Year 10 PPE CORE Knowledge Organiser

English, Maths & Science

A Christmas Carol – Knowledge Organiser

Plot

Stave One - Marley's Ghost:
1. Scrooge turns down his nephew, Fred's, invitation to his Christmas party and the request of two men who want money for charity.
2. Scrooge is visited by the ghost of his dead partner, Jacob Marley, who tells Scrooge that, due to his greedy life, he has to wander the Earth wearing heavy chains.
3. Marley tries to stop Scrooge from doing the same.
4. He tells Scrooge that three spirits will visit him.

Stave Two - The First of the Three Spirits:
1. He wakes and the Ghost of Christmas Past takes Scrooge into the past.
2. Invisible to those he watches, Scrooge revisits his childhood school days, his work with a jolly man named Fezziwig, and his engagement to Belle.
3. She leaves Scrooge as he loves money too much to love another human being.

Stave Three - The Second of the Three Spirits:
1. Scrooge watches the Cratchit family eat a tiny meal in their home.
2. He sees Bob Cratchit's disabled son, Tiny Tim, whose kindness and thankfulness warm Scrooge's heart.
3. The ghost shows Scrooge his nephew's Christmas party.
4. The ghost shows Scrooge two starved children, Ignorance and Want – deformed children as a result of his greed and selfishness.

Stave Four -The Last of the Spirits:
1. The Ghost of Christmas Yet to Come takes Scrooge through a sequence of scenes linked to an unnamed man's death.
2. Scrooge, is keen to learn the lesson. He begs to know the name of the dead man.
3. Scrooge looks at the headstone and is shocked to read his own name.
4. He is desperate to change his fate and promises to change his ways.

Stave 5- The End of It:
1. Scrooge rushes out onto the street hoping to share his Christmas spirit.
2. He sends a turkey to the Cratchit house and goes to Fred's party. 3. Scrooge transforms his ways and becomes charitable and loving. He develops a social conscience.

Key Themes

Christmas Spirit	Redemption	Supernatural	Greed
Family	Social Responsibility	Time	Poverty

Key Characters

Scrooge	Selfish businessman/miser who transforms in the end of the novella
Marley	Scrooge's dead business partner who comes to warn him to change his ways.
Bob Cratchit	Scrooge's clerk. Humble, works hard but is living in poverty.
Fred	Scrooge's nephew who forgives him despite his mean behaviours.
Christmas Spirits	Spirit of Christmas Past, Present and Yet to Come are sent to teach Scrooge the importance of Christmas Spirit
Fezziwig	Scrooge's kind, old, jolly employer who trained him.
Belle	Breaks up with Scrooge because he 'worships' money

Context

Religion & Christmas Spirit	1. Dickens believed that being a good Christian simply meant being charitable. 2. Christmas became a time to reconsider giving to charity and helping the poor.
Poverty & The Poor Laws	1. Many of the poor needed the generosity of charity and the wealthy. 2. In 1834, a Poor Law was introduced which ruled that the unemployed would have to work in a workhouse in order to receive food and shelter.
Thomas Malthus	The theory that food production will not be able to keep up with growth in the human population.

Key Terms

Allegory	a story which can be interpreted to reveal a hidden meaning, typically a moral or political one.
Foil	something or someone that makes another's good or bad qualities more noticeable.
Sins and Virtues	Sin – the offence or breaking, or the breaking of, a religious or moral law. Virtue – a good moral quality in a person, or the general quality of being morally good
Pathetic Fallacy	When writers use the environment (e.g. weather) to create a particular tone/mood

Key Quotations

- "Tight-fisted hand at the grindstone" (1)
- "As solitary as an oyster" (1)
- External heat and cold had little influence" (1)
- " A bright clear jet of light, by which all this was visible" (2)
- "A solitary child, neglected by friends" (2)
- "Another idol has displaced me" (2)
- "its genial face, its sparkling eye, its open hand, its cheery voice" (3)
- "brave in ribbons" (3)
- "if the shadows remain unaltered by the Future, the child will die" (3)
- "This boy is Ignorance. This girl is Want" (3)
- "the Phantom slowly, gravely, silently approached" (4)
- "Oh tell me I may sponge away the writing on this stone!" (4)
- "The time before him was his own to make amends in" (5)
- "as light as a feather" (5)
- "God bless us, everyone" (5)

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1. The Ghost of Christmas Yet to Come takes Scrooge through a sequence of scenes linked to an unnamed man's death.
2. Scrooge, is keen to learn the lesson. He begs to know the name of the dead man.

Stave 5- The End of It:

Key Themes

	Redemption		
Family		**Time**	

Key Characters

	Selfish businessman/miser who transforms in the end of the novella
	Scrooge's dead business partner who comes to warn him to change his ways.
	Scrooge's clerk. Humble, works hard but is living in poverty.
	Scrooge's nephew who forgives him despite his mean behaviours.
	Spirit of Christmas Past, Present and Yet to Come are sent to teach Scrooge the importance of Christmas Spirit
	Scrooge's kind, old, jolly employer who trained him.
	Breaks up with Scrooge because he 'worships' money

Context

Religion & Christmas Spirit	
Poverty & The Poor Laws	
Thomas Malthus	

Key Terms

	a story which can be interpreted to reveal a hidden meaning, typically a moral or political one.
	something or someone that makes another's good or bad qualities more noticeable.
	Sin – the offence or breaking, or the breaking of, a religious or moral law. Virtue – a good moral quality in a person, or the general quality of being morally good
	When writers use the environment (e.g. weather) to create a particular tone/mood

Key Quotations

"Tight-

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"Another

"its genial face,

"if the shadows

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"God

Macbeth – Knowledge Organiser

Plot (Acts)

-Macbeth wins a battle against Norway and the traitor: Thane of Cawdor.
-Macbeth meets the witches who give him three prophecies including that he will become Thane of Cawdor and king.
-Macbeth writes a letter to Lady Macbeth informing her of the prophecies and that Duncan plans on visiting Macbeth's castle.
-Lady Macbeth plots the death of Duncan so her husband will be king.
-Lady Macbeth shares her plans, encouraging Macbeth to commit regicide.

-Macbeth decides to murder Duncan; sees apparition of a dagger.
-Lady Macbeth finishes the plan by wiping blood on the drugged guards.
-Macduff discovers the body of Duncan and Macbeth kills the guards, blaming his grief and anger.
-Malcolm and Donalbain, Duncan's sons, leave the castle, afraid that they will be blamed for the murder of their father.

-Banquo suspects Macbeth of regicide and Macbeth is suspicious of him.
-Macbeth sends murderers to kill Banquo and his son, Fleance (escapes).
-At a banquet, Banquo's ghost appears, sending Macbeth into a fit.
-Lady Macbeth tries to explain the situation by saying that Macbeth is unwell.
-Macduff travels to England to support Malcolm.

-Macbeth confronts witches and receives 3 prophecies: beware Macduff; no man born of woman can kill him and safe until Birnam Woods move.
-Macbeth sends murderers to Macduff's castle to kill his family.
-Macduff is in England begging Malcolm to return to Scotland to take the throne from Macbeth who is a tyrant.
-Malcolm tests Macduff's loyalty, who then learns his family have been murdered and swears to kill Macbeth in revenge.

-Lady Macbeth's guilt drives her insane.
-More Scottish lords join Malcolm's huge army but Macbeth isn't concerned because he believes the prophecies.
-Lady Macbeth dies off stage and Macbeth regrets what has happened to her.
-Macbeth begins to doubt his safety when Birnam Woods move.
-Macbeth is confronted by Macduff who tells him he was not born naturally.
-Macduff defeats Macbeth, cuts off his head, proclaiming Malcolm as King.

Key Themes

Guilt	Supernatural	Kingship
Ambition	Masculinity/femininity	Deception

Key Characters

Macbeth	Brave warrior corrupted by ambition, becomes an evil tyrant.
Lady Macbeth	Macbeth's wife who drives his ambition in the beginning but loses her control by the end.
Banquo	Macbeth's foil, who is betrayed and murdered.
Macduff	Loyal; gains revenge by killing Macbeth.
Duncan	King at the beginning - respected leader.
Malcolm	Duncan's heir. Uses an English army to defeat Macbeth and become King.
Witches	Supernatural beings who give prophecies.

Context

King James 1	King when *Macbeth* was written, believed in witches; united England and Scotland.
The Great Chain of Being	Hierarchy of everything on earth - God was at the top. If this hierarchy was ignored then the natural order would be thrown into chaos.
Divine Right of Kings	The idea the king/monarch was chosen by God
Gunpowder plot	Plot to blow up parliament and kill King James.

Key Terms

Aside	character speech unheard by other characters on stage.
Soliloquy	character shares their thoughts/feelings.
Motif	Object/symbol repeated throughout a text
Couplets	rhyming pair of lines next to each other.
Tragic Hero	Suffer a downfall from greatness caused by a tragic flaw in their character
Hamartia	fatal or tragic flaw
Hubris	Extreme pride that leads to a downfall

Key Quotations

- " brave""noble", "worthy"" 1
- "Stay, you imperfect speakers" 1
- "Instruments of darkness" 1
- "Too full o' the milk of human kindness" 1
- "Look like the innocent flower but be the serpent under't" 1
- "when you durst do it, then you were a man" 1
- "Give me the daggers." 2
- "Will all great Neptune's ocean wash this blood clean from my hand?' 2
- "daggers in men's smiles" 2
- "fruitless crown", "barren sceptre" 3
- "O full of scorpions is my mind, dear wife" 3
- "bleed, bleed poor country" 4
- "Will these hands ne'er be clean?" 5
- "Turn, hell-hound, turn" 5
- "Dead butcher and his fiend-like queen" 5

Macbeth – Knowledge Organiser

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-Malcolm and Donalbain, Duncan's sons, leave the castle, afraid that they will be blamed for the murder of their father.
-Banquo suspects Macbeth of regicide and Macbeth is suspicious of him. -Macbeth sends murderers to kill Banquo and his son, Fleance (escapes). -Macduff travels to England to support Malcolm.
-Macbeth confronts witches and receives 3 prophecies: beware Macduff; no man born of woman can kill him and safe until Birnam Woods move.
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Key Themes

	Supernatural	
Ambition	**Masculinity/femininity**	

Key Characters

Macbeth	
Lady Macbeth	
Banquo	
Macduff	
Duncan	
Malcolm	
Witches	

Context

	King when *Macbeth* was written, believed in witches; united England and Scotland.
	Hierarchy of everything on earth - God was at the top. If this hierarchy was ignored then the natural order would be thrown into chaos.
	The idea the king/monarch was chosen by God
	Plot to blow up parliament and kill King James.

Key Terms

	character speech unheard by other characters on stage.
	character shares their thoughts/feelings.
	Object/symbol repeated throughout a text
	rhyming pair of lines next to each other.
	Suffer a downfall from greatness caused by a tragic flaw in their character
	fatal or tragic flaw
	Extreme pride that leads to a downfall

Key Quotations

" brave
"Stay,
"Look like
"when you
"Will
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"O full
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Year 10F – Sparx Codes (10A2, 10A3, 10B2 & 10B3)

Non Calculator Topic	Sparx Code
Order of operations	M521
Estimating	M878
Equation of a line	U848
FDP	M958, M264 & M553
Percentage of amounts	M437
Calculating with Fractions	M835, M601, M931, M157, M197, M110 & M265
Ratio	M801, M267 & M525
Venn Diagrams	U476 & U748
Bar Charts	M738
Index Laws	M120, M608 & M150
Solving equations	M634, M647, M401 & M554
Expanding single brackets	M237 & M792
Forming expressions	M957
Best Buy	M681
Angles rules	M818, M163, M351 & M319
Reverse percentages	M528
Types of angles	M502
Money	M901
HCF/LCM	M365
Angles in Polygons	U427
Column Vectors	U632, U903, U564

Calculator Topic	Sparx Code
Place Value	U435
Using a calculator	M757
FDP	M264 & M335
Finding factors	U211
Operations with money	U659
Probability	U803, U408
Coordinates	M618, M622, & M230
Roots and powers	M135
Unit conversion	U388 & U663
Angles rules	U390, U730 & U329
Bearings & Measuring	U525 & U107
Scale diagrams	M112
Averages	U526, U456, U260 & U291
Rounding	U298 & U965
Expand and Factorising	U179, U768 & U365
Indices	U235
Error intervals	U657
Standard Form	M719 & M678
Stem and Leaf	U200 & U909
Plotting Quadratics	U989

