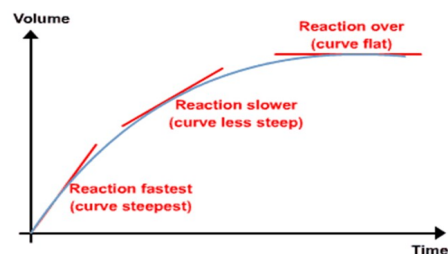


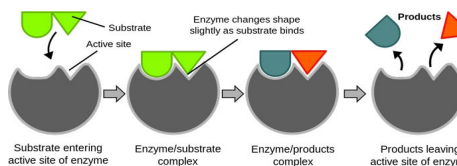
Key vocabulary:

Core Knowledge

Rate of reaction – the speed of a reaction.
Activation energy – the minimum energy needed for a reaction to occur.
Exothermic change – a reaction that gives out heat energy overall resulting in a rise in temperature.
Endothermic change – a reaction that takes in energy overall resulting in a temperature decrease.
Concentration – a measure of how many particles are in a given volume (not area).
Catalyst – a substance that speeds up a chemical reaction but without being chemically changed
Enzyme – a biological catalyst made from protein molecules.
Reaction profile diagram – shows the energy changes that take place during a reaction.
Collision Frequency – number of collisions per unit time e.g. number of collisions per second.



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



- Rate
- Reaction
- Exothermic
- Endothermic
- Concentration
- Catalyst
- Enzyme
- Reaction
- Profile
- Collision
- Frequency
- Effervescence
- Enzyme
- Substrate
- Complex
- Activation energy
- Precipitate
- Particles
- Pressure
- Compressed
- Surface area
- Proportion
- Volume
- Ratio

Powerful Knowledge

Rates of Reaction—Collision Theory

Factor affecting rate	Slower reaction	Faster reaction	Explanation
Surface area			The bigger the <u>surface area to volume ratio</u> the higher the collision frequency
Temperature			The higher the temperature the faster the particles move so the higher the collision frequency AND the greater the proportion of collisions equal to or
Concentration/pressure			The higher the concentration/pressure the more particles there are in a given volume so the higher the collision frequency
Catalyst	<p>A catalyst lowers the activation energy by providing an alternative reaction pathway which means there is a greater proportion of successful collisions</p>		

Practical methods for following rate of reaction:

<p>Glass tube Gas syringe Hydrochloric acid Marble chips</p>	<p>HCl Mg zero 11.88 tare</p>	<p>Add dilute acid and start timing Sodium thiosulfate solution A cross drawn on paper Time how long it takes for the cross to disappear</p>
If a gas is made you can collect it in a gas syringe and read off the volume every 30-seconds.	Alternatively, if a gas is made you can allow it to escape and measure the decrease in mass every 30-seconds. Note that the cotton wool is to stop the solution spattering and	If a precipitate (solid) is made use the 'disappearing cross' method to follow the rate.

Links to previous and future topics

Links to KS2:

There are no previous links to this content.

Links to KS3:

Some of the ideas from this unit link to the following topics

- Particles
- Diffusion
- States of matter
- Food and Digestion
- Pressure

Links to KS4:

There are a number of links to content within this key stage

Biology:

- Key Concepts in Biology
- Enzymes

Chemistry:

- Diffusion
- Haber process
- Particles
- Equilibria

Impressive reading

To complete the variety of experiments offered in this unit you will need to read and comprehend instructions from a number of method sheets and follow to accurately perform practical work and comply with lab rules and safety.

Impressive speaking

During class discussions you will present your findings from practical work by analysing your data and drawing conclusions using key terminology to present and share ideas to your peers.

Impressive writing

Here you will write conclusions which link results and theory using keywords and terminologies. In preparation for extended written responses to exam questions you will also practice engaging with a selection of past paper questions.

Resilience

Remembering the three methods to measure and the four factors effecting rate of reaction can be tricky! It is all about revisiting these new ideas. Spend 10-15 minutes after each lesson recapping what you have learnt to help build your core and powerful knowledge in these areas. Remember, never give up!

Employability

There are an extensive selection of careers that are linked to this topic:
 Analytical Chemist, Chemical Engineer, Chemistry Teacher, Forensic Scientist, Geochemist, Hazardous Waste Chemist, Materials Scientist., Pharmacologist and many, many more!

Topic 6: Groups

Duration: 6 lessons

Composite:

Key Vocabulary:

Effervescence

Displacement

Oxidation

Reduction

Inertness

Flammability

Physical property

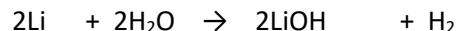
Electronic configuration

Relative

Predict

Group 1 The Alkali Metals and Water

Example: lithium + water → lithium hydroxide + hydrogen

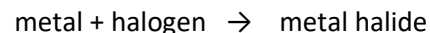


Observations: Effervescence (fizzing) due to hydrogen being produced; moves around on surface; melts and gets smaller; alkaline solution produced; crimson red flame when hydrogen is lit.

Reactivity increases down the group. The outer electron is lost more easily as it is further from the attraction of the nucleus and there is more electron shielding.

Group 7 Reactions of the Halogens

Reactivity decreases down the group. It is more difficult to gain an electron as the outer shell is further from the attraction of the nucleus and there is more electron shielding.



Example: sodium + chlorine → sodium chloride



Example: hydrogen + bromine → hydrogen bromide



The hydrogen halides formed readily dissolve in water to form acidic solutions.

Displacement Reactions

A more reactive halogen can displace (push out) a lesser reactive halogen from its compound in aqueous solution and can be used to compare reactivity.

