen is produced if the metal is more reactive than hydrogen. At the positive electrode (anode), oxygen is produced unless the solution contains halide ions when the halogen is produced.

Required Practical – electrolysis



Key process

Reactions at electrodes can be represented by half equations.

Cathodes at the cathode gain electrons, this is called reduction.

$2H^+ + 2e^- \rightarrow H_2$

$Pb^{2+} + 2e^- \rightarrow Pb$

Anion at the anode loose electrons, this is called oxidation

$4OH^- \rightarrow O_2 + 2H_2O + 4e$

$2Br^- \rightarrow Br_2 + 2e^-$

343	When an ionic compound is melted or dissolved in water, the ions are_____.	free to move
344	What is electrolyte?	A liquid or solution of ionic compound able to conduct electricity.
345	Passing an electric current through electrolytes causes the ions to _____ to the electrodes.	move
346	In electrolysis positively charged ions move to the _____	negative electrode (the cathode)
347	During electrolysis negatively charged ions move to the _____	positive electrode (the anode)
348	Why must ionic compounds be molten in electrolysis?	Because the ions must be free to move to the electrodes
349	What would the electrolysis of molten magnesium chloride produce?	Magnesium metal
350	What is anion?	The negative ion
351	What is cation?	The positive ion.
352	What is the name of the positive electrode?	anode
353	What is the name of the negative electrode?	catode
354	What is the product is solid lithium chloride is electrolised?	no reaction
355	what is the product if lithium chloride solution is electrolised?	lithium and chlorine
356	What are the products of electrolysis of molten copper oxide?	copper and oxygen
357	What are the products of the electrolysis of molten lead chloride?	lead and chlorine
358	What two things happen in electrolysis of potassium chloride?	K+ ions move toward the cathode. Cl^- ions move toward the anode.
359	What two things happen in electrolysis of aluminium oxide?	Aluminium ions move toward the cathode. Oxide ions are attracted to the positively charged electrode.
360	What two things happen during the process of electrolysis?	Negative ions will lose electrons at the anode to form an element. Positive ions will gain electrons at the cathode to form an element.
361	What is the first step in the electrolysis of zinc chloride?	Melt the zinc chloride
362	True or false? Ionic compounds always conduct electricity because they consist of charged particles.	FALSE
363	What is the product of electrolysis of chlorine?	no product, no reaction
364	What is the product of electrolysis of molten copper bromide?	copper and bromine
365	What is the product of electrolysis of iron iodide, molten?	iron and iodine
366	What is the product of electrolysis of molten tin chloride?	tin and chlorine
367	True or false: during electrolysis of tin chloride tin will be discharged at the cathode?	TRUE
368	True or false: during electrolysis of tin chloride tin will be reduced?	TRUE

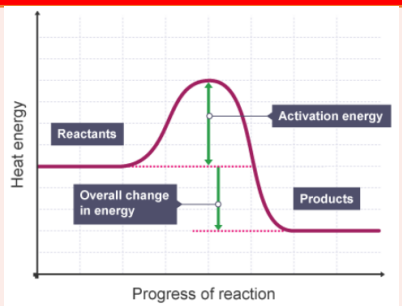
369	True or false: during electrolisis of tin chloride tin will gain electrons?	TRUE
370	True or false: during electrolisis of tin chloride tin will be oxidised?	FALSE
371	When is electrolysis useful in metal extractions?	When the metal is too reactive to be extracted by reduction with carbon or if the metal reacts with carbon.
372	Iron is not usually produced using electrolysis. Why?	It is cheaper to extract iron from its ore using carbon as the reducing agent.
373	Why is aluminium a relatively expensive metal?	A large supply of electrical power is needed to extract it from its ore.
374	True or false: The metals toward the top of the reactivity series usualy require electrolysis for extraction?	TRUE
375	True or false: Graphite anodes must be replaced periodically because they are oxidised to carbon dioxide ?	TRUE
376	True or false: Graphite anodes must be replaced periodically because the metal melts?	FALSE
377	True or false: Graphite anodes must be replaced periodically because they react with the aluminium?	FALSE
378	True or false: Graphite anodes must be replaced periodically because they react with the oxygen produced at the anode?	TRUE
379	True or false: in order to perform electrolysis we need bunsen burner?	FALSE
380	What is the product at the anode durng electrolysis of aqueus copper chloride?	chloride
381	What is the product at the cathode during electrolysis of aqueus magnesium chloride?	hydrogen
382	What is the product at the cathode during electrolysis of aqueus silver nitrate?	silver
383	what is the product at the anode durng electrolysis of aqueus copper sulphate?	oxygen

Exothermic and Endothermic reactions

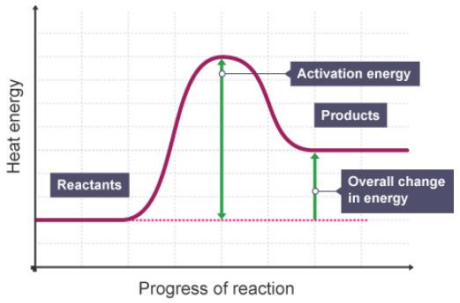
Key words

endothermic	Reaction in which energy is taken in.
activation energy	The minimum amount of energy that colliding particles must have for them to react.
energy level diagram	Chart showing the energy in the reactants and products, and the difference in energy between them.
exothermic	Reaction in which energy is given out to the surroundings.
oxidation	The gain of oxygen, or loss of electrons
reduction	The loss of oxygen or the gain of electrons.

Key diagram- Reaction profile



A reaction profile for an exothermic reaction



A reaction profile for an endothermic reaction

Key knowledge

An exothermic reaction is one that transfers energy to the surroundings so the temperature of the surroundings increases.

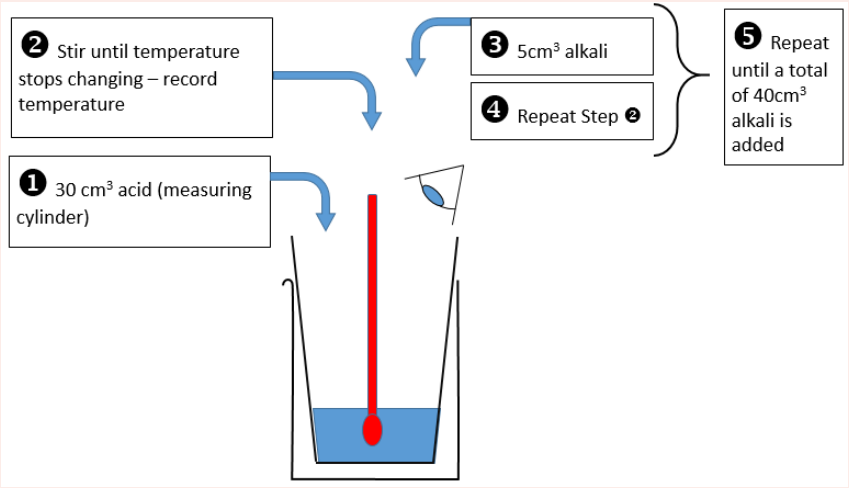
Exothermic reactions include combustion, many oxidation reactions and neutralisation.

An endothermic reaction is one that takes in energy from the surroundings so the temperature of the surroundings decreases.

Endothermic reactions include thermal decompositions and the reaction of citric acid and sodium hydrogen carbonate.

Reaction profiles can be used to show the relative energies of reactants and products, the activation energy and the overall energy change of a reaction.

Required Practical – Investigate temperature change



Key process

The energy change in a reaction can be calculated using bond energies. A bond energy is the amount of energy needed to break one mole of a particular covalent bond.

Different bonds have different bond energies. These are given when they are needed for calculations.

To calculate an energy change for a reaction:

- add together the bond energies for all the bonds in the reactants - this is the 'energy in'
- add together the bond energies for all the bonds in the products - this is the 'energy out'
- energy change = energy in - energy out

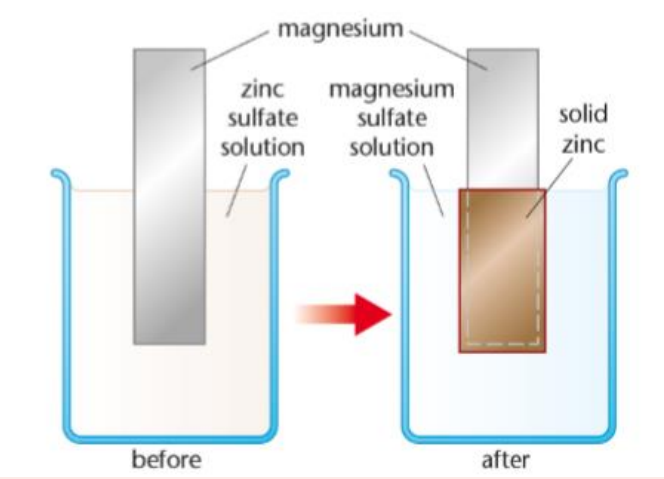
384	What is exothermic reaction?	An exothermic reaction is one that transfers energy to the surroundings so the temperature of the surroundings increases.
385	What is endothermic reaction?	When energy is taken in from the surroundings, this is called an endothermic reaction and the temperature of the surroundings decreases.
386	Give exmples of exothermic reaction.	combustion reactions many oxidation reactions most neutralisation reactions
387	Give examples of endithermic reactions.	thermal decomposition reactions the reaction of citric acid and sodium hydrogencarbonate
388	What dies an energy level diagram show?	Reaction profiles can be used to show the relative energies of reactants and products, the activation energy and the overall energy change of a reaction.
389	What is activation energy?	the minimum energy needed by particles when they collide for a reaction to occur.
390	How is actication energy represented in the reaction profile?	The activation energy is shown as a 'hump' in the line, which starts at the energy of the reactants and is equal to the difference in energy between the top of the 'hump' and the reactant
391	Describe how you can tell from a reaction profile that a reaction is exothermic.	In the profile for an exothermic reaction, the overall change is negative.

Chemical cells and fuel cells (chemistry only)

Key words

battery	Batteries consist of two or more cells connected together in series to provide a greater voltage.
cell	Cells contain chemicals which react to produce electricity.
fuel cell	Device that produces a voltage continuously when supplied with a fuel and oxygen.
voltage	The potential difference across a cell, electrical supply or electrical component. It is measured in volts (V).
flammable	Able to ignite and burn.

Key diagram



Key knowledge

Exothermic reactions transfer energy to their surroundings. This is usually transferred by heating, but the energy can be transferred in other ways. Chemical cells use chemical reactions to transfer energy by electricity.

Fuel cells produce a voltage continuously, as long as they are supplied with a fuel and oxygen (from the air).
In a hydrogen-oxygen fuel cell, hydrogen and oxygen are used to produce a voltage. Water is the only product.

Hydrogen + oxygen → water

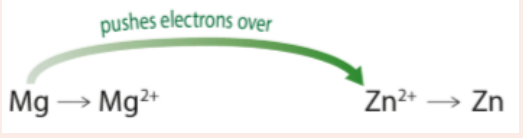
$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$

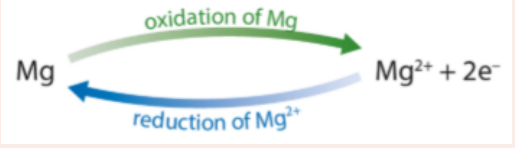
Key analysis

	Fuel cell	Petrol or diesel
Strengths	Quiet in use; only waste product is water; fewer moving parts	Petrol and diesel are easier to store; thousands of filling stations
Weaknesses	Hydrogen is more difficult to store; few filling stations	Noisy in use; carbon dioxide is a waste product; many moving parts

Key process

A voltage is produced in a simple cell because of the relative reactivity's of two metals. The more reactive metal forces the less reactive metal to accept electrons. These voltages are based on the 'relative' reactivity of metals.