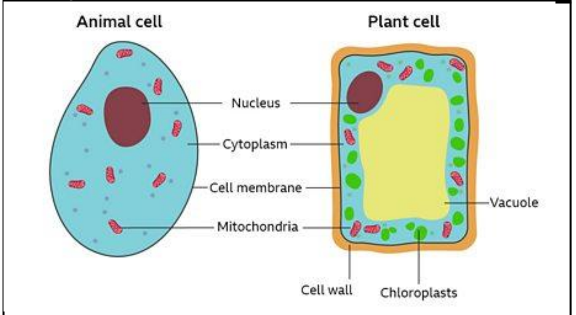
Year 10H – Sparx Codes (10A1 &10B1)

Non Calculator Topic	Sparx Code
Solving Equations Graphically	U601, U836, U875
Algebraic Proofs	U582
Equation of a line	U848
Ratio	U753, U176, U577, U595, U676
Algebraic Fractions	U437, U294, U685, U457
Functions	U637, U895, U448, U996
Transformations	U134, U196, U799, U696, U519, U766
Quadratic graphs	U989
Histograms	U814
Trigonometry	U605, U283, U545, U967, U170
Solving equations	M634, M647, U178, U858
Circle Theorems	U459, U251, U489, U130, U808, U807
Indices	U985, U772, U694
Vectors	U632, U903, U564, U781, U660
Bearings and Constructions	U525, U107, U187, U787, U245, U979, U820
Surds	U338, U707, U281
Simultaneous Equations	U760
Completing the Square	U589,
Venn Diagrams	U476, U748

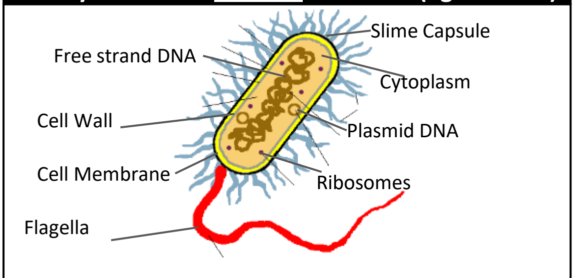
Calculator Topic	Sparx Code
Frequency Polygons	U840
Solving Equations	U325
Factorising	U365
Percentages	U349, U925, U286
Currency Conversions	U610
Error Intervals	U657, U301
Speed, Distance, Time	U151
Trapeziums	U265
Standard Form	U330, U534
Using your Calculator	U926
Index Rules	U235, U694, U772
Graphs	U980, U593, U229
Area of a Triangle	U592
Probability	U558, U729
Volume of 3D Shapes	U116, U915
Solving Algebraic Fractions	U685
Venn Diagrams	U476
Bounds	U587
Circle Theorems	U808
Quadratic Simultaneous Equations	U547
Equations of Circles	U567
Tangents to Circles	U758
Vector Geometry	U781, U660, U560

KS4 CELL BIOLOGY

Eukaryotes - Cells with a nucleus



Prokaryotes - Cells <u>without</u> a nucleus (eg bacteria)



Magnification	How many times larger an image is
Resolution	The ability to distinguish between 2 points

Magnification of a microscope = Eyepiece lens x Objective lens

<u>When using a microscope:</u>

Start with the **lowest powered objective lens** because it has **the greatest field of view**

Start with the **stage at the top** and move it down so the **slide and lens don't break.**

$$\text{Actual} = \frac{\text{Image}}{\text{Magnification}}$$

Light Microscope	Uses light. Colour image, live specimen, easy to use, cheaper & portable
Electron Microscope	Much better magnification & resolution. Can see detail inside organelles but expensive, difficult to use, black & white, dead specimens only

Specialised cell	Cell with 'special' shape/structure for its role
Differentiation	When a cell becomes specialised

Specialised animal cells

<u>Nerve Cell →</u>

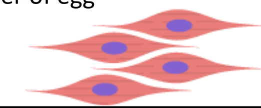
Long axon and dendrites to connect to other cells and transmit impulses.
Axon is insulated by myelin sheath

<u>Sperm Cell →</u>

'Tail' to move to egg
Many mitochondria for energy
Enzymes in head to digest outer layer of egg

<u>Muscle Cell →</u>

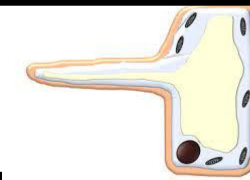
Elastic fibres to contract
Many mitochondria for energy



Specialised plant cells

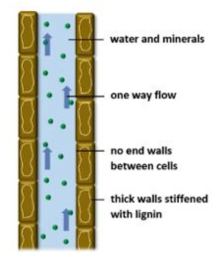
<u>Root Hair Cell →</u>

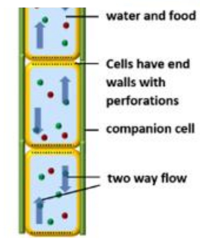
Elongated shape gives large surface area to absorb water.
Thin walls so substances can diffuse across
No chloroplasts as no light underground



<u>Xylem Cell ↓</u>

No end plates. Water moves up.
Walls reinforced with lignin





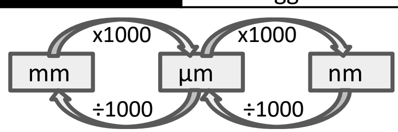
<u>Phloem Cell →</u>

Perforated sieve plates so substances can be transported both up & down
Nearby companion cells provide energy for active transport

Meristems	Areas of plant tissue in tips of roots and shoots where unspecialised plant stem cells are found.

Organelle	Parts of a cell (sub-cellular structures)			
Name	**Role in the cell**	**Animal**	**Plant**	**Prokaryote**
Nucleus	Contains DNA	✓	✓	✓
Cell membrane	Controls what enters/leaves cell	✓	✓	✓
Cytoplasm	Cell jelly where chemical reactions happen	✓	✓	✓
Ribosomes	Protein synthesis	✓	✓	✓
Mitochondria	Respiration	✓	✓	
Vacuole	Stores cell sap		✓	
Chloroplast	Contains chlorophyll		✓	
Cell Wall	Made of cellulose for support & structure		✓	✓

Order of magnitude	10x bigger/smaller
Example	100x bigger = 2 orders of magnitude 1000x bigger = 3 orders of magnitude

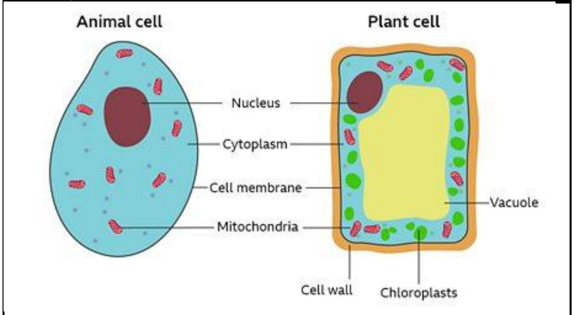


Stem Cell	Unspecialised or undifferentiated cell
Uses of stem cells	Can become other types of cell. Used to treat many disease such as diabetes, paralysis, Parkinsons
Embryonic stem cells	Most useful as these can become most types of cell. Harvested from embryos left over from IVF. Controversial as some people believe an embryo is a human life.
Stem cells from adult bone marrow	Can be donated from a live donor. Can only become certain types of blood cell

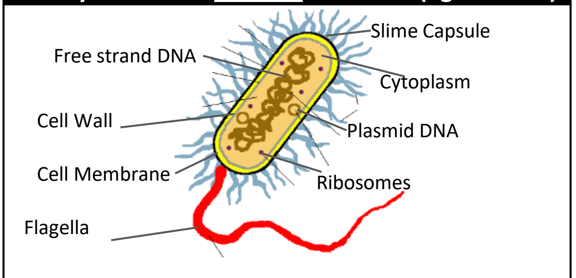
Cell Transport	The movement of substances in and out of cells. Also called **<u>exchange</u>**
Diffusion	The movement of particles from **<u>high to low</u>** concentration
Osmosis	The diffusion of water from **<u>dilute to concentrated</u>** solution through a partially permeable membrane.
Active Transport	The movement of particles from low to high concentration **<u>against a concentration gradient.</u>** Requires energy.
Exchange surface	Area where lots of exchange happens, eg alveoli, intestinal villi, gills in fish. These areas have large surface area, thin walls, good blood supply for efficient exchange.
Required Practical	Potato swells more in dilute (watery) solution as water moves in by osmosis. Potato shrinks in concentrated solution. Potatoes should start with same size/surface area.

KS4 CELL BIOLOGY

Eukaryotes - Cells with a nucleus



Prokaryotes - Cells without a nucleus (eg bacteria)



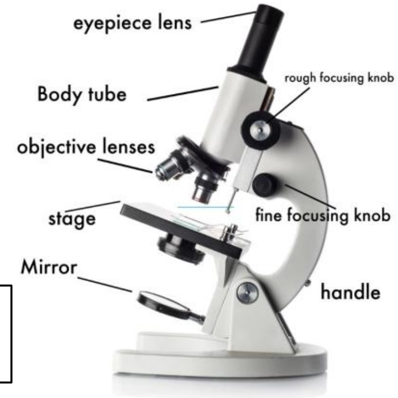
	How many times larger an image is
	The ability to distinguish between 2 points

Magnification of a microscope = Eyepiece lens x Objective lens

When using a microscope:

Start with the **lowest powered objective lens** because it has **the greatest field of view**

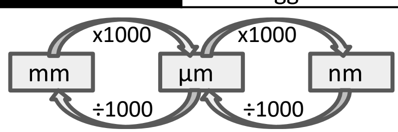
Start with the **stage at the top** and move it down so the **slide and lens don't break.**



Light Microscope	Uses light. Colour image, live specimen, easy to use, cheaper & portable
Electron Microscope	Much better magnification & resolution. Can see detail inside organelles but expensive, difficult to use, black & white, dead specimens only

Organelle	Parts of a cell (sub-cellular structures)			
Name	Role in the cell	Animal	Plant	Prokaryote
Nucleus				
Cell membrane				
Cytoplasm				
Ribosomes				
Mitochondria				
Vacuole				
Chloroplast				
Cell Wall				

	10x bigger/smaller
Example	100x bigger = 2 orders of magnitude 1000x bigger = 3 orders of magnitude



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	Most useful as these can become most types of cell. Harvested from embryos left over from IVF. Controversial as some people believe an embryo is a human life.
Stem cells from adult bone marrow	

Specialised cell	Cell with 'special' shape/structure for its role
Differentiation	W

Specialised animal cells

Nerve Cell →

Long axon and dendrites to connect to other cells and ....

Axon is insulated by myelin sheath

Sperm Cell →

'Tail' to move to egg

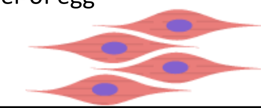
Many mitochondria for...........

Enzymes in head to digest outer layer of egg

Muscle Cell →

...............to contract

Many mitochondria for ....



Specialised plant cells

Root Hair Cell →

Elongated shape gives ....

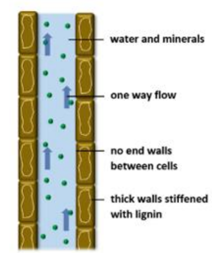
Thin walls so substances can ......

No chloroplasts as no ......

Xylem Cell ↓

No end plates. Water moves up.

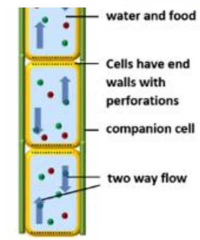
Walls reinforced with lignin



Phloem Cell →

Perforated sieve plates so substances can be transported both up & down

Nearby companion..............t



Meristems	Areas of plant tissue in tips of roots and shoots where unspecialised plant stem cells are found.

	The movement of substances in and out of cells. Also called **exchange**
	The movement of particles from **high to low** concentration
	The diffusion of water from **dilute to concentrated** solution through a partially permeable membrane.
	The movement of particles from low to high concentration **against a concentration gradient.** Requires energy.
Exchange surface Required	

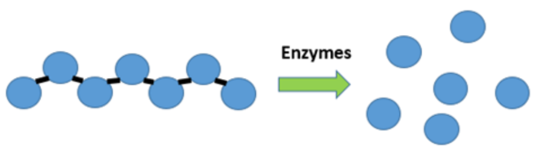
KS4 ORGANISATION

Levels of Organisation

Cells	The basic building blocks of all living organisms. (eg muscle cells)
Tissues	A group of cells with a similar structure and function. (eg muscle tissue)
Organs	Tissues working together to perform a specific function. (eg heart)
Organ systems	Organs working together to form organ systems, which work together to form an organism. (eg circulatory system)

Enzymes

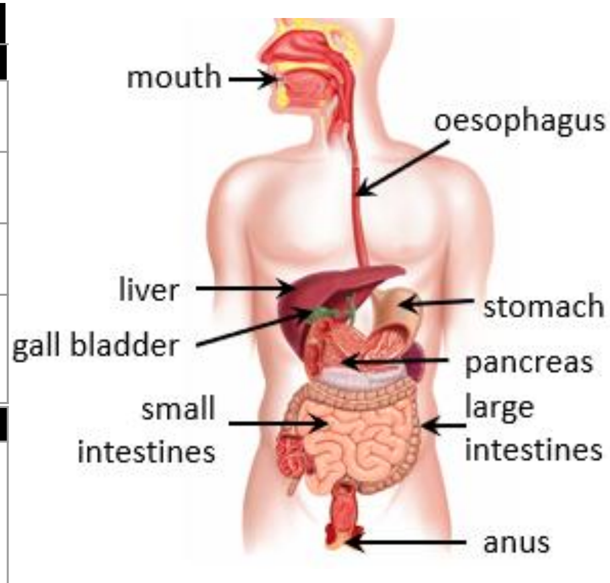
- biological catalysts that speed up chemical reactions without being used up.
- Digestive enzymes turn **large insoluble molecules** into **smaller soluble molecules** that can be absorbed into the bloodstream



- Have a specific shape to fit the substance they break down ('lock & key')
- Area that fits substrate is called the **active site**
- Enzymes work best at specific (**optimum**) temperatures & pHs
- Enzymes can be **denatured** (permanently damaged) by high temperatures or incorrect pH.