Example: chlorine + sodium bromide → sodium chloride + bromine (orange/brown)

HIGHER LEVEL ONLY – explain why displacement reactions are REDOX reactions.

Test for Cl₂

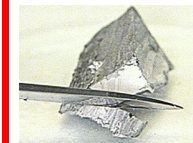
Damp blue litmus paper turns red then bleaches white.



Powerful Knowledge components critical to commit to long term memory:

Groups in the Periodic Table:

Group 1 The Alkali Metals - Li, Na and K



Soft metals that can be easily cut with a knife and have relatively low melting points

Group 7 The Halogens – Cl₂ Br₂ and I₂



Yellow/green gas

red/brown liquid

Grey solid

Group 0 The Noble Gases – He, Ne and Ar are unreactive gases as they already have a full outer shell of electrons.

Name	Use	Why
Helium	Balloons/ Airships	Less dense than air so rises
Neon	Fluorescent lights	Glow when electric current passed through
Argon	Light bulbs	Unreactive with metal filament

Links to previous and future topics

KS3 Elements, compounds and reactions

KS3 Acids and Alkalis

KS3 Metals and Reactivity

KS3 Microorganisms

KS3 The Periodic Table

KS3 Chemical Reactions

KS5 Periodic Table

KS5 Halogens

KS5 Redox

Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
Following written instructions in experiments and CC pdf	Should chlorine be added to drinking water?	Write up of practicals	Explaining concept of reactivity	Job opportunities water treatment, public health, chemical industry etc.

CULTURAL CAPITAL: Benefits and risks of adding chlorine to drinking water. <http://www.bioray.com/content/Chlorine.pdf> and John Snow articles. Also, http://www.bbc.co.uk/history/historic_figures/snow_john.shtml for shorter read.

SEND

- Opening activity/theme is Knowledge Recall to ensure learner buy in
- Opportunities for retrieval practice and building on prior knowledge using Knowledge Recall.
- Multi-sensory approach using reading, listening, watching, doing practicals, talking, observing demonstrations...
- Repetition of key vocabulary in every lesson
- Curriculum time allocated for the explicit teaching of key vocabulary
- Skills ordered logically and sequenced with an increase in complexity
- Links to prior learning explicitly highlighted to support non-verbal reasoning – then, now, next
- Activities are scaffolded with over-learning of previous content to encourage independence

Topic: Year 10 States of Matter and Mixtures Review

Duration: 1 lesson

Composite:

Key vocabulary:

State
Physical
Predict
Describe
Explain
Connective
Element
Compound
Mixture
Pure/Impure
Solvent
Solute
Solution
Soluble
Insoluble
Condensation
Condenser
Hazard
Risk
Chromatography
R_f value
Chromatogram
Mobile phase
Stationary phase
Solvent front
Sedimentation
Filtration
Chlorination
Potable
Precipitate
Vapour
Crystallisation
Evaporation
Concentration
Fractional
Distillation
Aquifer
Relative
Residue
Spattering

Core Knowledge in this unit: All matter is made of particles which are attracted to one another. Their movement is due to kinetic energy which increases with temperature.

There are weak attractions between small molecules called intermolecular forces which can be broken if heated sufficiently.

An element contains one type of atom and is found on the Periodic Table.

A compound contains two or more different elements chemically bonded together in fixed amount shown in a formula.

A mixture contains two or more different substances not chemically bonded together and therefore it can be easily separated. It has no chemical formula.

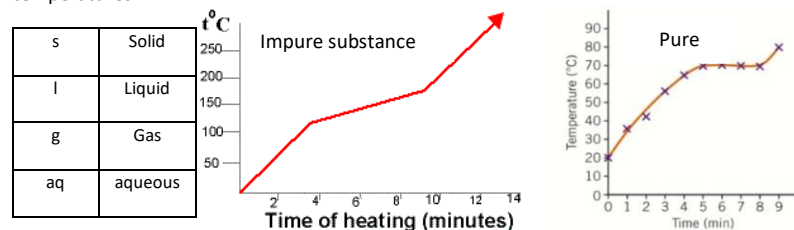
A pure substance has a specific melting point but impure substances melt over a range of temperatures.



A pure element



A pure compound



Solvent	the liquid in which a solute dissolves
Solute	the substance that dissolves in a liquid to form a solution
Solution	is the mixture formed when a solute has dissolved in a solvent
Soluble	describes a substance that will dissolve
Insoluble	describes a substance that will not dissolve

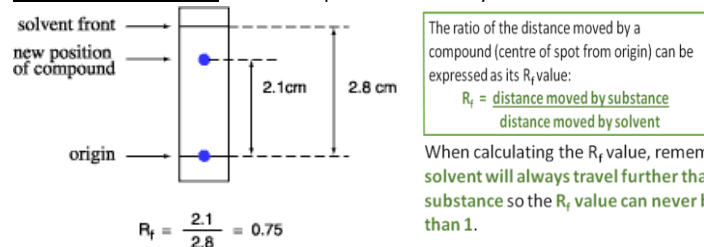
Crystallisation is used to separate a soluble substance from a solvent.

Filtration is used to separate an insoluble substance from a liquid.

Simple distillation separates a liquid from a mixture by evaporation and condensation.

Fractional distillation separates a mixture of more than two liquids.

Paper chromatography is used to separate and identify coloured substances.



Chromatography can be used to separate mixtures of soluble substances by running a solvent (mobile phase) through the mixture on the paper (stationary phase) causing the substances to move at different rates.