$Mg + Zn^{2+} \rightarrow Mg^{2+} + Zn$

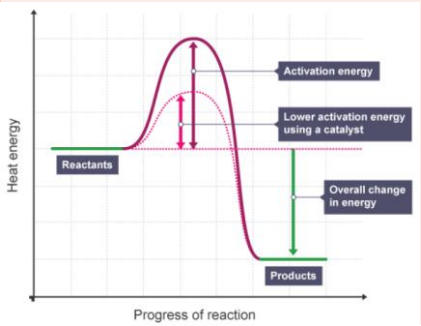
392	40What is chemical cell?	Cells contain chemicals which react to produce electricity.
393	What is a battery?	Batteries consist of two or more cells connected together in series to provide a greater voltage.
394	What is a fuel cell?	Fuel cells are supplied by an external source of fuel and oxygen.
395	Is the fuel burned in the fuel cell?	No
396	What is the overall reaction in a hydrogen-oxygen fuel cell(word equation) ?	hydrogen + oxygen → water
397	What is the overall reaction in a hydrogen-oxygen fuel cell (symbol equation)?	$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$
398	What is positive about alkaline cell?	Cheaper to produce.
399	What is the negative about alkaline cell?	Ends up in landfield and is expensive to recycle.
400	1What is the positve aspect of rechargable cell?	Can be recharged many times before being recycled
401	What is the negative aspect of rechargable cell?	Cost more to manifacture.
402	What is the posiive aspect of Hydrogen fuel cell?	Easy to maintain as there are no moving parts; small size; water is the only chemical product
403	What is the negative aspect of Hydrogen fuel cell?	Very expensive to manufacture; need a constant supply of hydrogen fuel, which is a flammable gas.

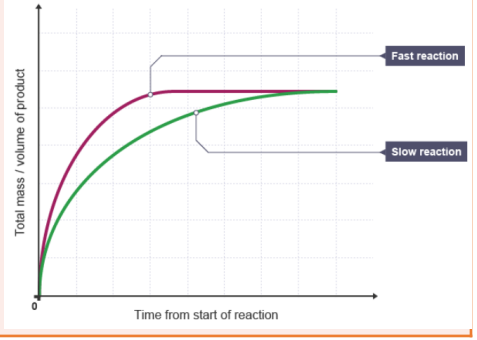
Rate and Extend of Chemical Reaction

Key words

catalysts	Change the rate of chemical reactions but are not used up during the reaction. Different reactions need different catalysts.
frequency	The total number of times an event occurs.
reaction profile	Chart showing how the energy of reactants and products changes during a reaction.
tangent	A straight line that just touches a point on a curve. A tangent to a circle is perpendicular to the radius which meets the tangent.
successful collision	A collision between reactant particles that has enough energy for a reaction to happen.

Key diagram





Key knowledge

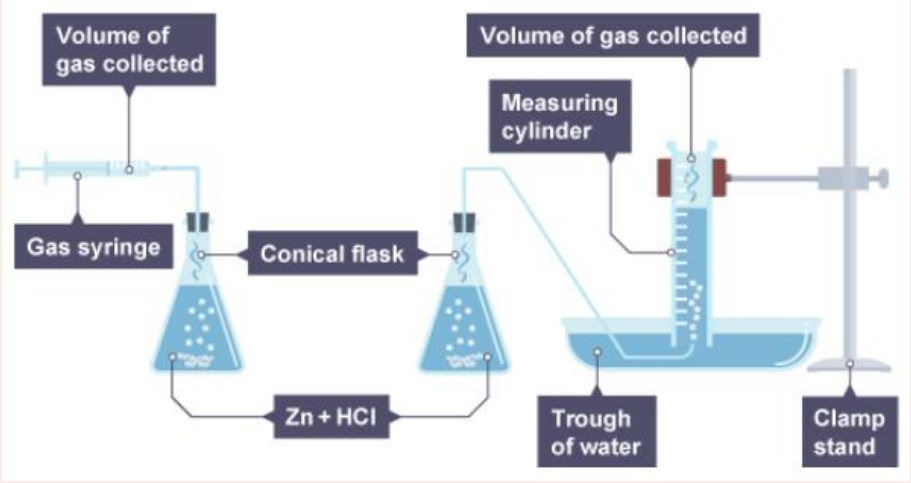
The rate of a chemical reaction can be found by measuring the quantity of a reactant used or the quantity of product formed over time.

Factors which affect the rates of chemical reactions include: the concentrations of reactants in solution, the pressure of reacting gases, the surface area of solid reactants, the temperature and the presence of catalysts.

Collision theory explains how various factors affect rates of reactions. According to this theory, chemical reactions can occur only when reacting particles collide with each other and with sufficient energy. The minimum amount of energy that particles must have to react is called the activation energy.

Catalysts increase the rate of reaction by providing a different pathway for the reaction that has a lower activation energy.

Required Practical



Key process

There are different ways to determine the rate of a reaction. The method chosen usually depends on the reactants and products involved, and how easy it is to measure changes in them.

$$\text{mean rate of reaction} = \frac{\text{quantity of reactant used}}{\text{time taken}}$$

$$\text{mean rate of reaction} = \frac{\text{quantity of product formed}}{\text{time taken}}$$

404	The minimum amount of energy that particles must have to react is called the _____.	activation energy
405	What is meant by the term 'activation energy'?	The minimum energy that colliding particles must have to react
406	Which three factors could have a significant effect on the rate of a reaction between magnesium ribbon and dilute hydrochloric acid if they were altered?	Surface area Temperature Concentration
407	How do catalysts affect a reaction?	They provide an alternative route therefore speeding up a reaction.
408	In the reaction between calcium carbonate and dilute hydrochloric acid, what is the effect of increasing the concentration of the acid?	The marble chips would disappear more quickly.
409	Lowering the temperature, what kind of effect it has on rate of reaction?	Decrease the rate
410	Adding a catalist, what kind of effect it has on the rate of reaction?	Increase the rate dramatically
411	Compress the gases into a smaller vessel, slightly increasing their pressure - what kind of effect it has on the rate of reaction?	Increase the rate slightly
412	Double the masses of both reacting gases and quadruple the size of the vessel - what kind of effect it has on the rate of reaction?	Have no effect on the rate
413	List the factors that affect the rate of the reaction.	A catalyst Temperature Pressure of gaseous reactants Concentrations of reactants in solution
414	How do catalysts affect a reaction?	They provide an alternative route therefore speeding up a reaction.
415	If you were using the reaction of calcium carbonate and dilute hydrochloride acid to investigate the effect of the surface to volume ratio on reaction rate, what would be your independent variable?	Size of calcium carbonate pieces
416	In an experiment to investigate the effects of temperature on the speed of the reaction between sodium thiosulfate and dilute hydrochloric acid. Which are the control variables?	Concentration of hydrochloric acid Volume of sodium thiosulfate
417	The reactant that is completely used up is called the_____ reactant because it limits the amount of products.	limiting
418	True or false: Catalyst can catalyse several reactions.	FALSE
419	True or false: Catalyst change the overall energy change of a reaction	FALSE
420	True or false: catalyst remain unchanged at the end of a reaction	TRUE
421	True or false: catalyst speed up the time to completion of a reaction	TRUE
422	True or false: an enzyme is biological catalyst	TRUE
423	True or false: A catalyst reduces the energy that reacting particles need for a successful collision.	TRUE
424	True or false: A catalyst creates a new reaction pathway with a lower activation energy.	TRUE
425	True or False: A catalyst increases the number of both successful and unsuccessful collisions in a reaction	FALSE

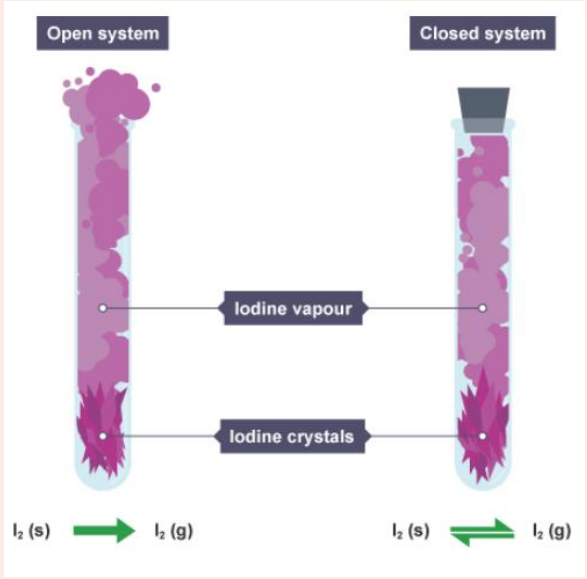
426	What is the formula for calculating rates of reaction?	mean rate of reaction = quantity of reactant used/ time taken mean rate of reaction = quantity of product formed/ time taken
427	What are the possible units for Rates of reaction?	g/s or cm3/s.
428	In the reaction between magnesium ribbon and hydrochloric acid, which aspect of the reaction can be used to measure its rate?	The production of a colourless gas
429	What are the products products of the reaction between calcium carbonate and dilute hydrochloric acid?	Water Carbon dioxide Calcium chloride
430	True or false: Rate of reaction can be calculated when we measure mass loss over time.	TRUE
431	True or false: Rate of reaction can be calculated when we measure volume of gas produced over time	TRUE
432	True or false: Rate of reaction can be calculated when we measure time taken for a solution to change colour .	TRUE
433	True or false: Rate of reaction can be calculated when we measure time taken for a reaction to go to completion .	TRUE
434	According to the collision theory, chemical reactions can occur only when reacting particles _____ with each other and with sufficient energy.	collide

Rate and Extend of Chemical Reaction

Key words

reversible reactions	Chemical reactions where the products of the reaction can react to produce the original reactants.
Product	A substance formed in a chemical reaction.
Reactant	A substance that reacts together with another substance to form products during a chemical reaction.
Le Chatelier's Principle	Predicts the effects of changing conditions on a system at equilibrium
exothermic	Reaction in which energy is given out to the surroundings. The surroundings then have more energy than they started with so the temperature increases.

Key diagram



Key knowledge

If a reversible reaction is exothermic in one direction, it is endothermic in the opposite direction. The same amount of energy is transferred in each case.

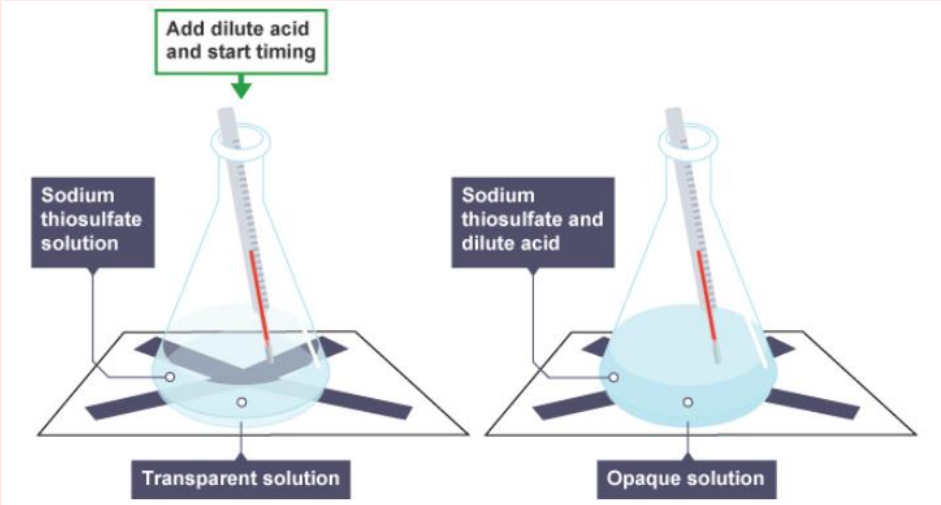
When a reversible reaction occurs in apparatus which prevents the escape of reactants and products, equilibrium is reached when the forward and reverse reactions occur at exactly the same rate.