Lock and Key hypothesis

Enzyme + substrate   lock & key mechanism   enzyme + products

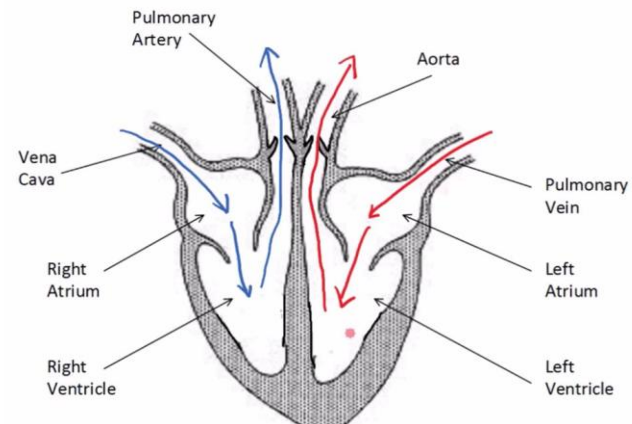


Digestive Enzymes

Carbohydrase (e.g. amylase)	Found in the salivary glands , pancreas , small intestine
Protease	Found in stomach, pancreas and small intestine
Lipase	Found in pancreas and small intestine

Bile (not enzyme)	Made in the Liver , stored in the gallbladder	Emulsifies lipids Neutralises stomach acid

Food Tests		**Positive result**
Sugars	Benedict's test (heat)	Orange to brick red
Starch	Iodine test	Brown to blue/black
Protein	Biuret reagent	Blue to purple
lipids	Ethanol (flammable!)	Cloudy layer



The Cardiovascular System

Right ventricle	Pumps blood to the lungs where gas exchange takes place.
Left ventricle	Pumps blood around the rest of the body.
Pacemaker (in the right atrium)	Controls the natural resting heart rate. Artificial electrical pacemakers can be fitted to correct irregularities.
Coronary arteries	Carry oxygenated blood to the cardiac muscle.
Heart valves	Prevent blood in the heart from flowing in the wrong direction.

Types of Blood Vessel

Artery	Carry blood **away** from the heart	Thick muscular walls, small lumen, carry blood under high pressure
Vein	Carry blood **into** the heart	Thin walls, large lumen, carry blood, have valves, under low pressure
Capillary	Connects arteries and veins	Walls one cell thick to allow diffusion

Blood Components

Plasma (55%)	Carries dissolved urea, amino acids, glucose
Red blood cells (45%)	Carry oxygen
White blood cells (<1%)	Immunity
Platelets (<1%)	Blood clotting

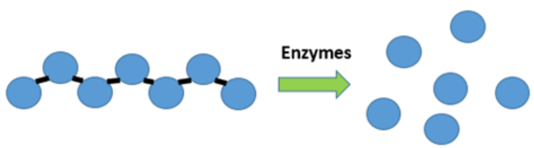
KS4 ORGANISATION

Levels of Organisation

Cells	
Tissues	
Organs	
Organ systems	

Enzymes

- biological catalysts that speed up chemical reactions without being used up.
- Digestive enzymes turn **large insoluble molecules** into **smaller soluble molecules** that can be absorbed into the bloodstream



- Have a specific shape to fit the substance they break down ('lock & key')
- Area that fits substrate is called the **active site**
- Enzymes work best at specific (**optimum**) temperatures & pHs
- Enzymes can be **denatured** (permanently damaged) by high temperatures or incorrect pH.

Lock and Key hypothesis

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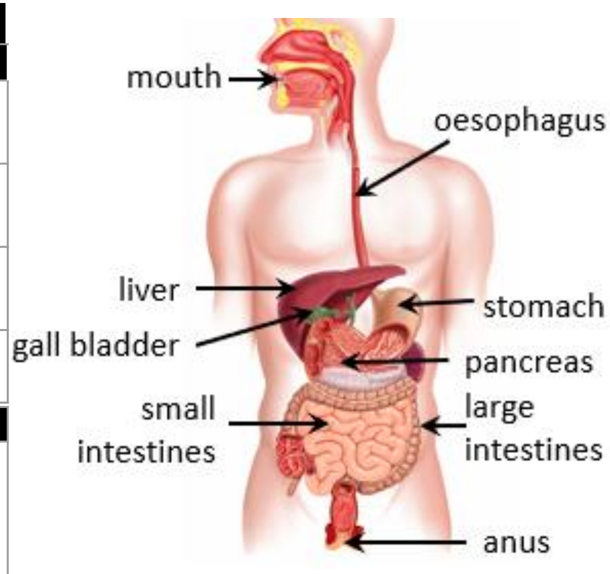

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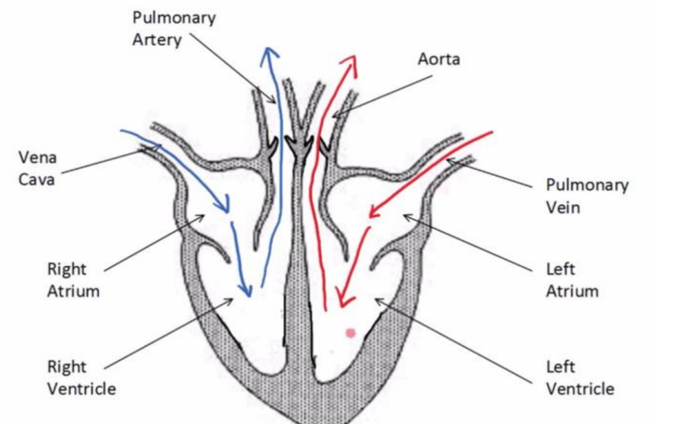

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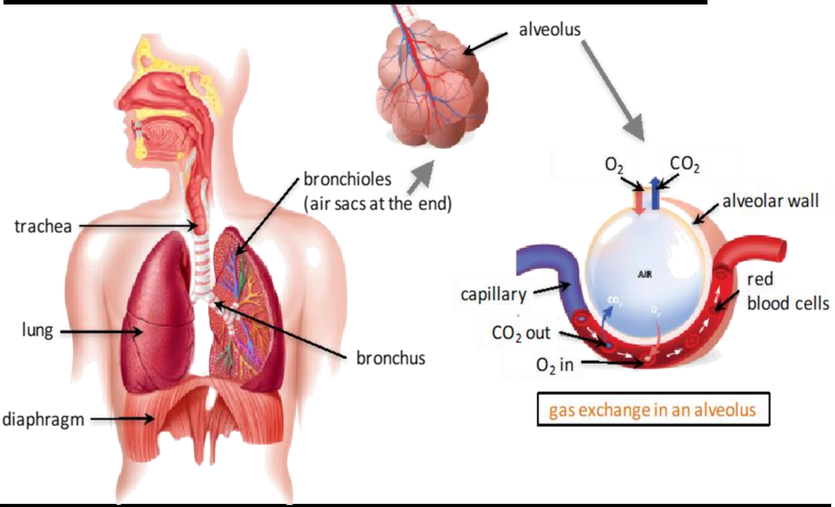
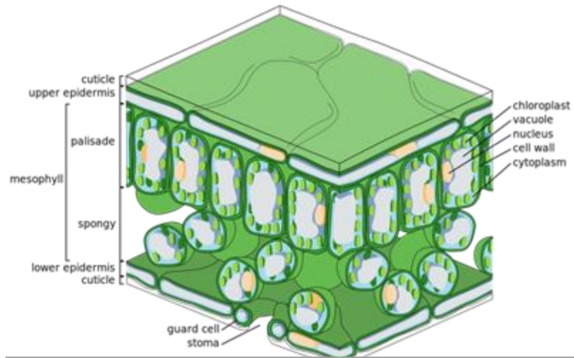
	Immunity
	Blood clotting

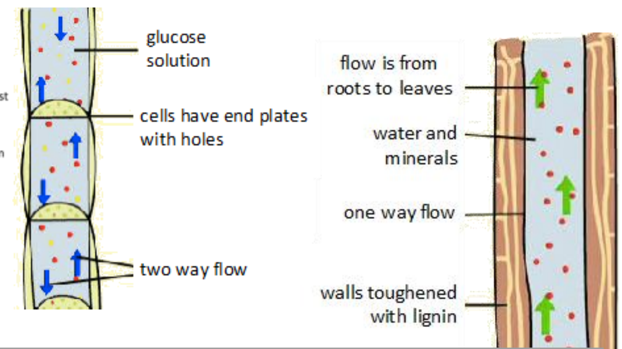
KS4 ORGANISATION



The Respiratory system		
Trachea	***Carries air to/from the lungs***	Rings of cartilage protect the airway.
Bronchioles	***Carries air to/from the air sacs (alveoli)***	Splits into multiple pathways to reach all the air sacs.
Alveoli	***Site of gas exchange in the lungs***	High surface area for efficient gas exchange.
Capillaries	***Allows gas exchange between into/out of blood***	Oxygen diffuses into the blood and carbon dioxide diffuses out.

Plant Organisation	
Waxy Cuticle (top)	Reduces water loss from the leaf
Guard cells and stomata (in lower epidermis)	Guard cells open and close the stomata to control water loss and allow for gas exchange
Palisade mesophyll	Contains palisade Cells near the top of the leaf that are packed with chloroplasts to maximise photosynthesis.
Spongy mesophyll	Contains air spaces between cells that Increase surface area for gas exchange so that carbon dioxide can diffuse into cells.



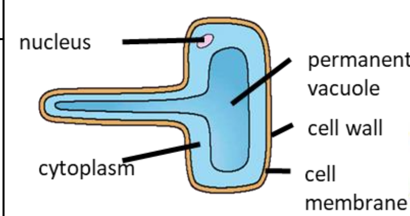


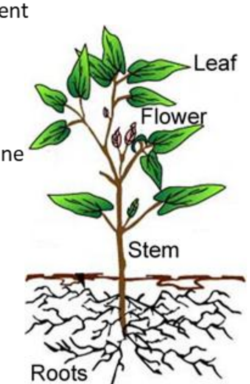
xylem	Allows transport of water and mineral ions from the roots to the stem and the leaves.
phloem	Transports dissolved sugars from the leaves to the rest of the plant for use or storage (translocation).
Transpiration	The loss of water through the leaf by evaporation
Translocation	The movement of dissolved sugars

Non-communicable Diseases		**Description**	**Treatment**
Cardiovascular Conditions	Coronary Heart Disease	Fatty deposits in the coronary artery causing a lack of blood flow to the cardiac muscle	Stents , statins
	Faulty Heart Valves	Valves failing to open or close properly causing blood to leak or flow in wrong direction	Biological Valve transplant , mechanical valve transplant
Cancer	Benign Tumour (not cancer)	Contained in one area of the body within a membrane	
	Malignant Tumour	Spreads to different parts of the body and forms more tumours	chemotherapy , radiotherapy

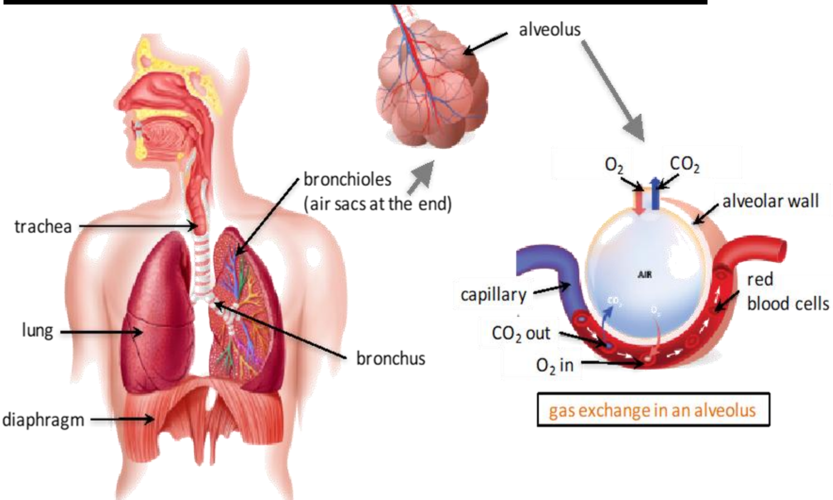
	Risk Factors
Heart Disease	drinking alcohol, diet, obesity
Cancer	Carcinogens and ionising radiation increase the risk of cancer by changing/ damaging DNA
	Some cancers have genetic risk factors
	smoking

Temperature, humidity, air movement and light intensity affect the rate of transpiration.