Filtration cannot be used to purify seawater as the dissolved salts would pass through the small holes in the filter paper.

Distilled water is used for chemical tests as it is pure and does not contain dissolved substances which could give false test results.

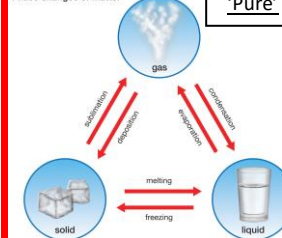
Powerful Knowledge components critical to commit to long term memory:

Solid Particles are arranged in a repeating regular pattern with no spaces between them and can only vibrate about a fixed position

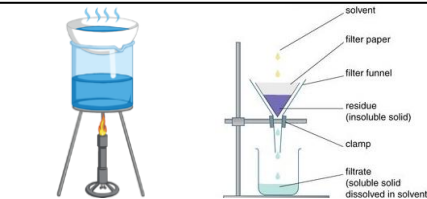
Liquid Particles are touching, not in a pattern and can move past one another

Gas Particles have empty spaces between them, they are not in a pattern and can move past one another

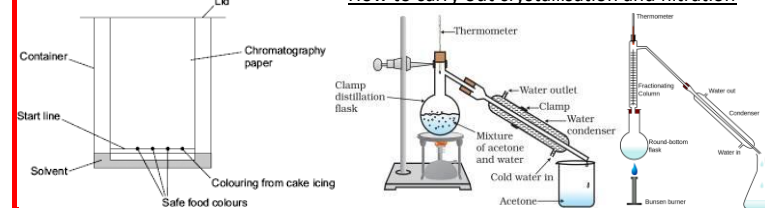
Phase changes of matter



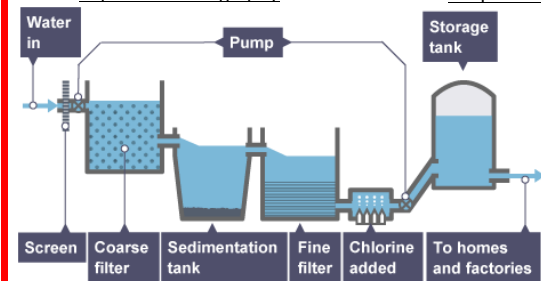
'Pure' means made of one type of substance in Chemistry.



How to carry out crystallisation and filtration



Paper chromatography



Simple and fractional distillation

Seawater is not safe to drink as it contains a high concentration of salts but it can be turned into potable water by using

Potable water is water that is safe to drink but it is not pure as it contains dissolved substances such as salts. It also contains added chlorine, which destroys microorganisms.

Links to previous and future topics

KS2 Materials

KS3 Elements, compounds and reactivity (Yr7)

KS3 Separations & Mixtures (Yr7)

KS3 Particles & Solutions (Yr7)

KS3 Solutions & Mixtures (Yr8)

KS4 States of Matter & Mixtures (Chem)

KS4 Particle Model (Physics)

KS5 Chromatography (Chem)

Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
CULTURAL CAPITAL:				
SEND				

Topic: KS4: Topic 4 Extracting metals and Equilibria – Obtaining and using metals (C)

Duration: 4 lessons

Composite: Unit test

Key vocabulary:

Reactivity, Displacement, Tendency, Salt, Electrons, Ions, Cations, Oxidised, Reduction, Ore, Extraction, Electrolysis, Recycling, Lifetime assessment (LTA) Reversible, Reactants, Products, Dynamic equilibrium, Rate, Haber Process, Catalyst, Temperature, Pressure

Core knowledge Components
Powerful knowledge components crucial to commit to long term memory (in red box)

1. Know the products of a reaction between metal and water. Products are a metal hydroxide (forming an alkaline solution) and hydrogen gas.
 Metal + water → metal hydroxide + water
2. Recall that fairly reactive metals react with acids to produce a salt and hydrogen gas.
 Acid + metal → salt + hydrogen
3. Know that the more reactive metals will react with oxygen more quickly and recall the word equation for metals reacting with oxygen:
 Metal + oxygen → metal oxide
4. Explain how displacement reactions can show which metal is the most reactive.

Applying the Reactivity Series of Metals

Let's assume Metal X is higher in the reactivity series (so more reactive) than Metal Y.

This means that Metal X can react with Metal Y and reduce the Salt (or Oxide) of Metal Y.

In other words, Metal X will displace Metal Y from its compound because Metal X is more reactive than Metal Y.

For example,

Fe, Zn and Mg are more reactive than Cu, so,

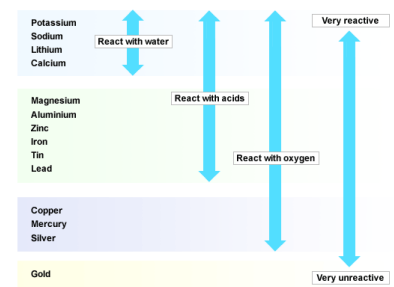
$$\text{Fe(s)} + \text{CuCl}_2(\text{aq}) \rightarrow \text{FeCl}_2(\text{aq}) + \text{Cu(s)}$$

$$\text{Zn(s)} + \text{Cu(NO}_3)_2(\text{aq}) \rightarrow \text{Zn(NO}_3)_2(\text{aq}) + \text{Cu(s)}$$

$$\text{Mg(s)} + \text{Cu}^{2+}(\text{aq}) \rightarrow \text{Mg}^{2+}(\text{aq}) + \text{Cu(s)}$$
5. Recall that: most metals are extracted from ores found in the Earth's crust, and unreactive metals are found in the Earth's crust as the uncombined elements.
 - Most metals are found as compounds that require chemical reactions to extract the metal but gold is very unreactive and can be found in the Earth as itself.
6. Recall that the extraction of metals involves reduction of ores
 - Metals less reactive than carbon.
 - Can be extracted from their oxides by reduction with carbon