If the concentration of a reactant is increased, more products will be formed until equilibrium is reached again. If the concentration of a product is decreased, more reactants will react until equilibrium is reached again.

If the temperature of a system at equilibrium is increased the relative amount of products at equilibrium increases for an endothermic reaction.

For gaseous reactions at equilibrium an increase in pressure causes the equilibrium position to shift towards the side with the smaller number of molecules as shown by the symbol equation for that reaction

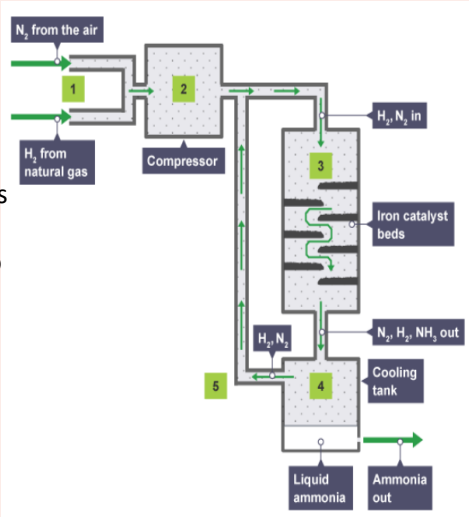
Required Practical – Disappearing Cross



Key process

In the Haber process:

1. nitrogen (extracted from the air) and hydrogen (obtained from natural gas) are pumped through pipes
2. the pressure of the mixture of gases is increased to 200 atmospheres
3. the pressurised gases are heated to 450°C and passed through a tank containing an iron catalyst
4. the reaction mixture is cooled so that ammonia liquefies and can be removed
5. unreacted nitrogen and hydrogen are recycled



435	Wh425at are reversible reactions?	The products of the reaction can react to produce the original reactants.
436	What is the symbol for reversible reaction?	⇌
437	If a reversible reaction is exothermic in one direction, it is _____ in the opposite direction.	endothermic
438	True or False: In reversible reaction the forward and backward reactions occur at the same time.	TRUE
439	True or False: Reversible reactions are indicated by a double half-headed arrow.	TRUE
440	True or False: All reactions which absorb energy but then release energy are reversible.	FALSE
441	True or False: The energy transfers in the forward and backwards reactions are equal and opposite.	TRUE
442	Why must a system be closed for equilibrium to be established?	So that reactants and products can't escape and affect the balance of the reaction
443	True or False: in equilibrium the concentration of products and reactants are the same.	FALSE
444	True or False: In equilibrium the rate of the forward reaction is less than the backward reaction.	FALSE
445	True or False: in equilibrium the rate of the forward reaction and the backward reaction are the same.	TRUE
446	True or False: The rate of the forward reaction is greater than the backward reaction.	FALSE
447	In a reversible industrial reaction, why is product removed during the process?	To increase the yield of the product
448	In equilibirium If the concentration of a reactant is increased, _____products will be formed until equilibrium is reached again.	more
449	If the concentration of a product is decreased, _____ reactants will react until equilibrium is reached again.	more
450	If the temperature of a system at equilibrium is increased, the relative amount of products at equilibrium increases for an _____ reaction	endothermic
451	If the temperature of a system at equilibrium is increased the relative amount of products at equilibrium decreases for an _____ reaction.	exothermic
452	If the temperature of a system at equilibrium is decreased, the relative amount of products at equilibrium _____ for an endothermic reaction	decreases
453	If the temperature of a system at equilibrium is decreased, the relative amount of products at equilibrium _____ for an exothermic reaction.	increases
454	For gaseous reactions at equilibrium an increase in pressure causes the equilibrium position to shift towards the side with the _____number of molecules.	smaller
455	For gaseous reactions at equilibrium a decrease in pressure causes the equilibrium position to shift towards the side with the _____number of molecules as shown by the symbol equation for that reaction.	larger
456	Which factors are explained in the le chatelier principle?	pressure, temperature and concentration?
457	3A + 2B ⇌3C + 4 D In this case the forward reaction is endothermic. What effect the increase of pressure will have?	Increases the rate but lowers the yield of products
458	3A + 2B ⇌3C + 4 D In this case the forward reaction is endothermic. What effect the increase the temperature will have?	Increases the rate and the yield of products
459	3A + 2B ⇌3C + 4 D In this case the forward reaction is endothermic. What effect the decrease of the pressure will have?	Lowers the rate but increases the yield of products
460	3A + 2B ⇌3C + 4 D In this case the forward reaction is endothermic. What effect the lowering the temperature will have?	Lowers the rate and the yield of products
461	The Haber process is used to manufacture _____.	ammonia
462	The raw materials for the Haber process are _____.	nitrogen and hydrogen
463	What is the chemical equation for the Haber process?	nitrogen +hydrogen ammonia
464	List the conditions of the Haber process?	catalyst, temperature and pressure

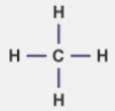
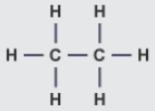
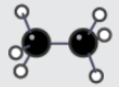
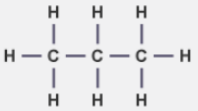
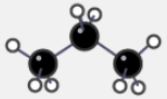
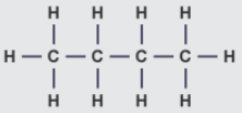
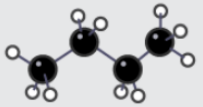
465	True or False: $NH_4Cl \rightleftharpoons NH_3 + Cl_2$ In the above reaction, the forwards reaction is endothermic. A high temperature favours the reverse reaction.	FALSE
466	True or False: $NH_4Cl \rightleftharpoons NH_3 + Cl_2$ In the above reaction, the forwards reaction is endothermic.A low temperature favours the reverse reaction.	TRUE
467	True or False: $NH_4Cl \rightleftharpoons NH_3 + Cl_2$ In the above reaction, the forwards reaction is endothermic. One 'volume' of gas is reacting to produce three 'volumes' of gas.	FALSE
468	What is the catalyt used in the Haber process?	Iron
469	True or False: A high temperature would increase the yield of ammonia.	TRUE
470	True or False: A high pressure increases the yield of ammonia.	FALSE
471	True or False: A catalyst in the Haber process will increase the rate of reaction.	TRUE
472	Compounds of _____, _____ and _____ are used as fertilisers to improve agricultural productivity	nitrogen, phosphorus and potassium
473	Ammonia can be used to manufacture _____ and _____.	ammonium salts and nitric acid
474	What is the name of the product made by adding sulfuric acid to sodium hydroxide?	Sodium sulfate
475	What are the products of phosphate rock reacting with nitric acid?	Phosphoric acid and calcium nitrate
476	What are the products of Phosphate rock and sulfuric acid?	Single superphosphate
477	What is the formula of nitric acid?	HNO_3
478	What is the chemical formula for calcium sulfate?	$CaSO_4$
478	True or False: Phosphate rock is the chemical calcium carbonate.	FALSE
480	True or False: In industry, calcium nitrate is made by adding acid to phosphate rock.	TRUE
481	True or False: The formula for phosphoric acid is H_3PO_2	FALSE

Carbon compounds as fuels

Key words

boiling point	The temperature at which a substance rapidly changes from a liquid to a gas.
chemical properties	A description of how a substance reacts with other substances.
complete combustion	Burning in a plentiful supply of oxygen or air. Complete combustion of a hydrocarbon produces water vapour and carbon dioxide.
general formula	An algebraic formula that sets out a rule or trend which is followed by all members of a homologous series.
homologous series	A 'family' of organic compounds that have the same functional group and similar chemical

Key diagram

Alkane	Molecular formula	Structural formula	Ball-and-stick model
Methane	CH_4		
Ethane	C_2H_6		
Propane	C_3H_8		
Butane	C_4H_{10}		

Key knowledge

Crude oil is a finite resource found in rocks. Crude oil is the remains of an ancient biomass consisting mainly of plankton that was buried in mud.

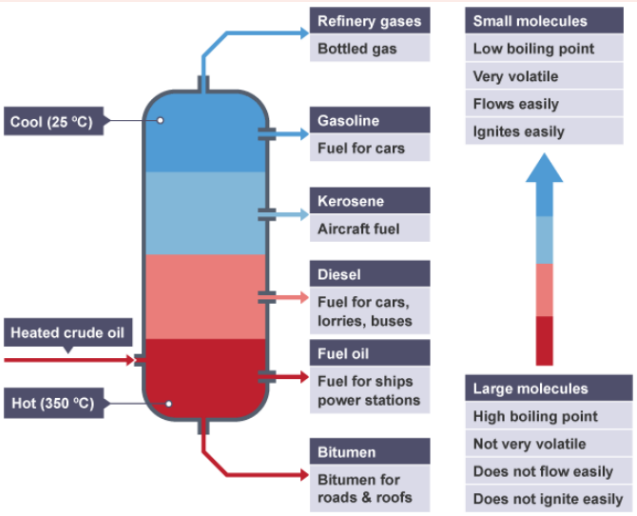
Most of the compounds in crude oil are hydrocarbons, which are molecules made up of hydrogen and carbon atoms only.

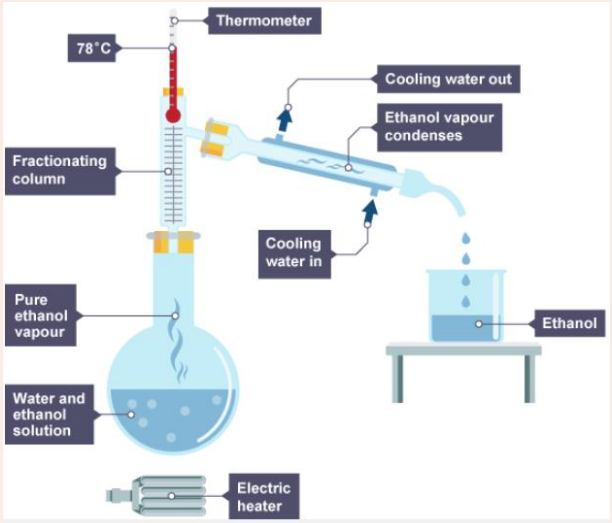
Most of the hydrocarbons in crude oil are hydrocarbons called alkanes. The general formula for the homologous series of alkanes is C_nH_{2n+2} The first four members of the alkanes are methane, ethane, propane and butane.

The many hydrocarbons in crude oil may be separated into fractions, each of which contains molecules with a similar number of carbon atoms, by fractional distillation.

Hydrocarbons can be broken down (cracked) to produce smaller, more useful molecules. Cracking can be done by various methods including catalytic cracking and steam cracking.

Required Practical – Fractional distillation





Key processes

Complete combustion:
Hydrocarbon + oxygen → carbon dioxide + water

Incomplete combustion
Hydrocarbon + oxygen → carbon monoxide + carbon + water

Cracking
Hexane → butane + ethene
$C_6H_{14} \rightarrow C_4H_{10} + C_2H_4$

482	List the first four alkanes?	methane, ethane, propane and butane.
483	why crude oil is a nonrenewable resource?	Crude oil is no longer being replaced, it will run out.
484	Write the formula for butane.	C_4H_8
485	Write the formula for propane.	C_3H_8
486	Write the formula for ethane.	C_2H_4
487	What is Homologous series?	Compounds with the same general formula
488	What is crude oil?	Mixture of many compounds, mostly hydrocarbons
489	What is Hydrocarbon?	Compound containing hydrogen and carbon atoms only
500	What is alkane?	Hydrocarbon with only single bonds
501	True or False: The more carbon atoms an alkane has, the lower its boiling point will be.	FALSE
502	True or False: For alkanes, the bigger the molecule, the higher the boiling point	TRUE
503	True or False: Propane will be a liquid at room temperature (20 °C).	FALSE
504	True or False: Ethane will be a gas at room temperature.	TRUE
505	What is the general formula for alkanes?	CnH2n+2
506	True or False: The fractionating column is cooler at the bottom than the top, so compounds with higher boiling points condense nearer the bottom.	TRUE
507	True or False: The fractionating column is cooler at the top than the bottom, so compounds with higher boiling points condense nearer the top.	FALSE
508	Trie or False: The fractionating column is cooler at the top than the bottom, so compounds with higher boiling points condense nearer the bottom.	FALSE
509	Triue or False: The fractionating column is cooler at the bottom than the top, so compounds with higher boiling points condense nearer the top.	FALSE
510	True or False: It is important to separate crude oil because different substances have different uses.	TRUE
511	True or False: Each fraction of crude oil contains just one substance.	FALSE
512	True or false: Fractional distillation purifies crude oil	FALSE
513	True or False: Each substance separates at its own boiling point.	TRUE
514	Why do substances consisting of larger molecules have higher boiling points?	Substances with larger molecules have stronger intermolecular forces. More energy is required to separate larger molecules from one another than to separate smaller molecules.
515	Which one of the following substances would have the lowest boiling point: C_2H_6 or CH_4 ?	CH_4
516	Why do hydrocarbons with large molecules have a higher viscosity than those with small molecules?	Larger molecules will have more intermolecular forces between them, so the molecules are not able to move as freely, meaning the hydrocarbon flows less easily.