KS4 ORGANISATION



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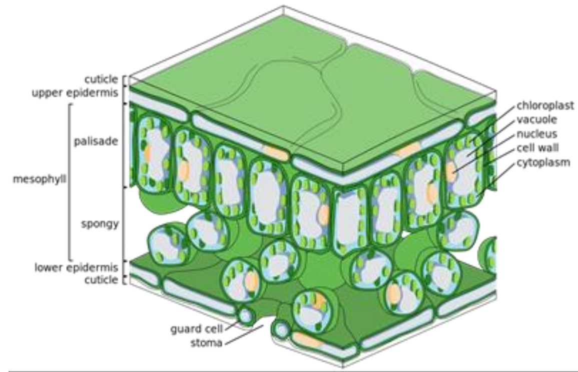

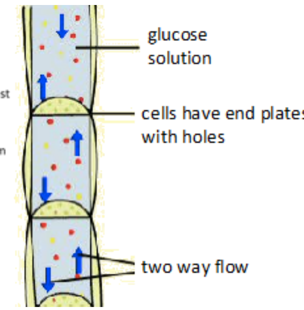

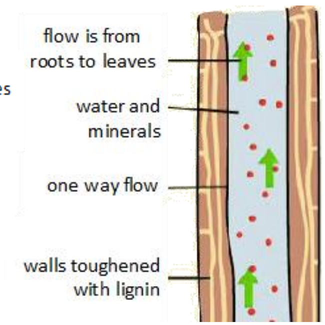

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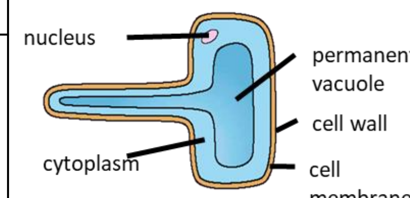

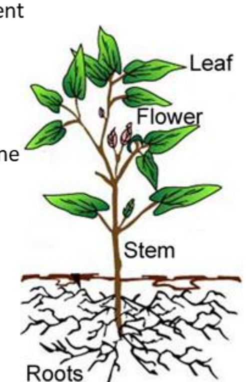

KS4 INFECTION & RESPONSE

Pathogen:	Disease causing microorganism
4 Types	**How they make you feel ill**
Bacteria	Produce toxins
Fungus	Produce toxins
Virus	Live inside cells, take over, damage
Protist	Live inside cells, take over, burst out

Communicable	Non-communicable
Contagious	Not contagious

6 ways pathogens spread

1. Air
2. Food
3. Water
4. Touch/Contact
5. Sex
6. Vector

1st lines of defence	2nd lines of defence
Skin, tears, mucus, stomach acid	White blood cells • Phagocytosis (Engulf) • Produce antibodies • Produce antitoxins

7 Diseases	Pathogen	Symptom
Salmonella	Bacteria	Vomiting & diarrhoea)
Gonorrhoea	Bacteria	Yellow discharge Pain urinating
HIV	Virus	Fever/poor immunity (can be treated with **antiretrovirals**)
TMV	Virus	Yellow mosaic on leaves
Measles	Virus	spots/fever/rash
Rose black spot	Fungus	Black spots on leaves
Malaria	Protist	Fever (spread by mosquitoes which are a **'vector'**)

Vaccine	Jenner • Inject weak/dead form of pathogen • WBC make antibodies • If exposed make antibodies quicker
Painkiller	Only treat symptoms not disease
Antibiotic	Fleming Penicillin from mould Only kill bacteria not viruses

Drug Trials	Tested on...	Tested for...
Pre-clinical	Animals/Cells	Efficacy/Toxicity
Clinical (phase I)	Small group healthy	Toxicity
Clinical (phase II)	Small/Medium patients	Efficacy dosage
Clinical (phase III)	Large group patients	Efficacy, dosage, side effects
Peer reviewed	Checked by independent body	
Placebo	Fake drug	
Double Blind Trial	Neither doctor nor patient know who has been given the placebo Eliminates bias	

Drugs from plants

Aspirin from willow

Penicillin from mould

Heart medication from digitalis (foxgloves)

Plant Disease (Triple Only)	
Plant diseases	Pest/pathogen/ Deficiencies: Mg- yellow leaves (chlorsis) Nitrate - stunt growth
Treatment	Fertilisers Pesticides
Defence	Chemical Physical Mechanical

Monoclonal Antibodies (Triple Only)

- Inject mouse.
- Mouse lymphocyte (WBC) combined with tumour = hybridoma.
- Cloned hybridoma makes antibodies
- Used in pregnancy/covid tests or biological markers

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KS4 BIOENERGETICS

Photosynthesis

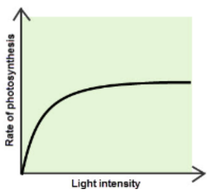
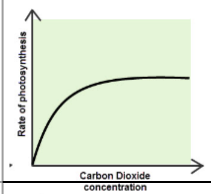
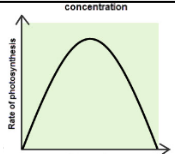
Plants absorb carbon dioxide through **stomata** (holes) in leaf and water through roots and break them down using **light.**

Plants are the only organisms that can produce **glucose (a chemical store of energy)** using energy from light.. They are the start of every food chain so they are called **producers**. This reaction requires energy so it is **endothermic.**

Photosynthesis happens in the **chloroplasts** in the leaf. A **green pigment called chlorophyll** captures the light.

Carbon dioxide + Water → Glucose + Oxygen

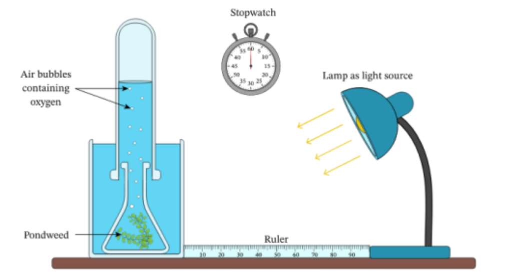
$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

Limiting Factor	Something that limits (slows) the rate of photosynthesis
1. Chlorophyll	No chlorophyll =no light absorbed =no photosynthesis
2. Light intensity	
3. Carbon dioxide concentration	
4. Temperature	

Uses of glucose from photosynthesis:

1. Respiration
2. Store as insoluble starch
3. Cellulose cell walls
4. Fructose for fruits
5. Fats & oils for seeds
6. Combine with nitrates to make amino acids & proteins

Photosynthesis Required Practical



Independent	Change distance from light to vary light intensity
Dependent	Bubbles per minute or volume of gas per minute
Controls	Pondweed, CO_2 concentration, Temperature
Inverse square law	Light intensity $\propto \frac{1}{d^2}$

Anaerobic respiration in yeast	'Fermentation'

Glucose → Ethanol + Carbon Dioxide

Ethanol is use for making **alcoholic drinks**

Carbon dioxide makes **bread rise**

Aerobic Respiration

Animals **and plants** use glucose as a chemical energy store. They react it with oxygen to release energy. The waste products of carbon dioxide & water are then breathed out.

This reaction happens inside the **mitochondria.** It is **exothermic** because it releases energy.

Glucose + Oxygen → Carbon Dioxide + Water

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$$

What is the energy from respiration used for?

1. Warmth
2. Movement
3. Chemical Reactions:
   - respiration
   - convert glucose to starch, glycogen & cellulose
   - Forming lipids from glycerol and fatty acids
   - Combine glucose + nitrates to make amino acids (**plants only**)
   - breakdown of excess proteins to form urea for excretion

Metabolism	The sum (total) of all the chemical reactions in the body
Exercise & Respiration	During exercise, cells need to respire more to get more energy. Heart rate, breathing rate & breathing volume all increase during exercise to get more oxygen into the blood and deliver more oxygenated blood to cells for respiration.

Anaerobic Respiration in animals	Anaerobic = **without oxygen** Eg) during periods of **vigorous exercise**, cells may not get enough oxygen & begin respiring **anaerobically** **Glucose → Lactic Acid** Anaerobic respiration happens in the **cytoplasm** Anaerobic respiration is **less efficient** than aerobic respiration
Lactic acid	**Product** of anaerobic respiration in animals Causes **muscle fatigue**
Oxygen debt	When you **continue to breathe heavily** after exercise to get enough oxygen to **break down the lactic acid** that has built up. This breakdown happens in the **liver.**

KS4 BIOENERGETICS

Photosynthesis

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Carbon dioxide + $\rightarrow$

$6CO_2$ + $\rightarrow$

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	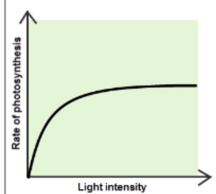
	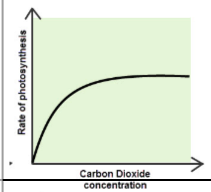
	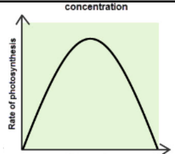

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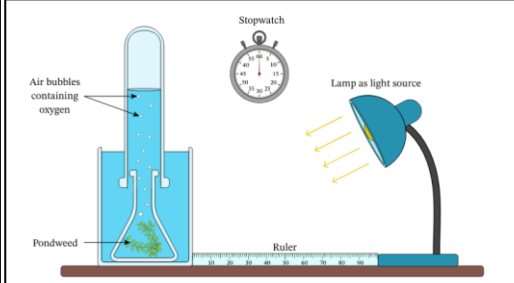

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   - ..
   - ..
   - ..
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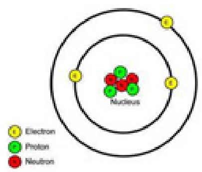
Lactic acid	
Oxygen debt	

Chemistry Knowledge Organiser
Topic 2: Atomic Structure and the Periodic Table

The Structure of the Atom

- All matter is made from atoms. Atoms are very small. The radius of atom is about 1×10^{-10} m (this is also known as 0.1 nanometres).
- The central part of the atom is known as the nucleus. It is only 1×10^{-14}m across, which is 10,000 times smaller than the total atom.
- An atom is made up of three subatomic particles: **protons**, **neutrons** and **electrons**.
- Protons and neutrons are found in the **nucleus**
- Electrons are found orbiting the nucleus in shells (also known as *energy levels*).

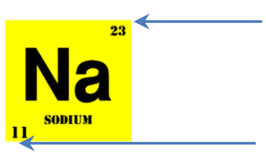


- The mass and charges of the sub atomic particles is shown below:

	Mass	Charge
Proton	1	+1
Neutron	1	0
Electron	0	-1

- Atoms have **no overall charge** because they have the same number of positive protons as negative electrons.

Atomic Number and Mass Number



Mass number: This is the total protons+neutrons

Atomic number: This is the number of protons

Therefore sodium has 11 protons, 11 electrons and 23 – 11 = 12 neutrons

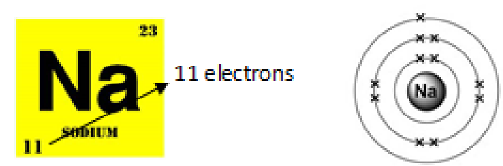
Key Terms	Definitions
atom	The particles that make up all substances with mass; they are made of protons, neutrons and electrons.
nucleus	The centre of an atom; it is made of protons and neutrons.
nanometre	A unit of measurement: 1×10^{-9}m
proton	A sub atomic particle found in the nucleus, it has an electric charge of +1 and a relative mass of 1.
electron	A sub atomic particle found in the shells of an atom, it has an electric charge of -1 and a negligible mass
subatomic	Describes particles smaller than an atom (protons, neutrons, electrons)
neutron	A subatomic particle found in the nucleus of an atom, it has a charge of 0 and a mass of 1
atomic number	The number of protons in an atom.
mass number	The total of protons and neutrons in an atom.

Electron Configuration/Electronic Structure

There are very strict rules about how electron fill up the electron shells, the inner shell is always filled first. Each shell has a maximum number of electrons it can take.