1. Deduce the relative reactivity of some metals, by their reactions with water, acids and salt solutions.
2. Explain the reactivity series of metals (potassium, sodium, calcium, magnesium, aluminium, (carbon), zinc, iron, (hydrogen), copper, silver, gold) in terms of the reactivity of the metals with water and dilute acids and that these reactions show the relative tendency of metal atoms to form cations.
 - When metals react with other substances, metal atoms form positive ions (they lose electrons to become cations)
 - Reactivity of a metal is related to its tendency to form positive ions (cations) more reactive metals can form cations more easily
3. Explain oxidation as the gain of oxygen and reduction as the loss of oxygen.

$\text{CuO} + \text{Mg} \rightarrow \text{Cu} + \text{MgO}$
4. Explain why the method used to extract a metal from its ore is related to its position in the reactivity series and the cost of the extraction process, illustrated by heating with carbon (including iron) and electrolysis.



Links to previous and future topics

KS3: Elements and compounds, The Periodic Table, Separation Techniques, Metals and Reactivity

KS4: Obtaining & Using Metals, The Periodic Table

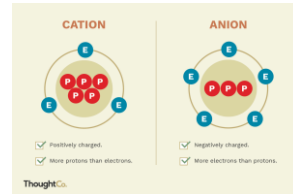
KS3: Elements and compounds, The Periodic Table, Separation Techniques, Metals and Reactivity

KS4: Obtaining & Using Metals, The Periodic Table, Dynamic Equilibria

7. Recall the general word equation for extracting a metal compound from its ore and give an example of a symbol equation.

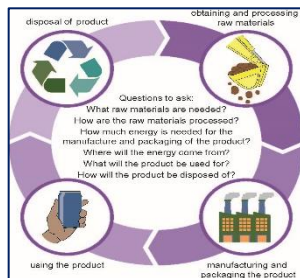
- Metal compound + carbon → metal + carbon dioxide
- $2\text{Fe}_2\text{O}_3 (\text{s}) + 3\text{C}(\text{s}) \rightarrow 4\text{Fe}(\text{l}) + 3\text{CO}_2 (\text{g})$

8. Explain how cations and anions are formed.



9. Describe that a life time assessment for a product involves the consideration of the effect on the environment of obtaining the raw materials, manufacturing the product, using the product and disposing of the product when it is no longer useful.

- These are carried out to assess the environmental impact of products in each of these stages:
 - o Extracting and processing raw materials
 - o Manufacturing and packaging
 - o Use and operation during its lifetime
 - o Disposal at the end of its useful life, including transport and distribution at each stage
- Use of water, resources, energy sources and production of some wastes can be fairly easily quantified
- Allocating numerical values to pollutant effects is less straightforward and requires value judgements, so LTA (life time assessment) is not a purely objective process
- Selective or abbreviated LTAs can be devised to evaluate a product but these can be misused e.g. in support of claims for advertising purposes



Extraction of Metals

The lower the position of a metal in the reactivity series, the easier it is to extract.

Potassium	Extract through Electrolysis
Sodium	
Calcium	
Magnesium	
Aluminium (Carbon)	
Zinc	Extract by burning with carbon
Iron	
Tin	
Lead	Extract by burning in air
Copper	
Silver	Occur native in the ground
Gold	

• Can only be extracted by reduction of carbon if metal is less reactive - carbon displaces the metal from the ore

• If more reactive than carbon, electrolysis can be used (metals less reactive than carbon can also be extracted this way)

• Electrolysis is expensive due to large amounts of energy needed to melt the compounds and to produce the electrical current (so you wouldn't extract a metal using electrolysis if it could be done more cheaply using carbon)

5. Explain how a metals' relative resistance to oxidation is related to its position in the reactivity series.

- Relative resistance to oxidation is the same as relative resistance to losing electrons / forming positive metal ions
- Less reactive a metal is, the more resistant it is to oxidation, because for a metal to react, it forms a positive metal ion by losing electrons (loss of electrons=oxidation)

6. Evaluate the advantages of recycling metals, including economic implications and how recycling can preserve both the environment and the supply of valuable raw materials.

- Recycling is important to achieve sustainable development
- o Requires less energy to melt and remould metals than it does to extract new metals from their ores
- o Mining ores is bad for the environment as large quarries are created, which produce noise pollution and dust
- o Also, recycling allows for waste metals to be reused, saving money, helping the environment and the supply of valuable raw materials (meaning metal ores will last longer).

7. Evaluate data from a life cycle assessment of a product.

1. Recall that chemical reactions are reversible, the use of the symbol \rightleftharpoons in equations and that the direction of some reversible reactions can be altered by changing the reaction conditions.