517	Which one is more flamable : methane or C_8H_{18}	C_8H_{18}
518	Which one has higher volality butane or octadecane?	butane
519	Which one has stronger intermolecular forces: butane or octadecane?	Octadecane
520	Which one has boiling point: butane or octadecane?	Octadecane
521	Which one hneeds less energy to separate molecules: butane or octadecane?	butane
522	What are the products of complete combustion?	carbon dioxide and water.
523	What is complete combustion?	When a fuel burns in plenty of air, it receives enough oxygen for complete combustion.
524	Write a word equation to describe the complete combustion of a hydrocarbon.	hydrocarbon + oxygen → carbon dioxide + water
525	Write a word equation to describe the incomplete combustion of a hydrocarbon.	hydrocarbon + oxygen → carbon monoxide + carbon + water
526	What is incomplete combustion.	Incomplete combustion occurs when the supply of air or oxygen is poor.
527	One molecule of the alkane hexadecane ($C_{16}H_{34}$) was cracked to form one molecule of nonane (C_9H_{20}), two molecules of ethene (C_2H_4) and one other molecule. What is the formula of this other molecule?	C_3H_6
528	Which two conditions are needed for cracking?	High temperature and a catalyst
529	What is Zeolite?	Catalyst used for breaking alkenes
560	What is Cracking	Breaking down of alkanes into shorter alkanes and alkenes
561	What is Catalyst	Substance which speeds up a reaction
562	What is Thermal decomposition	Breaking down of a substance using heat
563	Why might a company want to crack alkanes?	The supply of short-chain alkanes is less than the demand. Long-chain alkanes are in greater supply than short-chain alkanes.
564	Which one is more reactive: alkanes or alkenes?	Alkenes
565	What are alkenes used for?	Alkenes are used to produce polymers and as starting materials for the production of many other chemicals.
567	What are two types of cracking?	catalytic cracking and steam cracking

Reactions of alkenes and alcohols (chemistry only)

Key words

boiling point	The temperature at which a substance rapidly changes from a liquid to a gas.
chemical properties	A description of how a substance reacts with other substances.
complete combustion	Burning in a plentiful supply of oxygen or air. Complete combustion of a hydrocarbon produces water vapour and carbon dioxide.
general formula	An algebraic formula that sets out a rule or trend which is followed by all members of a homologous series.
homologous series	A 'family' of organic compounds that have the same functional group and similar chemical properties.

Key knowledge

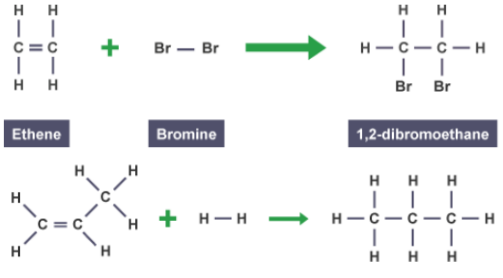
Alkenes are hydrocarbons with a double carbon-carbon bond. The general formula for the homologous series of alkenes is CnH2n Alkene molecules are unsaturated because they contain two fewer hydrogen atoms than the alkane with the same number of carbon atoms.

Ethanol is the alcohol found in beer, wine and other alcoholic drinks. It is also used as a fuel for vehicles, either on its own or mixed with petrol. Ethanol can be produced by fermentation and concentrated using fractional distillation.

The functional group in the carboxylic acids is the carboxyl group, -COOH. It is responsible for the typical reactions of carboxylic acids, which are weak acids.

Carboxylic acids can react with alcohols to make esters. Esters are organic compounds which all contain the functional group -COO-. Esters have fruity smells and can be used as solvents.

Key processes



ethanol + oxygen → carbon dioxide + water

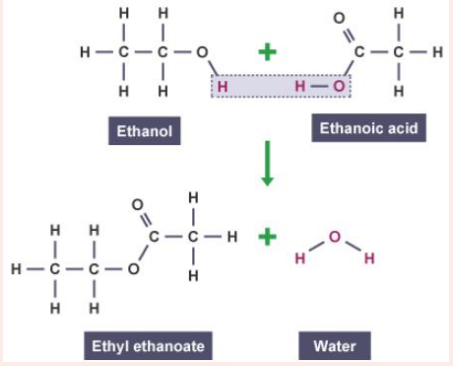
$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$

sodium + ethanol → sodium ethoxide + hydrogen

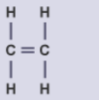
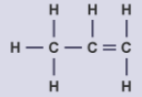
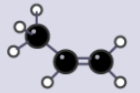
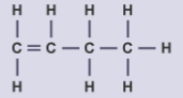
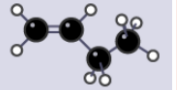
$2Na + 2C_2H_5OH \rightarrow 2C_2H_5ONa + H_2$

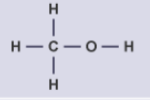
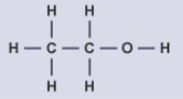
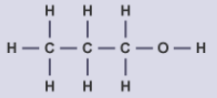
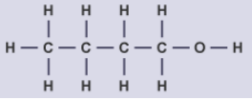
ethanol + oxidising agent → ethanoic acid + water

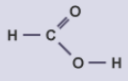
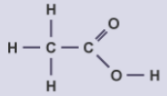
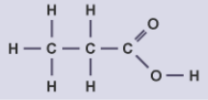
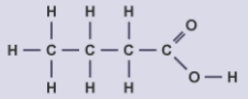
$CH_3CH_2OH + 2[O] \rightarrow CH_3COOH + H_2O$



Key diagram

Alkene	Molecular formula	Structure (showing all the covalent bonds)	Ball-and-stick model
Ethene	C_2H_4		
Propene	C_3H_6		
Butene	C_4H_8		

Alcohol	Formula	Structure (showing all the covalent bonds)
Methanol	CH_3OH	
Ethanol	C_2H_5OH	
Propanol	C_3H_7OH	
Butanol	C_4H_9OH	

Name	Formula	Structure (showing all the covalent bonds)
Methanoic acid	HCOOH	
Ethanoic acid	CH_3COOH	
Propanoic acid	C_2H_5COOH	
Butanoic acid	C_3H_7COOH	

568	What type of bond is unique for alkenes?	covalent double bond
569	What is the general formula for alkenes?	CnH2n
570	True of False: Butane will turn bromine water from orange to colourless?	TRUE
571	True or False: A hydrocarbon without any double carbon–carbon bonds is unsaturated	FALSE
572	True or False: If a hydrocarbon has the general formula CnH_2n, it must be unsaturated.	TRUE
573	True or False: The presence of one or more double carbon–carbon bonds in a hydrocarbon makes it saturated.	FALSE
574	True or False: Alkanes are saturated hydrocarbons.	TRUE
575	Alkanes or Alkanes react with react with Br_2?	Alkenes
576	What is the product: $C_4H_8 + 4O_2 \rightarrow$	$4CO + 4H_2O$
577	What is the product: $C_4H_8 + 5O_2 \rightarrow$	$2CO_2 + 2CO + 4H_2O$
578	What is the product: $C_4H_8 + 6O_2 \rightarrow$	$4CO_2 + 4H_2O$
579	What is the formula for ethanol?	C_2H_5OH
580	What is the formula for propanol?	C_4H_9OH
581	What is the formula for butanol?	C_3H_7OH
582	What is the formula for methanol?	CH_3OH
583	There are two different organic products of fermentation, depending on the amount of oxygen available.	Alcohol Ethanoic acid
584	What is the functional group of alcohols?	-OH
585	How is ethanol produced?	Aqueous solutions of ethanol are produced when sugar solutions are fermented using yeast.
586	Is this reaction balanced: $2C_3H_7OH + 9O_2 \rightarrow 6CO_2 + 8H_2O$?	Yes
587	Is this reaction balanced: $C_3H_7OH + 4O_2 \rightarrow 3CO_2 + 4H_2O$?	No
589	What is the name of the carboxylic acid with one carbon atom?	Metanoic acid
590	What is the name of the carboxylic acid with two carbon atoms?	Ethanoic acid
591	What is the name of the carboxylic acid with 3 carbon atoms?	Propanoic acid
591	What is the name of the carboxylc acid with 4 carbon atoms?	Butanoic acid
593	Propanoic acid reacts with calcium carbonate to form a salt, carbon dioxide and water. What is the name of the salt?	Calcium propanoate
594	Is this a dissosiation equilibria $C_3H_7COOH \rightleftharpoons C_3H_7COO^- + H^+$	Yes

Synthetic and naturally occurring polymers (chemistry only)

Key words

addition polymer	Large molecule formed in addition reactions between unsaturated monomer molecules.
amino acid	The building blocks that make up a protein molecule.
condensation polymerisation	Chemical reaction in which monomers (small molecules) join together to produce a polymer and a small molecule such as water.
covalent bond	A bond between atoms formed when atoms share electrons to achieve a full outer shell of electrons.
functional group	An atom, or group of atoms, that determines the main chemical properties of an organic compound.

Key knowledge

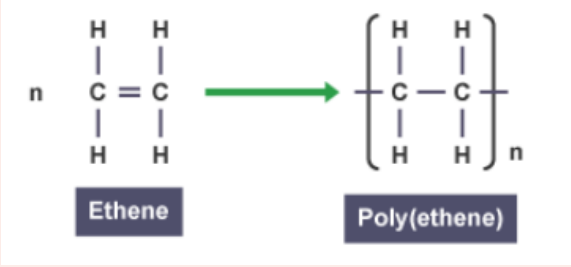
Alkenes can be used to make polymers such as poly(ethene) and poly(propene) by addition polymerisation. In addition polymerisation reactions, many small molecules (monomers) join together to form very large molecules (polymers).

DNA (deoxyribonucleic acid) is a polymer which is essential for life. Most DNA is a double helix, where two polymer chains are lined up and then twisted around each other. The DNA polymer is made from four different types of monomer, which are called nucleotides.

Proteins are biological polymers made inside cells. They are made from amino acid monomers and have a huge range of roles inside living things. For example, all enzymes are made from proteins.

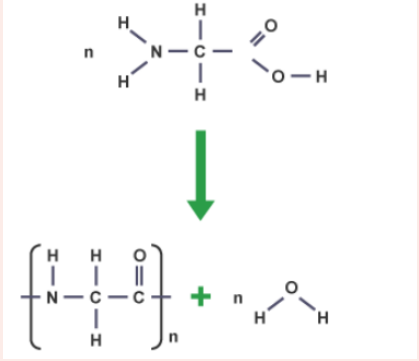
Condensation polymerisation involves monomers with two functional groups. When these types of monomers react they join together, usually losing small molecules such as water, and so the reactions are called condensation reactions.