Shell 1: maximum 2 electrons
Shell 2: maximum 8 electrons
Shell 3: maximum 8 electrons

Example:



The electronic configuration of Sodium (Na) can also be written like this: 2,8,1. This shows there is 2 electrons in the 1st shell, 8 electrons in the second shell and 1 electron in the 3rd shell.

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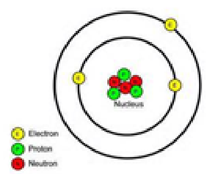

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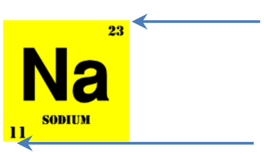
- Atoms have **no overall charge** because ………………….

Atomic Number and Mass Number



Mass number: This is the ………………

Atomic number: This is the ……………

Therefore sodium has ………………

Key Terms	Definitions
atom	
nucleus	
nanometre	
proton	
electron	
subatomic	
neutron	
atomic number	
mass number	

Electron Configuration/Electronic Structure

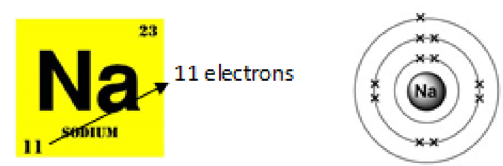
There are very strict rules about how electron fill up the electron shells, the inner shell is always filled first. Each shell has a maximum number of electrons it can take.

Shell 1: maximum ………….

Shell 2: maximum…………

Shell 3: maximum …………

Example:

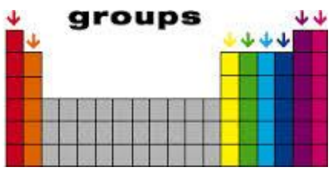


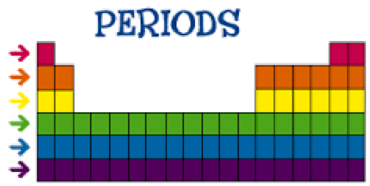
The electronic configuration of Sodium (Na) can also be written like this: 2,8,1. This shows there is 2 electrons in the 1st shell, 8 electrons in the second shell and 1 electron in the 3rd shell.

Chemistry Knowledge Organiser
Topic 2: Atomic Structure and the Periodic Table

Elements

- An ***element*** is a substance made from only one type of atom. All elements are given a symbol and are found on the periodic table. You need to learn the symbols for the first 20.
- The Periodic Table is arranged into groups (columns) and periods (rows), as shown below.





Elements in the same group have:

- The same number of electrons in their outer shell
- Similar properties

Elements in the same period have:

- The same number of electron shells

Compounds

- Compounds are made of 2 or more elements that are chemically bonded
- These are made in chemical reactions.
- Compounds are given a formula. For example, carbon dioxide is CO_2 means 1 carbon atom and 2 oxygen atoms.
- Another example is calcium hydroxide $Ca(OH)_2$ which means 1 calcium, 2 oxygen atoms and 2 hydrogen atoms

Chemical Reactions always Conserve Mass

- In some chemical reactions it may appear that there are less products than there were reactants; however, this is often because a gas has been made and this has escaped into the atmosphere.

Key Terms	Definitions
element	A substance that contains only one type of atoms
mixture	A mixture is two or more different atoms which are not chemically bonded
compound	Two or more elements that are chemically bonded
group	The columns on the periodic table
period	The rows on the periodic table
reactant	Chemicals you start with in a chemical reaction
product	Chemicals made in a chemical reaction

The Conservation of Mass

- In a chemical reaction, chemical bonds in the reactants are broken, the atoms are rearranged and new chemical bonds are made to form the products.
- In a chemical reaction, ***mass is never lost;*** you must start and finish with the same mass.

Balancing Equations

- We need to write balanced chemical equations represent chemical reactions and the conservation of mass.
- For example: The equation below shows hydrogen and oxygen making water but there are more oxygen atoms on the right than the left.

$$H_2 + O_2 \rightarrow H_2O$$

- In the equation below there are 4 hydrogen atoms on the left and right of the equation and 2 oxygen atoms on each side

$$2H_2 + O_2 \rightarrow 2H_2O$$

<u>Chemistry Knowledge Organiser</u>
<u>Topic 2: Atomic Structure and the Periodic Table</u>

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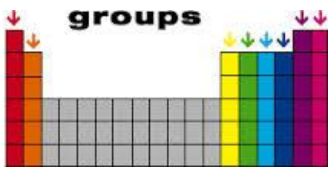

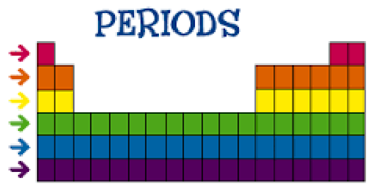

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- The same number of electrons in their outer shell
- Similar properties

Elements in the same period have:

- The same number of electron shells

Compounds

- Compounds are made of ……………………
- Compounds are given a formula. For example, carbon dioxide is CO_2 means 1 carbon atom and 2 oxygen atoms.
- Another example is calcium hydroxide $Ca(OH)_2$ which means …………………………

Chemical Reactions always Conserve Mass

- In some chemical reactions it may appear that there are less products than there were reactants; however, this is often because ………………………………………………………………………………………………………

Key Terms	Definitions
	A substance that contains only one type of atoms
	A mixture is two or more different atoms which are not chemically bonded
	Two or more elements that are chemically bonded
	The columns on the periodic table
	The rows on the periodic table
	Chemicals you start with in a chemical reaction
	Chemicals made in a chemical reaction

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- In a chemical reaction, chemical bonds in the reactants are broken, the atoms are rearranged and new chemical bonds are made to form the products.
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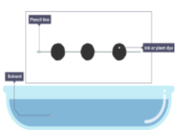
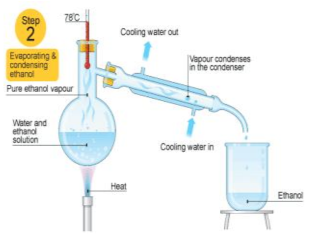
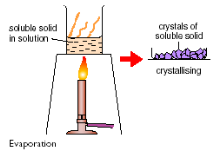
Chemistry Knowledge Organiser
Topic 2: Atomic Structure and the Periodic Table

Pure and Impure Substances

- A pure substance contains only <u>one</u> type of **element** or **compound.**
- **An impure substance** contains more than one type of element or compound in a mixture, for example salt water contains NaCl and H_2O. All mixtures are impure substances.
- Mixtures are much easier to separate than elements or compounds as they are not chemically bonded
- There are a variety of ways that mixtures can be separated and they are outlined below. Remember that these are all physical changes and chemical bonds are not broken during any of these processes.

Key Terms	Definitions
Pure	A substance made of only ONE type of element or compound
Impure	A mixture of elements and/or compounds
Chromatography	A technique where mixtures can be separated based on their solubility.
Distillation	A separation technique which means a mixture of two liquids is heated
Crystallisation	Method of mixture separation where a solvent is evaporated, leaving the solute behind.

Separating Impure Substance

Method	Diagram	Explanation
Chromatography		• Different substances travel different distances up the paper depending on their solubility in the solvent used (it is often water but not always). The more soluble, the further it moves up the paper • Line must be drawn with pencil because pencil will not run. • Artificial colours in foods can be identified using chromatography. Additives do not necessarily have a colour and therefore are identified using chemical analysis.
Distillation		
Crystallisation		• Crystallisation is when a solvent is evaporated from a solute. The evaporation should not begin until the solution is **saturated** (has as much solid dissolved in the solution as possible). The solution should the be allowed to cool, as the solution cools crystals will form. The crystals can then be separated and dried.

Chemistry Knowledge Organiser
Topic 2: Atomic Structure and the Periodic Table

Pure and Impure Substances

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- **An impure substance** contains more than one type of element or compound in a mixture, for example salt water contains NaCl and H_2O. All mixtures are impure substances.
- Mixtures are much easier to separate than elements or compounds as they are…………………………………………………………
- There are a variety of ways that mixtures can be separated and they are outlined below. Remember that these are all physical changes and chemical bonds are not broken during any of these processes.

Key Terms	Definitions
Pure	
Impure	
Chromatography	
Distillation	
Crystallisation	

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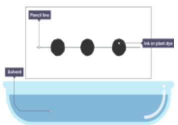
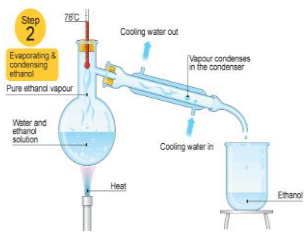
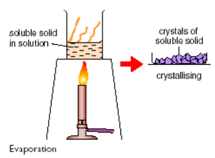
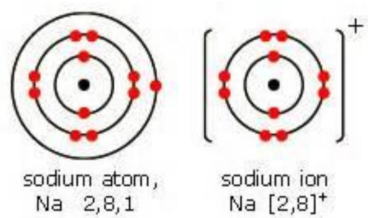
Chromatography		
Distillation		
Crystallisation		

Chemistry Knowledge Organiser
Topic 5: Bonding structure and properties of matter

Ions

All atoms of all elements react to get a full outer shell of electrons. Some atoms will lose electrons to get a full outer shell: these are metals. Some atoms will gain electrons to get a full outer shell: these **are non metals**. An ion is an atom with a positive or negative charge, these are formed by an atom gaining or losing electrons. For example, sodium has one electron in it's outer shell, it therefore loses one electron to form a Na^{+1} ion. We represent ions with square brackets around the ion and the charge in the top right corner.

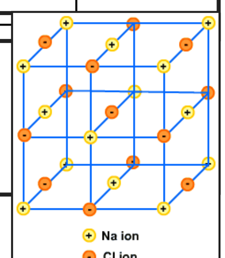


The **group number** indicates how many electrons an atom would have to lose or gain to get a full outer shell of electrons. See below to see what ions different groups form

Group	What happens to the electrons?	Charge on ions
1	Lose 1	
2	Lose 2	
3	Lose 3	
5	Gain 3	
6	Gain 2	
7	Gain 1	

Ionic Lattice

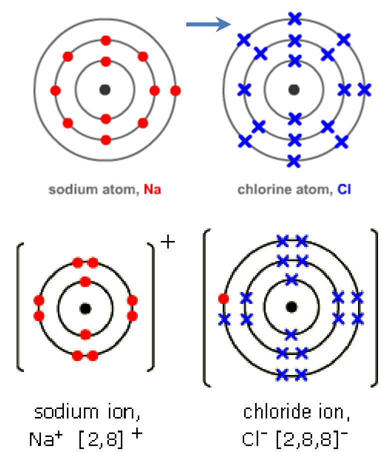
Ionic compounds form **regular structures** called **giant ionic lattices)** in which there are strong **electrostatic forces** of attraction in all directions between oppositely charged ions.



Key Terms	Definitions
metal	An element which loses electrons to form positive ions
non metal	An element which gains electrons to form negative ions
ion	An atom (or particle) with a positive or negative charge, due to loss or gain of electrons
ionic bond	A bond formed by the electrostatic attraction of oppositely charged ion
electrostatic	The force between a positive and negative charge.

Ionic Bonding

When a metal atom reacts with a non-metal atom electrons in the outer shell of the **metal atom are………..** This means the metal has a positive charge and the non metal has a negative charge. This means there is an **……………………….attraction** between the two ions, this is what forms an ionic bond. Both atoms will have **a full outer shell** (this is the same as the structure of a noble gas). See example to memorise below of sodium chloride.



Chemistry Knowledge Organiser
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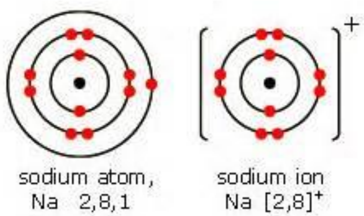
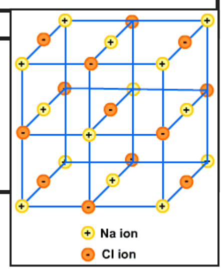


The **group number** indicates how many electrons an atom would have to lose or gain to get a full outer shell of electrons. See below to see what ions different groups form

Group	What happens to the electrons?	Charge on ions
1	Lose 1	+1
2	Lose 2	+2
3	Lose 3	+3
5	Gain 3	-3
6	Gain 2	-2
7	Gain 1	-1

Ionic Lattice

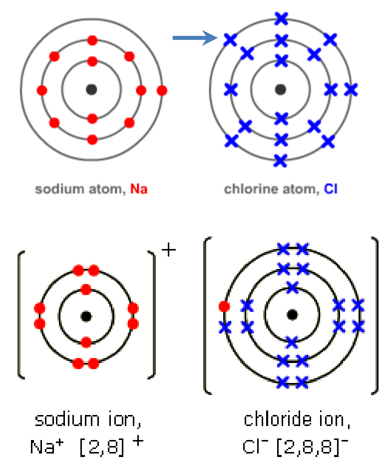
Ionic compounds form **regular structures** called **giant ionic lattices)** in which there are strong **electrostatic forces** of attraction in all directions between oppositely charged ions.