- The direction of the reaction can be changed by changing the conditions E.g. if the forwards reaction takes place in hot conditions, lowering the temperature can allow the reverse reaction to take place

2. Explain what is meant by dynamic equilibrium.

	<ol style="list-style-type: none"> Recall that the \rightleftharpoons symbol is used to show that a reaction is reversible. <ul style="list-style-type: none"> E.g. The Haber Process: nitrogen + hydrogen \rightleftharpoons ammonia Describe the connection between reactants and products during dynamic equilibrium. <ul style="list-style-type: none"> During the reaction, the same percentage of reactants and products are formed at the same rate. Identify where the products of the Haber process come from. <ul style="list-style-type: none"> nitrogen - extracted from the air hydrogen - obtained from natural gas Recall the conditions for the Haber process. <ul style="list-style-type: none"> The purified gases (nitrogen and hydrogen) are passed over a catalyst of iron at: <ul style="list-style-type: none"> a high temperature (about 450 °C) and a high pressure (about 200 atmospheres). 	<ol style="list-style-type: none"> Describe the formation of ammonia as a reversible reaction between nitrogen and hydrogen and that it can reach a dynamic equilibrium. <ul style="list-style-type: none"> Ammonia is manufactured using the Haber process. It is used to make nitrogen-based fertilisers. This is a reversible reaction between nitrogen (from the air) and hydrogen (from natural gas) that can reach dynamic equilibrium. The reaction is illustrated below: Word equation: Nitrogen + hydrogen \rightleftharpoons ammonia Formula equation: $N_2 (g) + 3H_2 (g) \rightleftharpoons 2NH_3 (g)$ 		
Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
1 lesson. Reading for information	Able to explain models of dynamic equilibrium. Explain the need for fertilisers and impact on food availability (culture capital)	Structured answers. Plastic bags vs Paper bags	Explaining how conditions push reverse changes in line with Chataliers principle (simple terms)	Product Design involving plastics, ceramics, polymers and composites; material scientist, engineering: composite, chemical, polymer; mining, artist, architect
SEND				
<ul style="list-style-type: none"> Opening activity/theme is opening slide to ensure learner buy in Opportunities for retrieval practice and building on prior knowledge: knowledge recall slide Multi-sensory approach using reading, listening, practical work, watching videos, dual-coding, practical work, paired working, observing teacher demonstrations Repetition of key vocabulary in every lesson Curriculum time allocated for the explicit teaching of key vocabulary Skills ordered logically and sequenced with an increase in complexity Links to prior learning explicitly highlighted to support non-verbal reasoning Texts used/alternative texts available with a consideration to reading age 				

Topic: Atomic Structure

Duration: 4 lessons

Composite:

Key vocabulary:
Atom
Proton
Electron
Neutron
subatomic
Nucleus
Electron shell
Electron configuration
Atomic number
Mass number
Isotope abundance

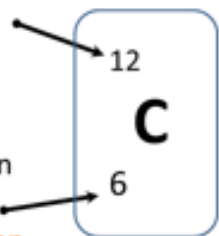
Core Knowledge in this unit:

Atomic number and mass number

Different atoms have different numbers of protons, neutrons and electrons.
 The periodic table is arranged in order of increasing number of protons.
 Information about the number of protons, neutrons and electrons can be found from the periodic table
 Every element has a different proton number
 If the proton number changes, the type of element changes!
 Atoms are overall neutral charge
 The number of protons = number of electrons in a neutral atom

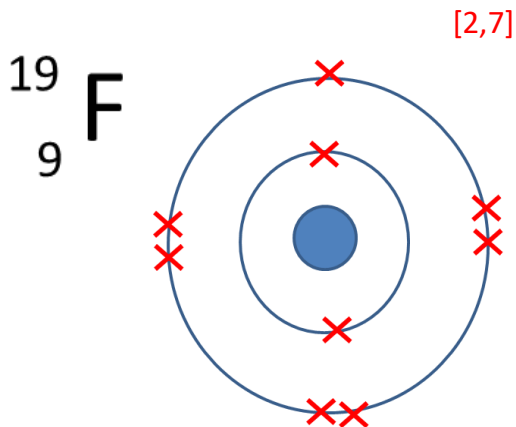
The number of protons and neutrons in an atom's nucleus is the **mass number**.

The number of protons in an atom is known as its **atomic number or proton number**.



Electron configuration

Electrons are found in 'shells' around the nucleus
 Each shells can only fit a certain number of electrons.
 Shells are filled with the inside (lowest energy) ones first.
 The first 3 shells can fit 2, 8, 18 electrons (best remembered 2,8,8)



Fluorine has 9 electrons

Powerful Knowledge components critical to commit to long term memory:

- Everything in the world is made up of tiny particles called atoms.
- There are 92 different types of atom and different combinations of these atoms make all of the things that you see around you.
- Scientists originally thought that atoms were tiny hard spheres that could not be broken down further (Dalton's atomic theory).
- We now know they are made of sub-atomic particles: Protons, Neutrons and Electrons
- Atoms are made of 3 types of subatomic particles: protons, electrons and neutrons
- The nucleus is in the middle of the atom and this contains the protons and the neutrons
- Compared to the overall size of an atom, the nucleus is tiny
- Almost all the mass of an atom is concentrated in the nucleus
- The electrons move around the nucleus in shells.

Protons neutrons and electrons have different mass and charge

Particle	Mass	Charge
proton	1	+1
neutron	1	0
electron	almost 0	-1

Links to previous and future topics
 KS2 Materials

KS3 Elements, compounds and reactivity (Yr7)

KS3 Separations & Mixtures (Yr7)

KS3 Particles & Solutions (Yr7)

KS3 Solutions & Mixtures (Yr8)

KS4 States of Matter & Mixtures (Chem)

KS4 Particle Model (Physics)

Isotopes

An isotope is the same element that has a different mass

Atoms of isotopes have the same number of protons and electrons but different numbers of neutrons giving them different mass.