Key processes

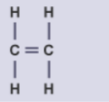
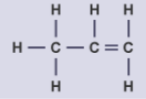
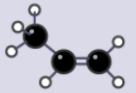
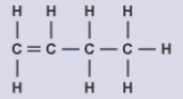
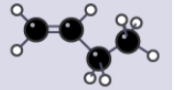


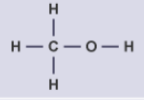
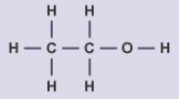
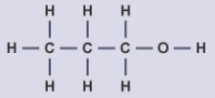
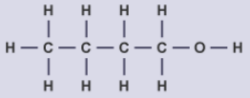
n glycine → poly(glycine) + water

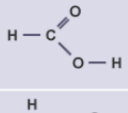
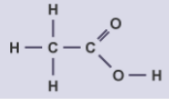
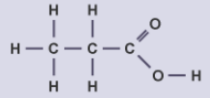
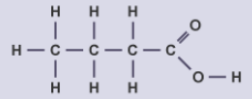
$n\ H_2NCH_2COOH \rightarrow (\text{-}HNCH_2CO\text{-})_n + n\ H_2O$



Key diagram

Alkene	Molecular formula	Structure (showing all the covalent bonds)	Ball-and-stick model
Ethene	C_2H_4		
Propene	C_3H_6		
Butene	C_4H_8		

Alcohol	Formula	Structure (showing all the covalent bonds)
Methanol	CH_3OH	
Ethanol	C_2H_5OH	
Propanol	C_3H_7OH	
Butanol	C_4H_9OH	

Name	Formula	Structure (showing all the covalent bonds)
Methanoic acid	HCOOH	
Ethanoic acid	CH_3COOH	
Propanoic acid	C_2H_5COOH	
Butanoic acid	C_3H_7COOH	

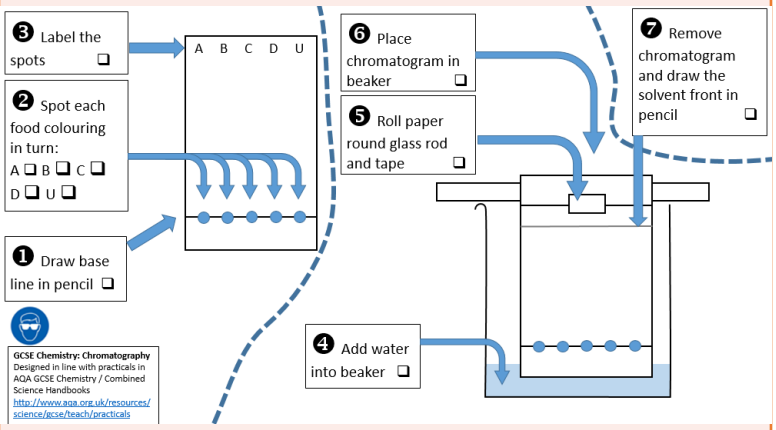
595	What is a polymer?	A molecule made from many small molecules called monomers
596	What is the name of the reaction when many monomers join to make a polymer?	Polymerisation
597	A small 'n' follows the last bracket to show that there could be ____ repeating units	more
598	The displayed formulae of polymers are written as repeating units with ____ at each end	a square bracket
599	Alkenes are able to make polymers by ____ reactions	addition
600	A ____ that makes an addition polymer contains at least one double bond between carbon atoms	monomer
601	The C=C double bonds are the ____ group of alkenes, and in these types of reactions they are monomers	functional
602	Alkenes are able to be monomers because of the ____ bond	double
603	Condensation polymerisation involves monomers with _____functional groups.	two
604	Condensation reaction are called that because one of the product is _____.	water
605	Amino acids have two functional groups. What are they?	Amine Carboxylic acid
606	Amino acids react by _____ polymerisation to produce polypeptides.	condensation
607	Amino acids react by condensation polymerisation to produce _____	polypeptides.
608	What is a nucleotide?	monomer for DNA
609	What does nucleotide consist of?	Sugar Phosphate group Base

Chromatography, pure substances, formulations

Key words

chromatogram	The results of separating mixtures by chromatography.
compound	A substance formed by the chemical union of two or more elements.
mixture	Two or more substances that are not joined together. The substances can be elements, compounds, or both.
stationary phase	Phase in chromatography that does not move, for instance, the paper in chromatography.
solvent	The liquid in which the solute dissolves to form a solution.
solution	Mixture formed by a solute and a solvent.

Key diagram



Key knowledge

In chemistry, a pure substance is a single element or compound, not mixed with any other substance.

Pure elements and compounds melt and boil at specific temperatures. Melting point and boiling point data can be used to distinguish pure substances from mixtures.

A formulation is a mixture that has been designed as a useful product.

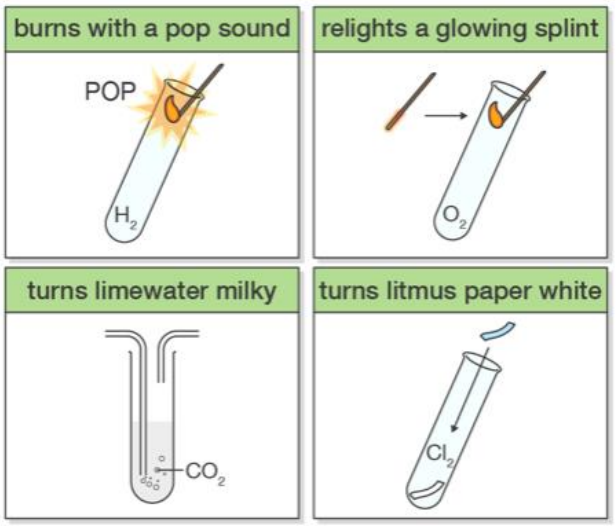
Chromatography can be used to separate mixtures and can give information to help identify substances. Chromatography involves a stationary phase and a mobile phase. Separation depends on the distribution of substances between the phases.

The test for hydrogen uses a burning splint held at the open end of a test tube of the gas. Hydrogen burns rapidly with a pop sound.

When carbon dioxide is shaken with or bubbled through limewater the limewater turns milky (cloudy).

The test for chlorine uses litmus paper. When damp litmus paper is put into chlorine gas the litmus paper is bleached and turns white.

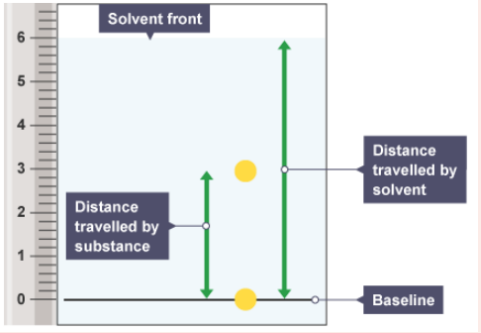
Required Practical - testing for gasess



Key processes

Rf values vary from 0 (the substance is not attracted at all to the mobile phase) to 1 (the substance is not attracted at all to the stationary phase).

$$R_f = \frac{\text{distance travelled by substance}}{\text{distance travelled by solvent}}$$



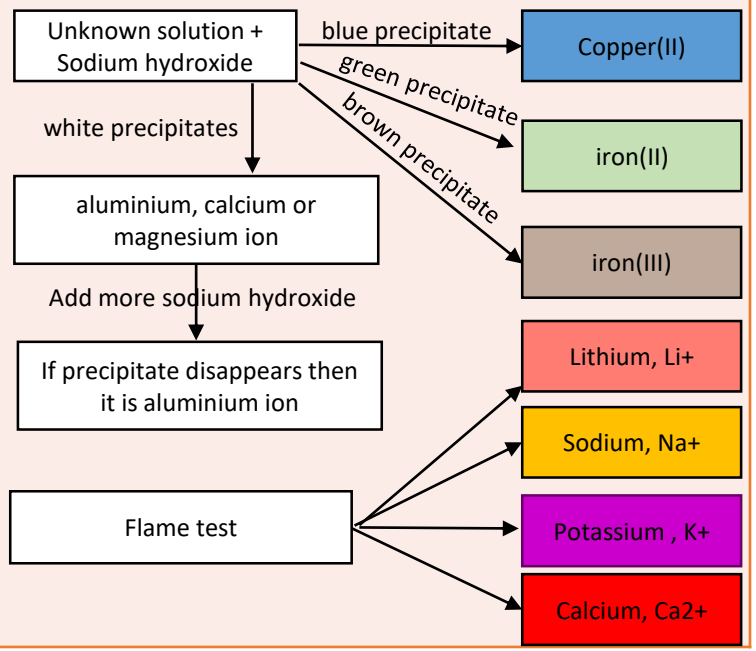
610	What does mixture consist of?	A mixture consists of two or more elements or compounds not chemically combined together.
611	How can mixture be seperated?	Mixtures can be separated by physical processes such as filtration, crystallisation, simple distillation, fractional distillation and chromatography.
612	What is chromatography?	Chromatography is a method for separating dissolved substances from one another.
613	What is evaporation?	Evaporation is used to separate a soluble solid from a liquid.
614	What is filtration?	Filtration can be used to remove solid from liquid.
615	What is distillation?	Distillation is a process which uses evaporation and condensation in order to obtain a solvent from a solution.
616	How can you test is a substance is pure?	Melting point and boiling point data can be used to distinguish pure substances from mixtures.
617	What is a pure substance in chemistry?	In chemistry, a pure substance is a single element or compound, not mixed with any other substance.
618	What is formulation?	A formulation is a mixture that has been designed as a useful product.
619	List examples of formulations.	Formulations include fuels, cleaning agents, paints, medicines, alloys, fertilisers and foods.
620	What is stationary phase?	The phase over which the mobile phase passes in the technique of chromatography.
621	What is mobile phase?	The solvent that moves through the stationary phase.
622	What are the two different phases in chromatography?	mobile and stationary phase.
623	How can chromatography distinquish between pure substance and an impure substance?	A pure substance produces one spot on the chromatogram and an impure substance produces two or more spots
624	How can chromatography be used to identify substances?	Different compounds have different Rf values in different solvents, which can be used to help identify the compounds.
625	What is Rf value?	The ratio of the distance moved by a compound (centre of spot from origin) to the distance moved by the solvent.
626	What are the possible values for Rf value?	Rf values vary from 0 to 1.
627	What does it mean when Rf=0?	The substance is not attracted at all to the mobile phase, I does not move.
628	What does it mean when Rf=1?	The substance is not attracted at all to the stationary phase, it has moved as much as the solvent.
629	What is the test for hydrogen?	The test for hydrogen uses a burning splint held at the open end of a test tube of the gas. Hydrogen burns rapidly with a pop sound.
630	What is the test for oxygen?	The test for oxygen uses a glowing splint inserted into a test tube of the gas. The splint relights in oxygen.
631	What is the test for carbon dioxide?	When carbon dioxide is shaken with or bubbled through limewater the limewater turns milky (cloudy).
632	What is the test for chlorine?	When damp litmus paper is put into chlorine gas the litmus paper is bleached and turns white.

Chemical analysis – Anions and Cations

Key words

ion	Electrically charged particle, formed when an atom or molecule gains or loses electrons.
precipitate	A suspension of particles in a liquid formed when a dissolved substance reacts to form an insoluble substance, eg in a precipitation reaction.
reduction	The loss of oxygen, gain of electrons, during a chemical reaction.
cation	Positively charged ion
anion	Negatively charged ion

Key diagram



Key knowledge

Elements and compounds can be detected and identified using instrumental methods. Instrumental methods are accurate, sensitive and rapid.