Key Terms	Definitions
metal	
non metal	
ion	
ionic bond	
electrostatic	

Ionic Bonding

When a metal atom reacts with a non-metal atom electrons in the outer shell of the **metal atom are transferred to the non metal atom**. This means the metal has a positive charge and the non metal has a negative charge. This means there is an **electrostatic attraction** between the two ions, this is what forms an ionic bond. Both atoms will have **a full outer shell** (this is the same as the structure of a noble gas). See example to memorise below of sodium chloride.

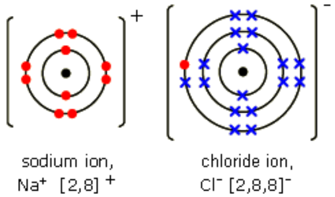


Chemistry Knowledge Organiser
Topic : Bonding structure and properties of matter

Ionic Bonding- Models

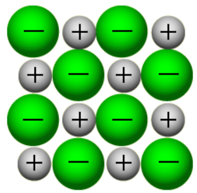
There are a number of ways we can represent ionic bonding all; of these have **advantages and limitations.** For example, all the diagrams below show ways we can represent **sodium chloride**

1. **Dot and cross diagrams-** These show clearly how the electrons are transferred. It does not, however, show the 3D lattice structure of an ionic compound or that this is a giant compound.



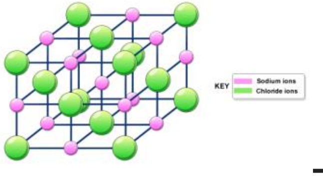
1. **2D ball and stick model of ionic bonding**

This has the advantage of showing that electrostatic forces exist between oppositely charged ions in an ionic compound. However, does not show the 3D structure of an ionic compound.



3. 3D Ball and Stick model of ionic bonding

This clearly shows the 3D structure of the **ionic lattice** and how different ions interact with other ions **in all directions** to create an ionic lattice.



Key Terms	Definitions
ionic lattice	The regular 3D arrangement of ions in an ionic compound
giant	When the arrangement of atoms is repeated may times, with large numbers of atoms or ions
aqueous	When a substance is dissolved in water
empirical formula	The simplest ratio of atoms in a compound

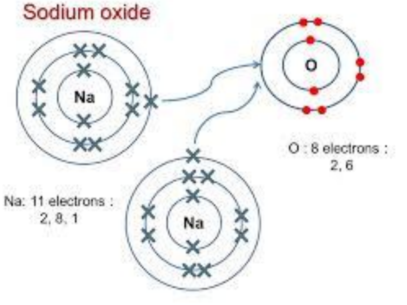
Properties of Ionic compounds

Ionic compounds have **high melting points, due to strong electrostatic forces between the oppositely charged ions.** This means a lot of energy is required to break these bonds. For example the melting point of sodium chloride is 801 °C.

Ionic compounds **do not conduct electricity** as a solid. They **do conduct electricity** if they are dissolved in water (aqueous) or in the liquid state. This is because the ions are free to move, carrying the electric charge.

Empirical Formula of Ionic Compounds

In sodium chloride, 1 sodium atom transfers one electron to a chlorine atom, therefore the empirical formula is NaCl. However, there are some examples where the ratio of atoms is not 1:1. For example when sodium bonds with oxygen, sodium only loses one electron but oxygen gains two. So there are two sodium atoms for every oxygen, so the **empirical formula is Na_2O.**



Chemistry Knowledge Organiser
Topic : Bonding structure and properties of matter

Ionic Bonding- Models

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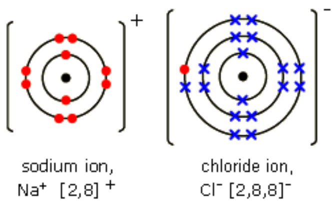

1. ....

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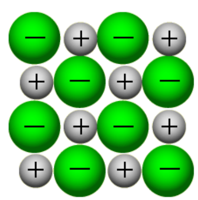
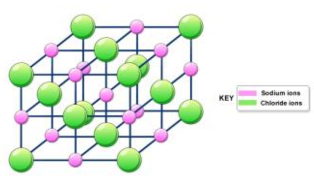


3. ....

This clearly shows the 3D structure of the **ionic lattice** and how different ions interact with other ions **in all directions** to create an ionic lattice.



Key Terms	Definitions
	The regular 3D arrangement of ions in an ionic compound
	When the arrangement of atoms is repeated may times, with large numbers of atoms or ions
	When a substance is dissolved in water
	The simplest ratio of atoms in a compound

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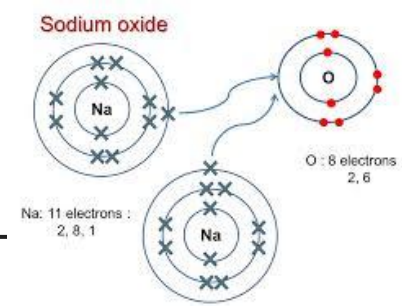
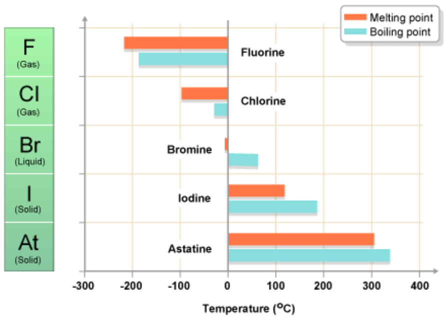


Chemistry Knowledge Organiser
Topic 5: Bonding structure and properties of matter

Properties of Covalent Compounds-Continued

The size of the intermolecular force between molecules increases as the molecules get larger. For example, as you go down group 7, the boiling points increase because **the molecules get larger**.

As you can see from the graph below, the boiling point of fluorine is -188°C and is therefore a gas at room temperature, whereas the melting point of astatine is 302°C and is therefore a solid at room temperature. This is because the intermolecular forces between the larger astatine molecules are larger than between the **smaller fluorine molecules.**



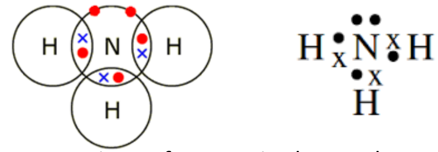
As well as having low melting points, covalent compounds **do not conduct electricity. T**his is because they have no free electrons or ions and therefore there is nothing to carry the electric charge**.** Remember pure water does not conduct electricity; only when it has ions dissolved in it will it conduct.

Key Terms	Definitions
polymer	A very large molecule, made from monomers
repeating unit	The shortest repeating section of a polymer
intermolecular forces	The force of attraction between two molecules

Representing Covalent Compounds

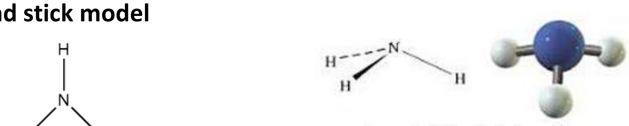
Like ionic compounds, there are variety of ways that scientists use to represent covalent compounds**.**

1. Dot cross diagram



There are two dot cross representations of ammonia shown above. The advantages of these diagrams are that it is very clear, which electrons are used in bonding and which are lone pairs. However it does not show the 3D structure of the molecule and this can be extremely important for scientists.

2. Ball and stick model



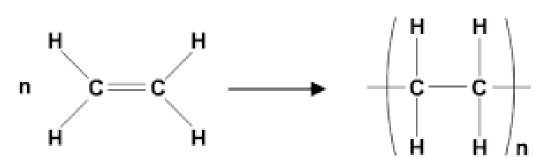
Ammonia (Ball and stick model)

A ball and stick diagram can either be 2D or 3D. While the 2D version clearly shows which atoms are bonded together, the 3D version gives the scientist more information about the 3D shape and the angles between the bonds in the molecule.

Polymers

Polymers are large covalent compounds which can be many thousands of atoms in length. They are made from small molecules known as **monomers.** Rather than drawing out all the atoms in a polymer we draw a **repeating unit** which is the structure of the monomer in square brackets, with a n representing a very large number of atoms.

Polymers have higher melting points than smaller covalent compounds like carbon dioxide as the intermolecular forces are stronger. However, these intermolecular forces are still not as strong as the bonds in ionic or giant covalent compounds so the melting points are lower than those compounds.



n = a big number of monomers

Chemistry Knowledge Organiser
Topic 5: Bonding structure and properties of matter

Key Terms	Definitions
polymer	
repeating unit	
intermolecular forces	

Properties of Covalent Compounds-Continued

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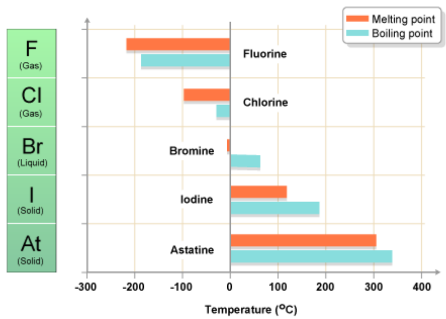

As well as having low melting points, covalent compounds **do not conduct electricity. T**his is because ……………………………………………………………

Representing Covalent Compounds

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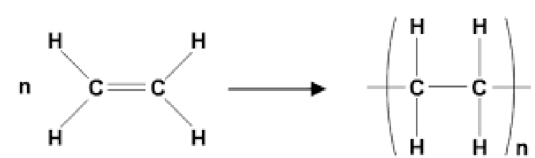


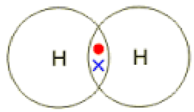
n = a big number of monomers

Chemistry Knowledge Organiser
Topic 9: Bonding structure and properties of matter

Key Terms	Definitions
covalent bonding	Bonding between 2 (or more) atoms where electrons are shared.
molecule	A substance which contains two or more covalently bonded atoms
lone pair	A pair of outer electrons that are not part of the covalent bond.

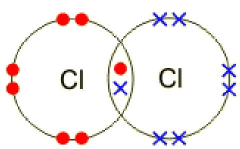
Covalent Bonding

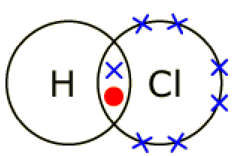
Covalent bonding occurs between atoms of non metal elements. **Electrons are shared between the atoms**, so that they have a full outer shell. Covalent bonds are strong and require a lot of energy to break. The simplest example is hydrogen: both hydrogen atoms have **one electron in their outer shell. Therefore both hydrogen atoms share one electron each,** to give them both a full outer shell, we can show this bond on a dot and cross diagram.

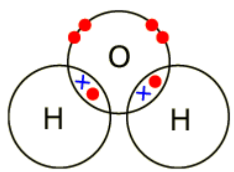


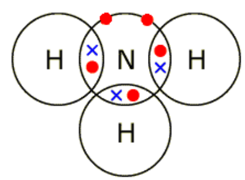
When drawing covalent molecules we use “dot cross diagrams” as we do with ionic compounds. It is important to represent the electrons on one atom with a dot and on the other atom with an X.

The first five examples, **hydrogen, chlorine, water, hydrogen chloride and ammonia (NH_3)** all share one electron per atom in a molecule to make a full outer shell of electrons on each atom.

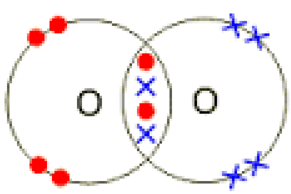


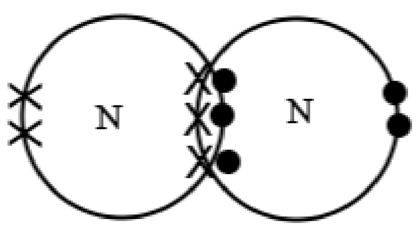






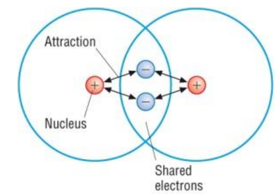
Some atoms need more than one electron to give them a full outer shell, for example oxygen needs 2 electrons to complete its outer shell. Oxygen therefore shares two electrons per atom to **make a double bond.** Nitrogen needs three electrons to complete its outer shell, this forms a triple bond between the two **nitrogen atoms, to make a nitrogen molecule.**





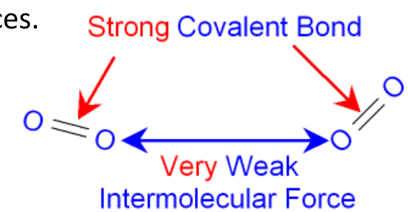
The Nature of a Covalent Bond

Covalent bonds are **strong** because there is <u>electrostatic attraction</u> between the electrons in the covalent bond and the positively charged nucleus. This means a lot of energy is required to break a covalent bond.