The Relative Atomic Mass (RAM) is the mass of an atom of an element relative to a Carbon-12 atom and taking into account the naturally occurring isotopes and their natural abundances

e.g. Chlorine has two isotopes
³⁵Cl and ³⁷Cl



If naturally occurring chlorine is
75% chlorine-35 and 25%
chlorine 37 then the RAM can be
calculated:

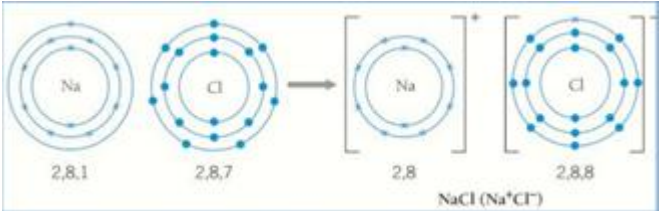
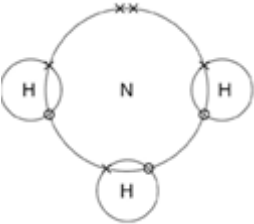
$$\frac{(75 \times 35) + (25 \times 37)}{100} = 35.5$$

Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
Following written practical instructions correctly	Presentation		Public speaking -	Chemist, recycling technologies, product planning, Hazardous waste chemist. Environmental scientist.

CULTURAL CAPITAL:

SEND

- Opening activity/theme is Knowledge Recall slide to ensure learner buy in
- Opportunities for retrieval practice and building on prior knowledge – opening slide @the, now, next’ and during lesson.
- Multi-sensory approach using: listening, reading, talking, watching, practical, paired works...
-
- Repetition of key vocabulary in every lesson
- Curriculum time allocated for the explicit teaching of key vocabulary
- Skills ordered logically and sequenced with an increase in complexity
- Links to prior learning explicitly highlighted to support non-verbal reasoning
- Activities are scaffolded with over-learning of previous content to encourage independence
-

Bonding		Duration:	Composite															
Key vocabulary:	Core Knowledge in this unit:	Powerful Knowledge components critical to commit to long term memory:	Links to previous and future topics															
Bond Electron Outer shell Dot and cross Ionic Covalent Simple Giant Allotrope Metal Non-metal Shared pair Diamond Graphite Electrostatic Positive negative	<p>Ionic compounds have specific properties related to their structure:</p> <ul style="list-style-type: none"> • Melting points are high as ionic compounds form giant ionic lattices (crystals). To melt the compound, many of the strong ionic bonds will need to be broken. This requires a lot of energy. • Solid ionic compounds do not conduct electricity as the ions are fixed and unable to move. • Molten and dissolved ionic compounds do conduct electricity as the ions are free to move and can carry a charge • Ionic compounds are electrically neutral substances. We can find the formula of an ion by using the ion charges to work out how many of each ion are needed to create a neutral compound. • We can use the 'cross-over' method to work out the formulae <table border="1" data-bbox="309 671 1032 1035"> <thead> <tr> <th>+ Ion</th> <th>- Ion</th> <th>What to do</th> </tr> </thead> <tbody> <tr> <td>Ca²⁺</td> <td>Cl⁻</td> <td></td> </tr> <tr> <td>2+</td> <td>1-</td> <td>Note down charge</td> </tr> <tr> <td>1</td> <td>2</td> <td>Cross numbers over</td> </tr> <tr> <td colspan="2" style="text-align: center;">CaCl₂</td> <td>Write formulae</td> </tr> </tbody> </table>	+ Ion	- Ion	What to do	Ca ²⁺	Cl ⁻		2+	1-	Note down charge	1	2	Cross numbers over	CaCl ₂		Write formulae	<p>Powerful Knowledge components critical to commit to long term memory:</p> <p>Ionic Bonding:</p> <ul style="list-style-type: none"> • Metals react with non-metals • Metals lose the electron(s) on the outer shell • These electrons are transferred to a non-metal • This way, both electrons achieve a full outer shell • Metals form positive ions • Non-metals form negative ions • An ionic bond is the strong electrostatic attraction between two oppositely charged ions  <p>Covalent Bonding:</p> <ul style="list-style-type: none"> • Non-metals share pair of electrons in order to fill their outer shells • A shared pair of electrons is a covalent bond • We draw dot and cross diagrams to represent the covalent bonds  <p>Metallic Bonding</p> <ul style="list-style-type: none"> • Metallic bonds form between metal atoms and metals form giant metallic structures • The structure of a metal consists of a regular arrangement of metal ions surrounded by a sea of delocalised electrons 	<p>KS2 Materials</p> <p>KS3 Elements, compounds and reactivity (Yr7)</p> <p>KS3 Separations & Mixtures (Yr7)</p> <p>KS3 Particles & Solutions (Yr7)</p> <p>KS3 Solutions & Mixtures (Yr8)</p> <p>KS4 States of Matter & Mixtures (Chem)</p> <p>KS4 Particle Model (Physics)</p>
+ Ion	- Ion	What to do																
Ca ²⁺	Cl ⁻																	
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CaCl ₂		Write formulae																

COMMON IONS

CATIONS

Name	Formula
Hydrogen	H ⁺
Sodium	Na ⁺
Silver	Ag ⁺
Potassium	K ⁺
Lithium	Li ⁺
Copper (II)	Cu ²⁺
Iron (II)	Fe ²⁺
Iron (III)	Fe ³⁺
Calcium	Ca ²⁺
Barium	Ba ²⁺
Lead	Pb ²⁺
Aluminium	Al ³⁺
Ammonium	NH ₄ ⁺
Zinc	Zn ²⁺