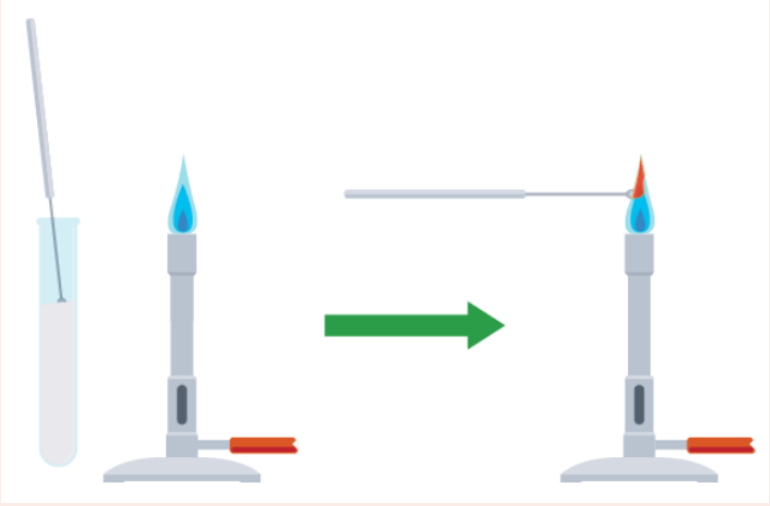
Flame emission spectroscopy is an example of an instrumental method. The sample is put into a flame and the light given out is passed through a spectroscope. The output is a line spectrum that can be analysed to identify the metal ions in the solution and measure their concentrations.

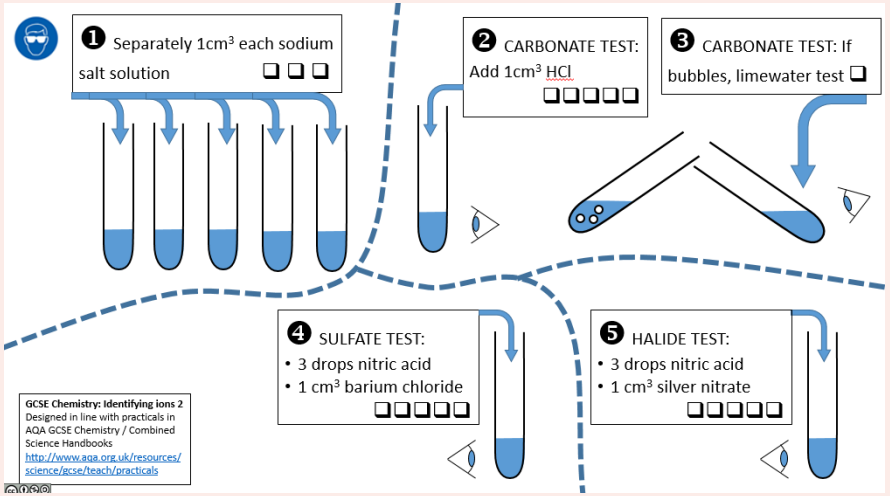
Metal atoms lose electrons to become positively charged ions.

Non-metal atoms gain electrons to become negatively charged ions.

The ions produced by non-metals in Groups 6 and 7 have the electronic structure of a noble gas (Group 0) and a negative charge.

Required Practical - Flame test





633	Many transition elements have ions with _____charges.	different
634	Many transition elements form _____ compounds.	coloured
635	Many transition elements are useful as _____.	catalysts
636	Where are the transition metals in the periodic table?	The transition elements are in the central part of the periodic table.
637	Compare the typical properties of transition elements to the metals in group 1	higher melting points higher densities greater strength greater hardness
638	Compare the reaction of alkali and transition metals with oxygen.	The group 1 elements react quickly with oxygen in the air at room temperature. Most transition elements react slowly, or not at all, with oxygen at room temperature.
639	Compare the reaction of alkali and transition metals with water.	The group 1 elements react vigorously with cold water. Most transition elements react slowly with cold water, or not at all.
640	Name one catalist of the transition metals.	iron is the catalyst in the Haber process, which makes ammonia manganese(IV) oxide increases the decomposition of hydrogen peroxide to oxygen and water
641	Flame tests of lithium compounds result in a_____ flame	crimson
642	Flame test of sodium compounds result in a _____ flame	yellow
643	Flame test of potassium compounds result in a _____ flame	lilac
644	Flame test of calcium compounds result in an _____flame	orange-red
645	Flame test of copper compounds result in a _____ flame.	green
656	Flame tes flame is crimson. What is the ion?	lithium
657	Flame test flame is yellow. What is the ion?	sodium
658	Flame test flame is orange-red. What is the ion?	calcium
659	Flame test flame is green. What is the ion?	copper
660	What state best represents a precipitate?	Solid
661	Write the word equations for the production of a precipitate of magnesium hydroxide?	magnesium sulfate + sodium hydroxide → magnesium hydroxide + sodium sulfate
662	When sodium hydroxide is added to a solution of a metal ion, precipitates may form. Which metal ion forms white percipitate?	Magnesium
663	When sodium hydroxide is added to a solution of a metal ion, precipitates may form. Which metal ion forms gray/green percipitate?	Iron(II)
664	When sodium hydroxide is added to a solution of a metal ion, precipitates may form. Which metal ion forms blue percipitate?	Copper
665	When sodium hydroxide is added to a solution of a metal ion, precipitates may form. Which metal ion forms brown percipitate?	Iron (III)
667	Write the formula of copper hydroxide.	$Cu(OH)_2$
668	Write the formula for Iron (II) hydroxide.	$Fe(OH)_2$
669	Write the formula for Magnesium hydroxide.	$Mg(OH)_2$
670	Write the formula for clacium hydroxide.	$Ca(OH)_2$

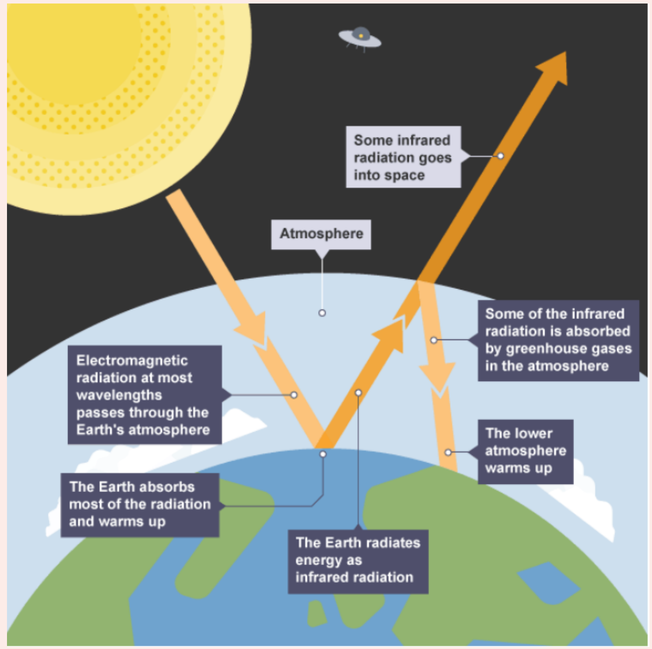
671	An unknown solution is tested with barium chloride solution in the presence of hydrochloric acid. A white precipitate forms. A sample of the compound used to produce the solution has a lilac flame when held in a Bunsen burner flame. Which is the most likely identity of the unknown compound?	Potassium sulfate
672	Write a word equation for the reaction between potassium carbonate and nitric acid?	potassium carbonate + nitric acid → potassium nitrate + water + carbon dioxide
673	What colour of percipitate Iodide forms?	Yellow
674	What colour of percipitate bromide forms?	Cream
675	What colour of percipitate chloride forms?	White
676	What is the test for caron dioxide?	Limewater groes milky
677	What is the formula for silver nitrate?	$AgNO_3$
678	What is the formula for Barium chloride?	$BaCl_2$
679	What is the formula for Sulfate?	SO_4^{2-}
680	What is the formula for Carbonate?	CO_3^{2-}
681	What are the products in the reaction between silver nitrate and potassium iodide?	Silver iodide Potassium nitrate
682	True or False:Spectroscopy is an example of an instrumental method.	TRUE
683	True or False: You must have a large quantity of your sample to test using mass spectrometry.	FALSE
684	What are the advantages of instrumental technique?	accurate, sensitive and rapid.
685	True or False: The emission spectrum of neon will look the same as that of argon	FALSE
686	True or False: Flame emission spectroscopy is an instrumental method	TRUE

Atmosphere

Key words

limewater	Calcium hydroxide solution. It turns milky in the presence of carbon dioxide.
litmus paper	A type of indicator that can be red or blue. Red litmus turns blue in alkalis, while blue litmus turns red in acids.
photosynthesis	A chemical process used by plants to make glucose and oxygen from carbon dioxide and water, using light energy.
atmosphere	The layers of gases that surround the Earth.
vapour	Vapour is a cloud of liquid particles. Steam is water vapour.

Key diagram



Key knowledge – Greenhouse effect

Greenhouse gases in the atmosphere maintain temperatures on Earth high enough to support life. Water vapour, carbon dioxide and methane are greenhouse gases.

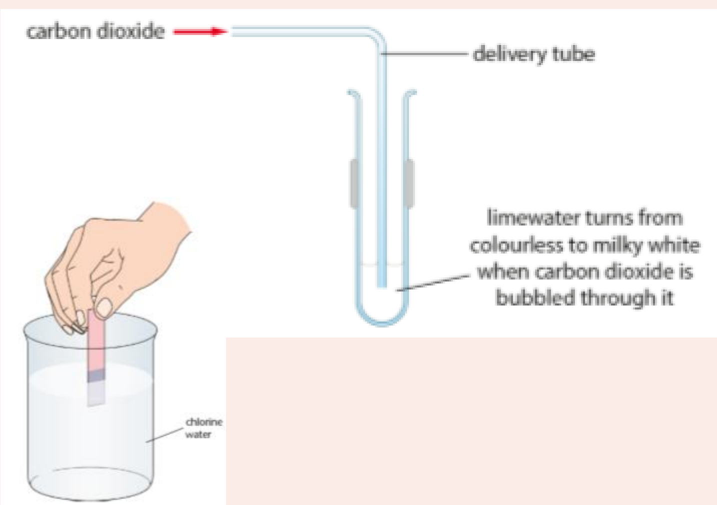
Human activities are increasing the amount of some greenhouse gases in the atmosphere. For example:

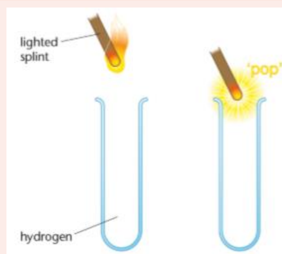
- farming cattle releases methane
- farming rice in paddy fields releases methane
- burning fossil fuels in vehicles and power stations releases carbon dioxide
- deforestation releases carbon dioxide and reduces the absorption of carbon dioxide through photosynthesis

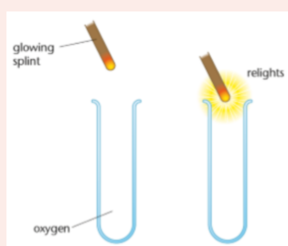
The effects of global warming include:

- glaciers and polar ice melting
- sea levels rising
- patterns of rainfall changing, producing floods or droughts
- habitats changing

Required Practical – Testing for gasses







Key process – Evolution of atmosphere

Intense volcanic activity that released gases: nitrogen, methane, ammonia → Water vapour that condensed to form the oceans. → Carbon dioxide dissolved in the water. → Carbonates were precipitated producing sediments. → Algae and plants photosynthesised to use carbon dioxide and produce oxygen.