Properties of Simple Covalent Compounds

Simple covalent compounds have low melting and boiling points. They are often gases at room temperature: for example, **oxygen** and **carbon dioxide.** Although the covalent bonds between the atoms are strong, the **intermolecular forces between the molecules are weak. It is very important to remember that covalent bonds are strong but the intermolecular forces are weak.** This means that only a small amount of energy is required to overcome these weak forces.



Please see the next page for more properties of covalent compounds.

Chemistry Knowledge Organiser
Topic 9: Bonding structure and properties of matter

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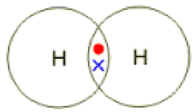

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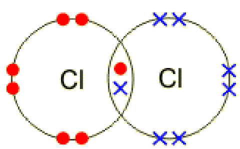

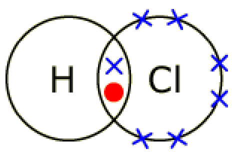

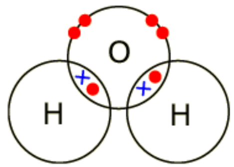

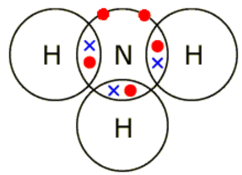

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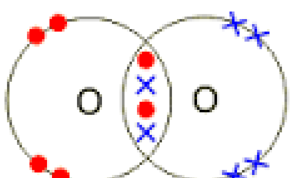

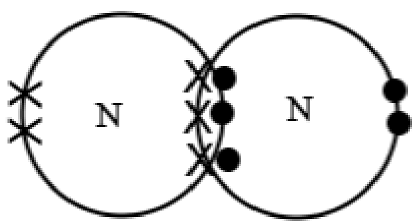

Key Terms	Definitions
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molecule	
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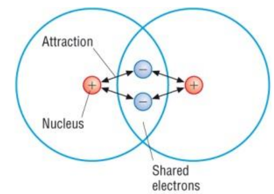

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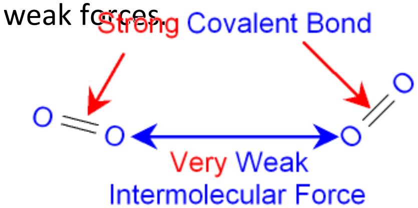


Please see the next page for more properties of covalent compounds.

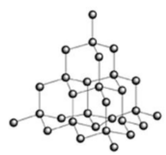
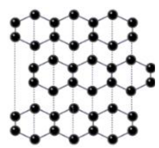
Chemistry Knowledge Organiser
Topic 5: Bonding structure and properties of matter

Key Terms	Definitions
giant covalent	Giant covalent structures contain a lot of non-metal atoms, each joined to adjacent atoms by covalent bonds
delocalised electron	An electron that is free, not part of an atom
allotrope	Different forms of the same element for example diamond and graphite are allotropes of carbon
macromolecule	A molecule which contains many atoms

Giant Covalent Compounds

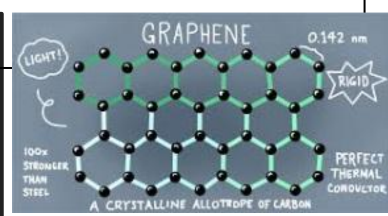
In a giant covalent structure all atoms are bonded to each other by strong covalent bonds. Giant covalent compounds have a **high melting point** because many strong covalent bonds need to be broken and this requires a lot of energy.

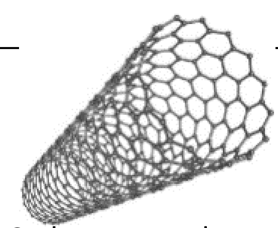
There are three examples you need to know, diamond, graphite and silica (see table below).

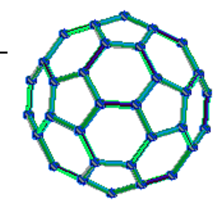
Substance	Diagram	Description	Properties
Diamond		Each carbon is covalently bonded to four other carbons	• Vey hard • Very high melting point, due to strong covalent bonds between all the atoms • Does not conduct electricity.
Graphite		Each carbon is covalently bonded to 3 other carbons, there are weak (non covalent) bonds between the layers.	• High melting point • Conductor of electricity due to **delocalised electrons** between the layers • Slippery as layers can slide over each other
Silica (silicon dioxide)		Every silicon atom is bonded to 2 oxygen atoms and vice versa	• Strong • High melting point

Graphene and Fullerenes

There are other forms of carbon which have been discovered recently: **graphene is a single layer of graphite** so it is 1 atom thick. Fullerenes are molecules of carbon with hollow shapes. The most famous example is Buckminsterfullerene (C_{60}). Fullerenes have use in drug delivery and as catalysts. Carbon nanotubes are cylinder shaped fullerenes, these are strong and are excellent conductors of both **heat and electricity.**




Carbon nanotube


Buckminsterfullerene

Chemistry Knowledge Organiser
Topic 5: Bonding structure and properties of matter

Key Terms	Definitions
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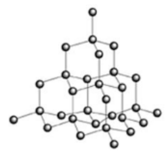
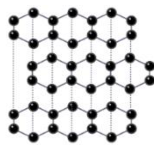
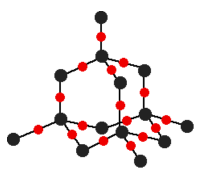
Diamond			
Graphite			
Silica (silicon dioxide)			

Graphene and Fullerenes

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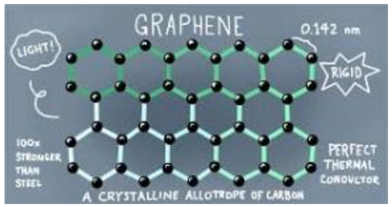
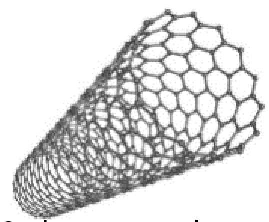
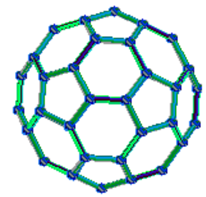


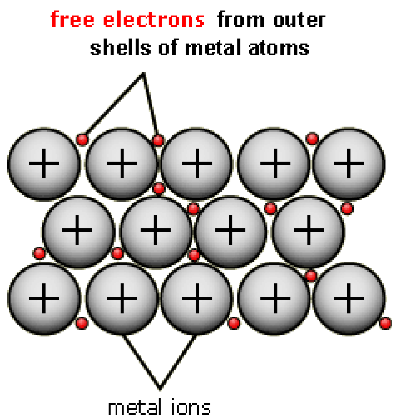

Carbon nanotube


Buckminsterfullerene

Chemistry Knowledge Organiser
Topic 5: Bonding structure and properties of matter

Metallic Bonding

Metals form giant structures. The metal atoms form a regular pattern and the donate their outer electron to the **“sea of delocalised electrons”.** These electrons are free to move. The 2D structure of metallic bonding looks like this:



This would be the structure of a group 1 metal like sodium, if it were a group 2 metal (e.g. magnesium) then the charge on the ions would be 2+

Properties of Metals

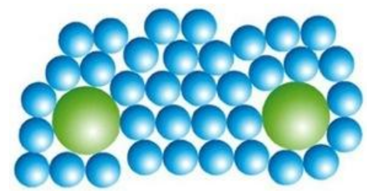
Metals are **good conductors of electricity**, due to the delocalised electrons, which can carry the electric charge. Metals are also **good conductors of heat** as the free electrons can transfer the heat energy through the metal.

Metals are also **malleable** (bendy) as the layers of ions can easily slide over one another. This means that many pure metals are too soft for uses such as building.

Key Terms	Definitions
metallic bonding	A type of bonding which occurs only in metals
alloy	A mixture of 2 or elements, one of which is a metal (the other element may be metal or non metal)
delocalised electron	An electron that is free, not part of an atom
malleable	The ability of a material to be bent into shape.

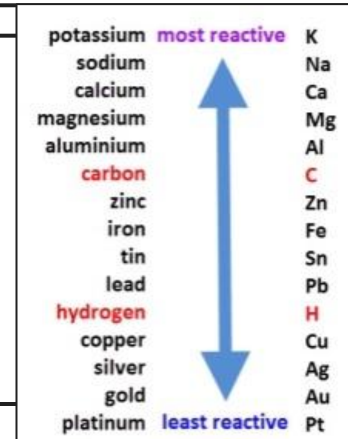
Alloys

Alloys are mixtures of **2 or more elements, one of which is a metal.** Examples of alloys include brass and steel. Metals are alloyed so that the regular structure of metals is changed and the layers of ions can no longer slide over one another; therefore making it much stronger.



Reactivity of metals

When a metal reacts it **forms a positive ion.** The easier it is for a metal to form a positive ion, the more reactive it is. This is shown in the reactivity series; you should memorise the position of these elements:



Chemistry Knowledge Organiser
Topic 5: Bonding structure and properties of matter

Key Terms	Definitions
metallic bonding	
alloy	
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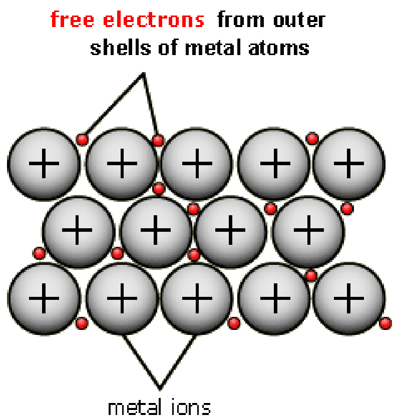

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Properties of Metals

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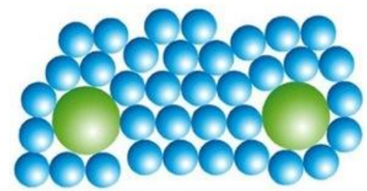

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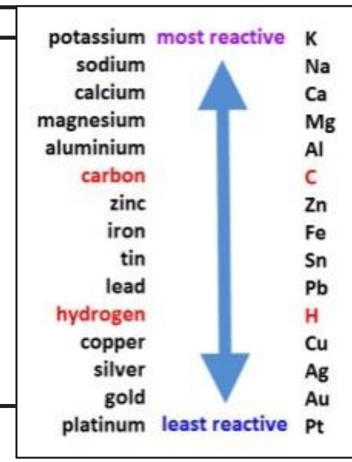

Chemistry Knowledge Organiser
Topic 8: Quantitative Chemistry

Relative formula mass (M_r)

This is the mass in grams of 1 mole of a substance. To calculate it you need to add up the atomic masses (bigger number) of all of the atoms in the molecule.

e.g 1. NaCl = Na + Cl = 23 + 35.5 = 58.5

e.g 2. MgF_2 *= Mg + (2 x F) = 24 + (2 x 19) = 62*

The Mole

A mole of an element is simply **6.02×10^{23} atoms (this number is known as Avogadro's number)**. Obviously, if the atoms are larger then 1 mole of that atom will be heavier. For example, one mole of hydrogen atoms weighs 1 gram but 1 mole of carbon weighs 12 grams. To calculate the number of moles in an element you need to divide the mass by the relative atomic mass:
For example, how many moles are there in 6 grams of carbon?
6/12= 0.5

To work out the number of moles in a compound you divide the mass of the compound by the relative formula mass, for example how many moles in 30 grams of magnesium oxide (MgO)?
M_r of MgO=24+16= 40
Moles= 30/40=0.75

Higher Tier: Calculating Masses in Reactions

An understanding of the mole will allow to calculate the mass made in a chemical reaction.
Take the chemical reaction below:

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

This equation 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. Suppose you started with 5 grams of magnesium, how much magnesium chloride would you make?

Step 1: Calculate the moles of the element or compound you were given in the equation:

5/24=0.21 moles of magnesium

Step 2: Look at the balanced equation, you must therefore have 0.21 moles of magnesium chloride, as the ratio in the balanced equation between magnesium and magnesium chloride is 1 to 1.

Step 3: Calculate the M_r of the relevant product: what you want to find is the M_r of magnesium chloride:
M_r of $MgCl_2$ =24+35.5+35.5= 94

Step 4: Now find the mass that will be made from that number of moles of magnesium chloride
Mass = moles x M_r, so 0.21 x 94= 19.7 grams

Key Terms	Definitions
mole	6.02×10^{23} atoms of an element or molecules in a compound
Avogadro's number	6.02×10^{23} This is the number of atoms in 12 grams of carbon 12.
relative formula mass	The total atomic mass of elements in compound
limiting reagent	The reagent which is used up first in a chemical reaction.