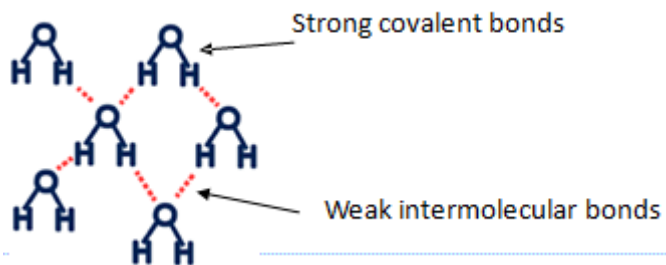
ANIONS

Name	Formula
Chloride	Cl ⁻
Fluoride	F ⁻
Bromide	Br ⁻
Iodide	I ⁻
Oxide	O ²⁻
Nitrate	NO ₃ ⁻
Carbonate	CO ₃ ²⁻
Sulphate	SO ₄ ²⁻
Sulphide	S ²⁻
Hydroxide	OH ⁻
Hydrogen carbonate	HCO ₃ ⁻
Nitrite	NO ₂ ⁻

Covalent Bonding:

Simple Covalent Molecules:

- Simple molecular substances consist of molecules when atoms are joined by *strong covalent bonds*
- But...the molecules are held together by *weak intermolecular forces* – this causes the property of **low melting and boiling points**
- When we boil or melt a simple molecule, the weak intermolecular forces break
- They do not conduct electricity as there are no free electrons, nor an overall electric charge



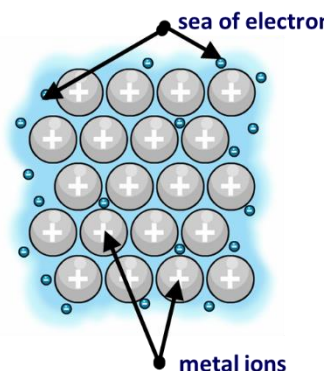
Giant Covalent Substances

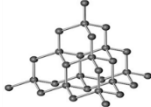
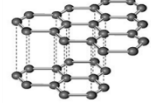
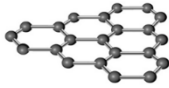
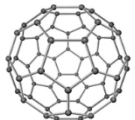
- Have huge numbers of atoms, and form giant lattices
- There are strong covalent bonds between all of the atoms, which require lots of energy to break, therefore they have high melting and boiling points

Allotropes of Carbon

Metallic Bonding

- Metallic bonds form between metal atoms and metals form giant metallic structures
- The structure of a metal consists of a regular arrangement of metal **ions** surrounded by a sea of **delocalised electrons**



Material	Structure	Bonding	Properties	Uses
Diamond	 Giant covalent	Every carbon atom bonded to 4 other carbon atoms with strong covalent bonds. Carbon atoms form tetrahedral shapes	Hard, strong High melting point Does not conduct electricity Does not dissolve	Cutting equipment
Graphite	 Giant covalent	Every carbon bonded to 3 other carbon atoms to form hexagons which form layers. Strong covalent bonds in the layers Weak forces of attraction between layers	Forms layers which slide over each other High melting point Conducts electricity along layers Does not dissolve	Pencil lead Electrodes Lubricant
Graphene	 Giant covalent	Every carbon bonded to 3 other carbon atoms to form hexagons in a single layer. A single layer of graphite	Strong but flexible High melting point Conducts electricity along sheet	
C ₆₀	 Simple molecular	Large molecule with 60 atoms. In the molecule every carbon bonded to 3 other carbons with strong covalent bonds. Weak intermolecular forces between molecules	Molecules are strong Low melting points	

Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
Following written practical instructions correctly	Presentation			

CULTURAL CAPITAL:

SEND

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-

The Periodic Table

Key vocabulary:

- Periodic Table
- Group
- Period
- Atomic mass
- Atomic number
- Isotope
- Abundance
- Electron configuration
- Mendeleev
- Properties
- Patterns

Core Knowledge in this unit:

Mendeleev's periodic Table

The earliest version of the Periodic table was created by Dimitri Mendeleev. He arranged the elements in order of increasing atomic mass. Mendeleev also looked at the chemical and physical properties of the elements and created groups in which to put them. Mendeleev noticed that when he combined these two methods, he needed to leave gaps (if the properties were to match up). Mendeleev predicted that these gaps meant that there were elements that were yet to be discovered and added to the periodic table. He left gaps for them and predicted their properties based on other elements in the group.

Electron Configuration

We can work out the number of electrons in the neutral atoms of an element by looking at the atomic number. These electrons are arranged in electron shells around the nucleus. Different shells can hold different numbers of electrons. The first shell, can hold up to 2 electrons, the second shell can hold up to 8 and the third shell also up to 8.

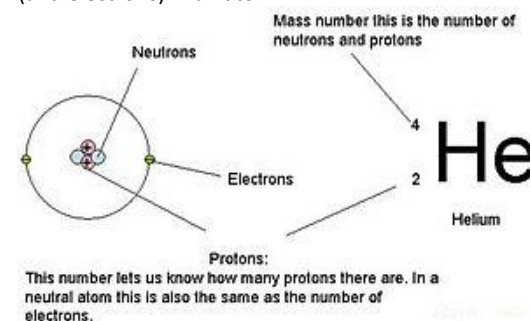
hydrogen 1							helium 2
lithium 2.1	beryllium 2.2	boron 2.3	carbon 2.4	nitrogen 2.5	oxygen 2.6	fluorine 2.7	neon 2.8
sodium 2.8.1	magnesium 2.8.2	aluminium 2.8.3	silicon 2.8.4	phosphorus 2.8.5	sulfur 2.8.6	chlorine 2.8.7	argon 2.8.8
potassium 2.8.8.1	calcium 2.8.8.2						

Duration:

Powerful Knowledge components critical to commit to long term memory:

The periodic table is a list of all the known elements arranged in order of atomic number in rows. These rows are called periods.