687	A glowing splint relights in the presence of which gas?	Oxygen
688	A popping sound is heard if a burning splint is held in the presence of which gas?	Hydrogen
689	What is the chemical formula of carbon dioxide?	CO_2
690	What is the chemical formula of Calcium carbonate?	$CaCO_3$
691	What is chemical formula of oxygen?	O_2
692	What is chemical formula of hydrogen?	H_2
693	What is test the balanced chemical equation for test for hydrogen?	$2H_2 + O_2 \rightarrow 2H_2O$
694	What is the test for chlorine?	Litmus paper is bleached
695	What is the balanced chemical formula for carbon dioxide test?	$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$
696	True or false: A glowing splint relights when held in the presence of hydrogen.	FALSE
697	True or false: Calcium carbonate forms when carbon dioxide is bubbled through limewater.	TRUE
698	True or false: Chlorine gas bleaches damp litmus paper white.	TRUE
699	True or false: When chlorine gas is bubbled into water, a popping sound is heard.	FALSE
700	True or false: Water is formed in the test for oxygen.	FALSE
701	True or false: Chlorine can be bubbled through water, which can then be tested with litmus paper.	TRUE
702	True or false: A popping sound is heard in the test for hydrogen because the splint is exploding.	FALSE
703	True or false: To test for carbon dioxide gas, a gas is bubbled through limewater	TRUE
704	Name the process by which animals and plants use oxygen and produce carbon dioxide.	Respiration
705	Why does the proportion of nitrogen in the atmosphere remain constant?	t is relatively unreactive
706	What is the proportion of nitrogen in clean air?	80%
707	What is the proportion of Oxygen in clean air?	20%
708	What is the propoertion of Carbon Dioxide in clean air?	0.04%
709	What is he proportion of Argon and noble gases in clean air?	Small proportions
710	Which gas was the most abundant in the early atmosphere?	carbon dioxide
711	Why does the lack of oxygen on Mars mean it is not a suitable environment for human life?	Respiration cannot occur.
712	In the early atmosphere there was not much _____	oxygen
713	In the earlya tmosphere the water vapour condenced to form the _____	oceans
714	In the early atmosphere volcanoes produced _____	nitrogen, carbon dioxide, methane, ammonia
715	In the early atmosphere carbonates precipitated to form _____	sediments
716	Which two methods could you use to obtain data about the composition of the Earth's early atmosphere?	Boron isotope ratios Volcanic gas composition
717	What is the name of the biological process which caused oxygen in the atmosphere to increase?	Photosynthesis
718	You are monitoring the relative levels of carbon dioxide and oxygen in a greenhouse. You notice that, during the day, the percentage of oxygen in the air increases. WHY?	The rate of photosynthesis increases during the day.
719	What is the word equation for photosynthesis?	carbon dioxide + water --> glucose + oxygen
720	What is the symbol equation for photosynthesis?	$6CO_2 + 6\ H_2O \rightarrow C_6H_{12}O_6 + 0_2$
721	What is the chemical name of limestone?	Calcium carbonate
722	The main component of coal is _____	carbon
723	Photosynthesis produces_____	glucose and oxygen
724	Photosynthesis uses _____	carbon dioxide and water
725	Give reasons for the decrease in levels of carbon dioxide?	Fossil fuel formation Formation of sedimentary rocks, Photosynthesis
726	Evidence from ice cores can only be plotted as far back as 800 000 years. Why?	There are no ice deposits from before 800 000 years ago.
727	If the greenhouse effect suddenly stopped occurring, what would happen?	The temperature on Earth would decrease so much that life would not be able to survive.
728	If the amount of carbon dioxide and methane in the atmosphere were to decrease, what effect do you think this would have on the temperature on Earth?	It would decrease.
729	True or False: Some of the heat energy from Earth is emitted back into space,	TRUE
730	The Sun emits long wavelength radiation	FALSE
731	Give an example of green house gas.	Water vapour, carbon dioxide and methane
732	True or False: Greenhouse effect has always been artificial phenomenon	FALSE
733	True or False: Greenhouse effect only involved carbondioxide and methane	FALSE
734	True or False: Greenhouse effect relies on the Sun	TRUE

735	Tru771e of False: Greenhouse gases in the atmosphere maintain temperatures on Earth high enough to support life.	TRUE
736	Which greenhouse is released by decomposition of landfill?	Methane
737	What greenhouse is released by combustion of fossil fuels?	Carbon Dioxide
738	The greenhouse effect is a ____ phenomenon	natural
739	Some scientists believe that the ____ levels of CO_2 are part of the Earth's natural cycles	increased
740	It is thought the first objects to cause global warming were____	volcanoes
741	Burning coal releases ____ dioxide	carbon
742	If the level of carbon dioxide in the atmosphere increases, which two of these events may occur?	The greenhouse effect would be enhanced. The global temperature increases.
743	List a potential effect of global climate change by warming?	Retreat of glaciers, lack of water, changes to wildlife habitat
744	What are the likely effects on coastal cities as a result of global climate change?	Erosion of coastal wetlands Increased risk of flooding
745	What kind of effect global change might have on wheat production?	Changes to the yield of wheat Increased susceptibility to a different range of pests and disease
746	List action that a household could take to reduce their carbon footprint?	Use more renewable energy sources Install insulation in the home Drive a car which uses less fuel Leave lights on for shorter
747	Which term is defined by 'the total amount of carbon dioxide and other greenhouse gases emitted by an object in its lifetime'?	Carbon footprint
748	What is Carbon capture and storage?	Collecting CO2 emissions and storing them underground
749	What is Carbon offsetting?	Increasing the availability of carbon sinks to absorb CO2
750	What is carbon tax?	An emmiter of CO2 has to pay money depending on how much CO2 they emit
751	What is carbon neutrality?	No net release of CO2 into the atmosphere from processes
752	List the major reason for rising methane levels	Increased farming, more wet cultication of rice fields, more landfill rubish sites
753	True or false: A lack of public information and education is one limitation on reducing the carbon footprint	TRUE
754	True or False:Limitations to the carbon footprint model is that the scientific models are explained in complex terminology and it hard to understand them.	TRUE
755	True or False: Differing opinions over cost and employment levels, as affected by climate change models is limittion to the carbon footprint model	TRUE
756	True or False: A limitation to the carbon footprin model is that not all countries agree to sign climate change treaties.	TRUE
757	True or False: Limitation to Carbon footrpint model is the fact people are unwilling or unable to change their daily activities.	TRUE
758	True or False: Developed nations do not need to make many changes to reduce their CO_2 emissions	FALSE
759	True or False: The underlying cause of the increase in greenhouse gas emissions is population growth	TRUE
760	What can individuals do to reduce carbon footprint	Use electricity more efficiently. Choose local produce instead of imported food.
761	List the major atmosperic polutants from fuels.	carbon monoxide, soot (carbon particles), sulfur dioxide and oxides of nitrogen
762	Which products will form when octane burns in a lack of oxygen?	H_2O and CO
763	How is carbon dioxide formed?	Combustion of fuels
764	How is nitrogen oxide formed?	Combustion at VERY HIGH temperature
765	How is Sulfur dioxide formed?	Combustion of petrol
766	How is carbonmonoxide formed?	Combustion in an inadequate suply of oxygen
767	How can the pollutant emissions of car be directly reduced?	catalytic converter and low-sulfur fuel.
768	What are the properties of carbon dioxide?	toxic gas, odourless, colourless and not easily detected.
769	What can sulfur dioxide cause?	respiratory problems and acid rain
770	What can Nitrogen oxide cause?	respiratory problems and acid rain
771	What 2 things can particulates in the air cause?	global dimming and health problems for humans

Obtaining potable water

Key words

desalination	The removal of salt from water. This is an energy-intensive process.
distillation	A separation technique which involves a solution being heated so that the solvent evaporates before being cooled to form a pure liquid.
potable	Water that is safe to drink.
precipitate	A suspension of particles in a liquid formed when a dissolved substance reacts to form an insoluble substance
reverse osmosis	A method of purifying water by forcing it under pressure through a membrane which has tiny holes in it.
sterilise	To kill any living organisms, usually microbes that might cause disease..

Key diagram

Waste water

↓

Screening and grit removal

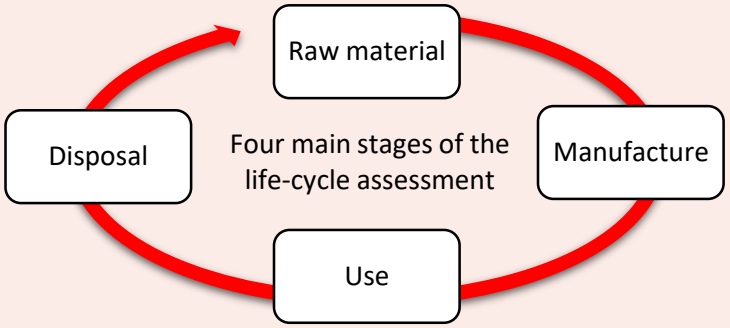
↓

Sedimentation to produce sewage sludge and effluent

↓

Anaerobic digestion of sewage sludge.

Aerobic biological treatment of effluent.



Key knowledge

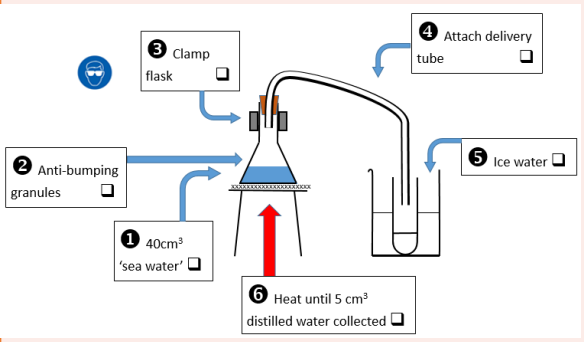
Potable water is not pure water because it almost always contains dissolved impurities. For water to be potable, it must have sufficiently low levels of dissolved salts and microbes.

Most potable water in the UK is produced from naturally occurring fresh water by: passing the water through filter beds to remove insoluble particles and sterilising the water to kill microbes

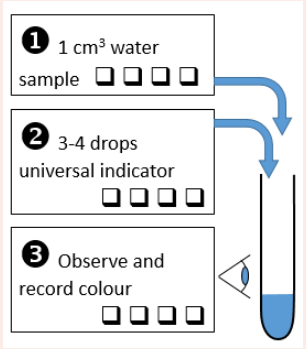
Potable water can be made from sea water, through a process known as desalination. It is preferable to make potable water from fresh water reserves rather than from sea water. This is because removing the large amount of sodium chloride (35 grams in every kilogram of sea water) requires a lot of energy.

Waste water from homes, industry and agriculture must be treated before being released into the environment.

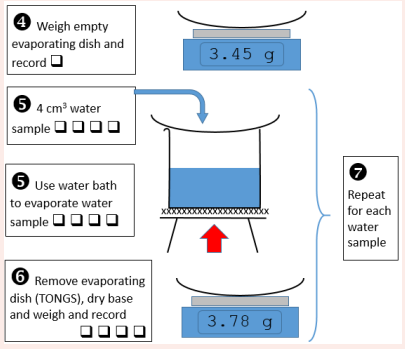
Required Practical- Analysis and Purification of Water Samples



Distillation



pH



Dissolved solids

Key processes - Analysis

Life cycle stage	Plastic carrier bags	Paper carrier bags
Raw materials	Finite resource; require a lot of energy.	Can be made from recycled paper (less energy), or from trees (more energy).
Manufacture	Cheaper to make large quantities of bags from plastic.	More expensive to make bags from paper because the handles must be glued on.
Use	Can be reused many times.	Relatively short lifetime.
Disposal	Can be recycled, reused they do not biodegrade.	Can be recycled easily; if disposed of in landfill, they biodegrade quickly.