The atomic number of an element tells us the number of protons (and electrons) in an atom.



Metals are on the left of the periodic table, and non-metals are on the right.

H	Metals, Nonmetals, and Metalloids																He	
Li	Be											B	C	N	O	F	Ne	metals
Na	Mg											Al	Si	P	S	Cl	Ar	metals
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	metals
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	metalloids
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	metals
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Uub	Uuq	---	---	---	---	---	nonmetals
Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu																		
Th Pa U Np Pu Am Cm Bk Cf Es Fm Md No Lr																		

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Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
https://www.pbs.org/wgbh/nova/article/make-an-element/ or https://www.nhm.ac.uk/discover/are-we-really-made-of-stardust.html	Share cultural capital findings	Report on how elements are made naturally and by scientists. Are there more to come?	Drawing and writing electron configurations	Logical processing, reading for information, problem solving, numeracy.

CULTURAL CAPITAL: Why are there only 118 (ish) elements? How are elements made? <https://www.pbs.org/wgbh/nova/article/make-an-element/> Is it possible that there may be more elements to be discovered?

- SEND**
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Topic: Calculations involving masses

Duration: 6 lessons

Composite:

Key vocabulary:
Moles
Avogadro's Number
Concentration
Relative atomic Mass
Relative formula mass
Mass
Conservation

Conservation of Mass

Mass is always conserved in a chemical reaction, i.e. the number of atoms going in the reactants will be the same as the number of atoms in the products.

Relative Formula Mass (M_r)

The relative formula mass of a compound is the sum of the atomic masses of each of its elements. One mole of a substance will weigh the same as its M_r .

E.g. Find the M_r of H_2O

1. Count the atoms: $H \times 2$, $O \times 1$

2. Find the atomic masses: $H = 1$, $O = 16$

3. Multiply the no. of atoms by masses:

$$(2 \times 1) + 16 = 18$$

Moles

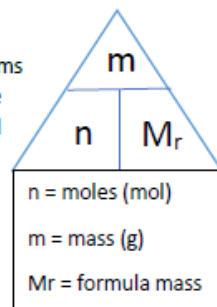
One mole is 6.02×10^{23} atoms (Avogadro's number). One mole of any substance will have this same number of atoms.

E.g. find the number of moles in 6g of H_2 .

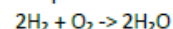
1. Calculate the M_r of H_2

2. Divide mass by M_r :

Reacting Masses



A balanced equation tells us the ratio that is reacting. For example:



This tells us that 2 moles of hydrogen react with 1 mole of oxygen to form 2 moles of water. We can use this information to calculate the masses of reactants or products using the moles equation.

E.g. find the mass of hydrogen that reacts with 48g O_2 to form water.

1. Draw a table and write in what you know, outline what you need to know.

1. Calculate the M_r 's.
2. Calculate moles O_2 using mass/ M_r .
3. Use ratios from the equation to find moles H_2 (double in this case)
4. Calculate mass H_2 using mol x M_r .

Using Moles to Balance Equations

By calculating the moles of each reactant in an equation we can then use them to prove balancing is correct.

E.g. 3g of carbon (C) reacts with 64g sulfur (S_8) to form 19g carbon disulfide (CS_2). Balance the equation using moles.

1. Write a chemical equation and draw a table.
2. Write in the masses you know.
3. Calculate the M_r 's.
4. Find the moles using mass/ M_r .
5. Divide by the smallest number to get the coefficient.

	C	+	S_8	\rightarrow	CS_2
Mass	2.3		2.64		2.76
M_r	3.12		3.256		3.76
Moles	4.025		4.025		4.1
Coefficient	5.1		5.1		5.4

2. Write a balanced equation with the coefficients.

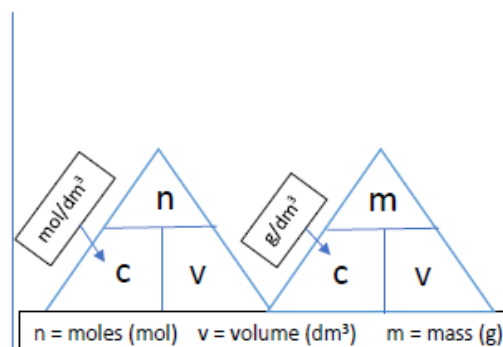
Concentration

$$M = \text{mol}/\text{dm}^3$$

The concentration of a solution is a measure of the number of solute particles dissolved in a solvent.

We can convert concentration from mol/dm^3 to g/dm^3 by multiplying by M_r . You can divide by M_r to go the other way.

$$1000\text{cm}^3 = 1\text{dm}^3$$



Links to previous and future topics
KS2 Materials

KS3 Elements, compounds and reactivity (Yr7)

KS3 Separations & Mixtures (Yr7)

KS3 Atomic model (Yr 9)

KS3 Solutions & Mixtures (Yr8)

KS4 Rates of reaction (Chem)

KS4 Particle Model (Physics)

Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
Following written practical instructions correctly	Presentation		Public speaking -	Chemist, physical chemist, efficiency manager, Materials engineer, Chemical engineer

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