772	Wha807t is sustainable development?	Development that meets the needs of current generations without compromising the ability of future generations to meet their own needs.
773	What is finite resourse?	Resource that can be used once and it in limited supply.
774	What is the most important finate resourse?	Crude oil.
775	Why is Haber process important?	It can priduce fertilisers synthetic fertilisers from nitrogen and air, which meand we can prduce more food.
776	What is renewable resource?	Resource that will not ran out in forceable future.
777	What is natural resource?	Resource that has been made through through formation of the world and it benefit to the human.
777	What is fuel?	Material that is used to produce heat
778	Give example of fuels	coal, oil
779	What is mixture of hydrocarbons, mainly alkanes, formed over millions of years from the remains of ancient dead marine organisms.	crude oil
780	What is a material made by a chemical proces	synthetic
781	What is a nutrient added to the soil to increase the soil fertility.	fertiliser
782	What is potable water?	Water that is safe to drink is called potable water
783	IS potable water a pure water?	Potable water is not pure water in the chemical sense because it contains dissolved substances.
784	What is the first stage of producing potable water?	choosing an appropriate source of fresh water
785	What is the second stage of producing potable water?	passing the water through filter beds
786	What is the third stage of producing potable water?	sterilising
787	What agents are used for sterilising potable water?	chlorine, ozone or ultraviolet light.
788	How can desalination be perfomred?	Desalination can be done by distillation or by processes that use membranes such as reverse osmosis.
789	Why is ground water passed through filter bed?	
790	Why is ground water sterilised?	
791	Why is ground water used more than sea water to produce potable water?	
792	What is the first stage of wate water treatment?	screening and grit removal
793	What is the second stage of waste water treatment?	sedimentation to produce sewage sludge and effluent
794	What is the third stage of waste water treatment?	anaerobic digestion of sewage sludge
795	What is the forth stage of waste water treatment?	aerobic biological treatment of effluent.
796	What is phytomining?	Phytomining uses plants to extract metal compounds.
797	What is bioleaching?	Bioleaching uses bacteria to produce leachate solutions that contain metal compounds.
798	What is Life cycle assessment?	LCAs) are carried out to assess the environmental impact of products in each of these stages
799	Is Life cycle assessment an objective process?	no
800	What is the life cycle assessment main stages?	Raw materials, Manifacture, Use and Disposal
801	How can we reduce the use of limited resourses?	reduction in use, reuse and recycle
802	Why plastics are difficult to dispose of?	They are not biodegradable.
803	What is meant by end users?	The people who use a finished product
804	How can metals be recycled?	by melting and recasting
805	Which problems can be caused by quarrying?	Noise pollution Removal of habitat
806	What is carbon footprint?	the total amount of carbon dioxide and other greenhouse gases emitted over the full life cycle of a product, service or event.

Using materials (chemistry only)

Key words

alloy	An alloy is a mixture of two or more elements, at least one of which is a metal.
composite material	Material made from two or more different materials with contrasting properties.
corrosion	When chemicals in the water dissolve minerals in the rocks, causing them to break up (also called solution).
properties	The characteristics of something. In chemistry, chemical properties include the reactions a substance can take part in. Physical properties include colour and boiling point.
metal	Shiny element that is a good conductor of electricity and heat, and which forms basic oxides.

Key knowledge

Corrosion can be prevented by applying a coating that acts as a barrier, such as greasing, painting or electroplating. Aluminium has an oxide coating that protects the metal from further corrosion. Some coatings are reactive and contain a more reactive metal to provide sacrificial protection, eg zinc is used to galvanise iron.

Bronze is an alloy of copper and tin. Brass is an alloy of copper and zinc. Gold used as jewellery is usually an alloy with silver, copper and zinc. Aluminium alloys are low density.

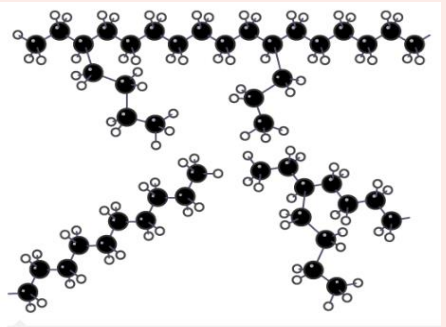
Steels are alloys of iron that contain specific amounts of carbon and other metals. High carbon steel is strong but brittle. Low carbon steel is softer and more easily shaped. Steels containing chromium and nickel (stainless steels) are hard and resistant to corrosion.

Most of the glass we use is soda-lime glass, made by heating a mixture of sand, sodium carbonate and limestone. Clay ceramics, including pottery and bricks, are made by shaping wet clay and then heating in a furnace.

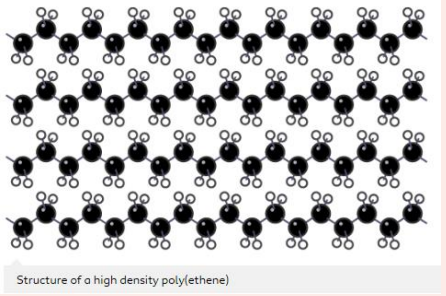
A composite material consists of two or more materials with different properties. They are combined to produce a material with improved properties. Most composite materials have two components: the reinforcement and the matrix, which binds the reinforcement together

	Glass ceramics	Clay ceramics	Metals	Plastics	Composites
Appearance	Transparent	Opaque	Shiny	Various	Usually opaque
Melting point	High	High	High	Usually lower	High
Malleable, brittle or flexible	Stiff and brittle	Stiff and brittle	Malleable	Usually flexible	Usually stiff and brittle
Ability to conduct electricity	Poor	Poor	Good	Poor	Poor
Ability to conduct heat	Poor	Poor	Good	Poor	Poor
Strength	Relatively poor	Strong under compression	Strong	Relatively weak	Usually very strong

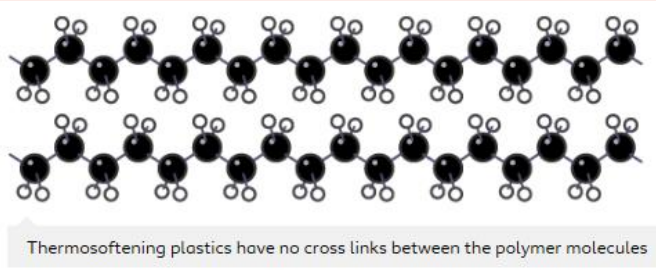
Key diagram



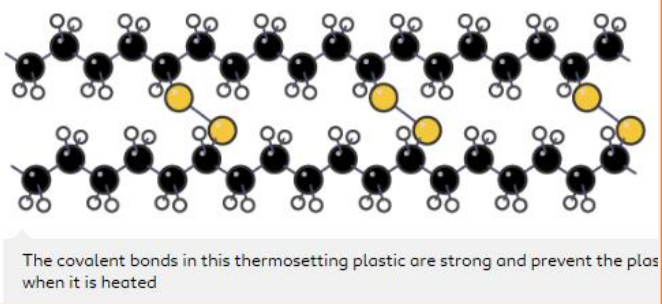
Structure of a low density poly(ethene)



Structure of a high density poly(ethene)



Thermosoftening plastics have no cross links between the polymer molecules



The covalent bonds in this thermosetting plastic are strong and prevent the plas when it is heated

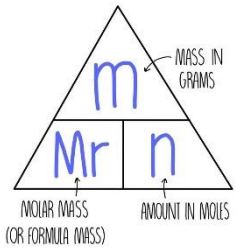
807	What is corrosion?	destruction of materials by chemical reactions with substances in the environment
808	How can corrosion be prevented?	Corrosion can be prevented by applying a coating that acts as a barrier, such as greasing, painting or electroplating.
809	What is neccesery for rusting?	air or water
810	What is bronze?	Bronze is an alloy of copper and tin.
811	What is brass?	Brass is an alloy of copper and zinc.
812	Is gold in jewllery pure metal or alloy?	alloy
813	How is the proportion of gold in alloy measured in?	carats
814	What does 24 carat mean?	100% gold
815	What is steel?	Steels are alloys of iron that contain specific amounts of carbon and other metals.
816	What are the properties of high carbon steel?	High carbon steel is strong but brittle.
817	What are the properties of low carbon steel?	Low carbon steel is softer and more easily shaped.
818	What are the properties of stanless steel?	Hard and resistant to corrosion
819	What does stainless steel contain?	Steels containing chromium and nickel
820	What is the characteristic propertu of aluminium alloy?	low density
821	Condensation polymerisation involves monomers with _____functional groups.	two
822	Condensation reaction are called that because one of the product is _____.	water
823	Both _____ and _____ are necessary for iron to rust.	air and water
824	Corrosion can be prevented by applying a _____ that acts as a barrier	coating
825	What is meant by an alloy?	A metal made by combining other metals
826	What is galvanising?	Covering iron with a layer of zinc
827	What is electroplating?	Using electricity to coat a metal with another metal
828	What is corrosion?	Changes to materials caused by chemical reactions with substances in the environment
829	Which two types of reaction must occur in a redox reaction?	Oxidation Reduction
830	What are the metals in solder?	Tin and lead
831	What are the metals in bronze?	Copper and tin
832	What are the metals in stainless steel?	Carbon, nickel, chromium, iron
834	What are the metals in brass?	Copper and zinc
835	True or False: The higher the proportion of tin in pewter the more malleable the alloy is.	TRUE
836	True or False: Phosphor bronze is not suitable for use in cryogenics	FALSE
837	True or False: Alloys of aluminium have low density.	TRUE
838	True or False: Alloys have the same physical properties as their component elements.	FALSE

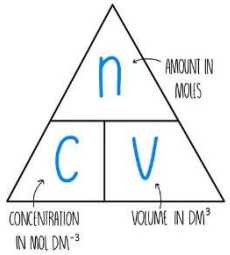
839	What is a polymer?	A molecule made from many small molecules called monomers
840	What is the name of the reaction when many monomers join to make a polymer?	Polymerisation
841	A small 'n' follows the last bracket to show that there could be ____ repeating units	more
842	The displayed formulae of polymers are written as repeating units with ____ at each end	a square bracket
843	Alkenes are able to make polymers by ____ reactions	addition
844	A ____ that makes an addition polymer contains at least one double bond between carbon atoms	monomer
845	The C=C double bonds are the ____ group of alkenes, and in these types of reactions they are monomers	functional
850	Alkenes are able to be monomers because of the ____ bond	double
851	Condensation polymerisation involves monomers with _____functional groups.	two
852	Condensation reaction are called that because one of the product is _____.	water
853	What is Thermosetting polymer?	Polymer chains have cross-links between them; do not melt when heated
854	What is Material which is surrounded by a matrix?	Reinforcement
855	What is Composite?	A material made by combining other materials
856	Is wood a composite?	yes

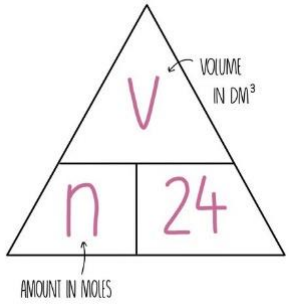
FORMULAS TO LEARN

ONE MOLE OF A SUBSTANCE WILL HAVE THE SAME MASS IN GRAMS AS THE RELATIVE ATOMIC MASS OR FORMULA MASS OF THAT SUBSTANCE

$$\text{PERCENTAGE YIELD} = \frac{\text{ACTUAL YIELD}}{\text{THEORETICAL YIELD}} \times 100$$







	CHARGE	MASS
PROTONS	+1	1
ELECTRONS	-1	1/2000
NEUTRONS	0	1

NAME:

The Periodic Table of Elements

Group no. tells you the number of electrons in the outer shell

The relative atomic mass is made up of the total number of protons and neutrons

Proton number is the same as the total number of electrons

Key: relative atomic mass, **atomic symbol**, name, atomic (proton) number

1	2											3	4	5	6	7	0
Alkali metals	Alkali earth metals															Halogens	Noble gases
7 **Li** lithium 3	9 **Be** beryllium 4																4 **He** helium 2
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	[285] **Cn** copernicium 112	[286] **Nh** nihonium 113	[289] **Fl** flerovium 114	[289] **Mc** moscovium 115	[293] **Lv** livermorium 116	[294] **Ts** tennessine 117	[294] **Og** oganesson 118

Transition metals

Least reactive → Most reactive (Opposite for Gp 7)

* The Lanthanides (atomic numbers 58 – 71) and the Actinides (atomic numbers 90 – 103) have been omitted.

Relative atomic masses for **Cu** and **Cl** have not been rounded to the nearest whole number.

REMEMBER: The relative atomic mass is the average mass of all the isotopes of an element. All the others have been rounded to a whole number.