Higher Tier - Concentration

Most chemical reactions are done using solutions of chemicals. The concentration can be measured in grams per dm^3.

Conc= Mass/Vol   Conc= 2.4/0.5   **Conc= 4.8 g/dm^3**

One decimetre = $1000cm^3$

Higher Tier - Calculating moles from masses

If you know the mass of each reactant and product you can calculate a balanced equation from the masses, for example: Calculate the balanced equation when 12 grams of magnesium reacts completely with 38.5g of HCl, to make 49.5 grams of $MgCl_2$ and 1 gram of H_2

$$Mg + HCl \rightarrow MgCl_2 + H_2$$

Step 1: work out the moles of each reactant and product.
Mg=12/24= 0.5 HCl=38.5/38.5= 1 $MgCl_2$ =49.5/99 = 0.5 H_2 = 1/2 = 0.5
Step 2 divide through by the smallest number

Mg=0.5/0.5=1 HCl= 1/0.5 = 2 $MgCl_2$ =0.5/0.5=1 H_2 = 0.5/0.5=1

Step 3 write the balanced equation:

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

Higher tier - Limiting Reagent

When a chemical reaction is carried out, one or more reagents are in excess and one reagent is the limiting reagent. The **limiting reagent** is the reagent which is used up first in a chemical reaction, if all of this reagent is used up the reaction can no longer continue, for example, if a tiny amount of sodium is dropped into a large bowl of water there are a lot more water particles that there are sodium atoms. We therefore say that the sodium is the **limiting reagent** and the water is in **excess.**

The amount of product formed is **directly proportional** to the amount of limiting reagent. Therefore if you double the amount of limiting reagent you will get double the amount of product.

Chemistry Knowledge Organiser
Topic 8: Quantitative Chemistry

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Step 2 divide through by the smallest number

Mg=0.5/0.5=1 HCl= 1/0.5 = 2 $MgCl_2$ =0.5/0.5=1 H_2 = 0.5/0.5=1

Step 3 write the balanced equation:

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

Higher tier - Limiting Reagent

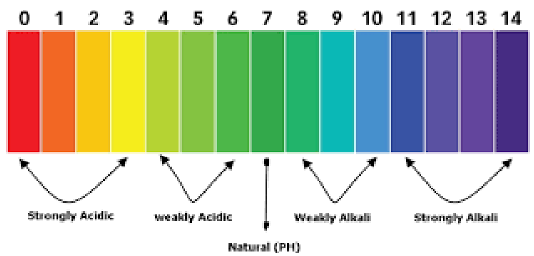
When a chemical reaction is carried out, one or more reagents are in excess and one reagent is the limiting reagent. The **limiting reagent** is the reagent which is used up first in a chemical reaction, if all of this reagent is used up the reaction can no longer continue, for example, if a tiny amount of sodium is dropped into a large bowl of water there are a lot more water particles that there are sodium atoms. We therefore say that the sodium is the **limiting reagent** and the water is in **excess.**

The amount of product formed is **directly proportional** to the amount of limiting reagent. Therefore if you double the amount of limiting reagent you will get double the amount of product.

Chemistry Knowledge Organiser
Topic 11: Chemical changes

Acids and Alkalis

Acids produce hydrogen ions (**H^+) in aqueous** solutions. Aqueous solutions of alkalis contain **hydroxide ions (OH^-).**
We measure the acidity of a substance using the **pH scale which runs from 0-14** between 0 and 6 the substances are acidic, 7 is neutral and between 8 and 14 is alkaline. The pH scale is a logarithmic scale: a *decrease* of 1 on the pH scale makes a substance **10 times more acidic.**



The pH scale is a measure of H^+ concentration: the **lower the pH the higher the concentration of H^+ ions**.

Neutralisation Reaction

When a salt is made in a neutralisation reaction, it will either be **soluble** or **insoluble**. For example, sulphuric acid can be neutralised with copper oxide to make copper sulphate and water. The **copper sulphate is soluble in water.**
The steps outlined below can be used to make copper sulphate:

1. Add several spatulas of copper oxide to sulphuric acid in a **conical flask**
2. Stir until all the sulphuric acid has reacted
3. Filter off any excess copper oxide (it does not dissolve)
4. Place solution in evaporating basin
5. Allow water to evaporate and blue crystals of copper oxide should be left

HT - Strong and Weak Acids

Acids can be defined as either a **strong or weak acid** a strong acid is one which fully dissociates in water for example hydrochloric acid

$$HCl \rightarrow H^+ + Cl^-$$

A weak acid is defined as one which only partially dissociates in water.
Strong acids are **not the same** as concentrated acids. Concentration is the number of particles in a given volume and not how much they dissociate.

Key Terms	Definitions
acid	A substance which forms H+ ions in aqueous solution
alkali	A substance which forms OH- ions when dissolved: these are soluble bases
neutralisation	A reaction between an acid and an alkali making a salt and water
strong acid	An acid which totally dissociates in water
base	A substance that can neutralise an acid to make a salt and water

Neutralisation

To work out the names and formulae of salts you will need to know the names and formulae of the common acids.

Acid	Name of salt	Negative ion in the salt
Hydrochloric acid (HCl)	Chloride	Cl^-
Sulphuric Acid (H_2SO_4)	Sulphate	SO_4^{2-}
Nitric Acid (HNO_3)	Nitrate	NO_3^{1-}

Neutralisation

When an acid reacts with an alkali a salt and water are produced. The ionic equation for the reaction of an **acid and an alkali is:**

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

Neutralisation

When an acid reacts with an alkali it will produce salt and water, below are the general equations for different types of neutralisation reaction:

- **Metal oxide + Acid → Salt + Water**
  - Copper oxide + Hydrochloric Acid→ Copper chloride +Water
  - $CuO + HCl \rightarrow CuCl_2 + H_2O$
- **Metal carbonate + acid → Salt +Water + Carbon Dioxide**
  - Magnesium Carbonate + Sulphuric Acid → Salt +Water +Carbon Dioxide
  - $MgCO_3 + H_2SO_4 \rightarrow MgSO_4 + H_2O + CO_2$
- **Metal Hydroxide + Nitric Acid → Sodium Nitrate + Water**
  - Sodium Hydroxide + Nitric Acid→ Sodium Nitrate + Water
  - $NaOH_+ + HNO_3 \rightarrow NaNO_3 + H_2O$

Some of the reactants (for example copper oxide) are insoluble but these can still carry out a neutralisation reaction. We call these **bases** not **alkalis.**

Chemistry Knowledge Organiser
Topic 11: Chemical changes

Acids and Alkalis

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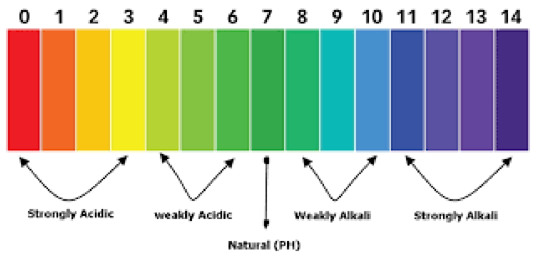

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1.
2.
3.
4.
5.

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$HCl \rightarrow H^+ + Cl^-$

A weak acid is defined as one which ……………………………………

Strong acids are **not the same** as concentrated acids. Concentration is the number of particles in a given volume and not how much they dissociate.

Key Terms	Definitions
acid	
alkali	
neutralisation	
strong acid	
base	

Neutralisation

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  - CuO+ HCl→
- **Metal carbonate + acid →**
- Magnesium Carbonate + Sulphuric Acid →
- $MgCO_3 + H_2SO_4 \rightarrow$
- **Metal Hydroxide + Nitric Acid →**
- Sodium Hydroxide + Nitric Acid→
- $NaOH_+ + HNO_3 \rightarrow$
- Some of the reactants (for example copper oxide) are insoluble but these can still carry out a neutralisation reaction. We call these **bases** not **alkalis.**

Chemistry Knowledge Organiser
Topic 11: Chemical changes

Reactions of Metals

When a metal reacts with water it produces a metal hydroxide and **hydrogen gas.**
The more reactive the metal is**,** the more vigorous the reaction. For example:

Lithium + Water → Lithium Hydroxide + Hydrogen

You see a similar pattern for the reaction between metals and acids however the products in these reactions are different, in this case you will make a salt and water, the salt will depend on the type of acid that you have used.

Lithium + Hydrochloric Acid → Lithium Chloride + Hydrogen

If sulphuric acid is used the salt made will be a sulphate, if nitric acid is used the salt will be a nitrate**.**

Metals also react with oxygen to form metal oxides; in this reaction the metal donates electrons to the oxygen. This means the metal is **oxidised as it has lost electrons. The oxygen is reduced as it has gained electrons.**

Extraction of Metals

A metal ore is a compound found in rock, dug out of the ground, that contains enough metal that it is **economical** to extract it. For example, magnesium oxide. In order for us to use the magnesium we need to **extract** it from the oxide.
Metals more reactive than carbon are extracted from their ore using **electrolysis**.
Metals which are less reactive than carbon are extracted from their ore using **reduction** (by adding carbon). Reduction is the removal of oxygen as seen in the example.

Example: Iron Oxide + Carbon → Iron + Carbon Dioxide

The least reactive metals such as gold and silver are found on their own—they do not form a compound. This means they do not need to be extracted from their ore.

Key Terms	Definitions
oxidation	The loss of electrons from an atom OR when an atom gains an oxygen atom
reduction	The opposite to oxidation: when an atom gains electrons OR when an atom loses an oxygen atom
redox reaction	A reaction where one atom is oxidised and another atom is reduced

Oxidation Reactions

When working out whether a reaction is oxidation or reduction: in terms of electrons, remember OILRIG. This stands for oxidation is loss and reduction is gain.

HT - Oxidation Reactions of Acids

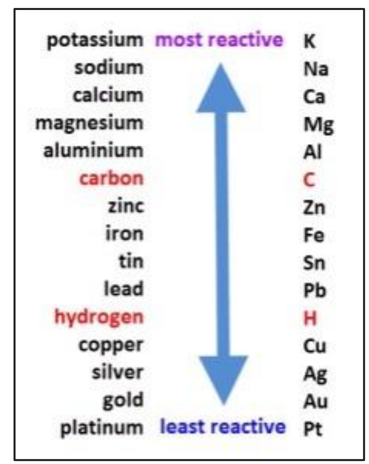
When an acid reacts with a metal a salt and hydrogen are produced.
For example the symbol the symbol equation for an acid reacting with lithium is:

$$2Li + 2HCl \rightarrow 2LiCl + H_2$$

In this reaction, lithium has been oxidised because it has lost an electron to form a +**1 ion** and hydrogen has been reduced from a +1 ion to a **hydrogen molecule.**

Reactivity of metals

When a metal reacts it **forms a positive ion.** The easier it is for a metal to form a positive ion, the more reactive it is. This is shown in the reactivity series; you should memorise the position of these elements:



Chemistry Knowledge Organiser
Topic 11: Chemical changes

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Key Terms	Definitions
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reduction	
redox reaction	

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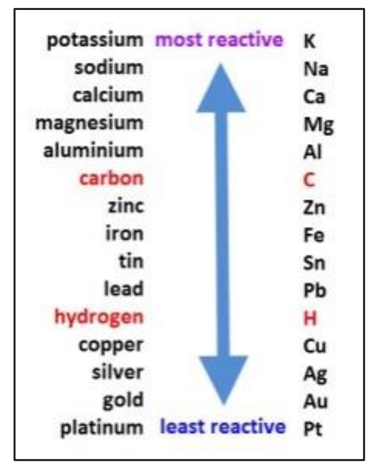
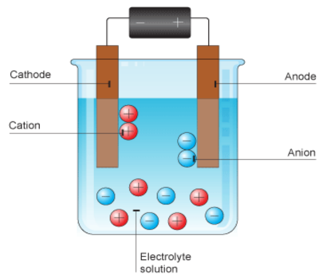


Chemistry Knowledge Organiser
Topic 11: Chemical changes

Electrolysis

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.**

If an electric current is passed through this solution the ions will move to the electrodes. **Remember-opposites attract. The positive ions (cations) will go to the negative electrode (cathode), the negative ions (anions) go to the positive electrode (anode).**
For example in the electrolysis of lead bromide, Lead (Pb^{2+}) goes to the negative electrode and bromine (Br^{-1}) goes to the positive electrode.



Electrolysis of Brine

Which elements form at which electrode depends on the **reactivity** of the elements involved.
For example , the electrolysis of brine is electrolysis of a solution of sodium chloride. However there are also H^+ and OH^- ions form the water, which is used as the solvent. This means there is more than one possible ion that can go to each electrode.

· **Positive ions:** sodium (Na^+) and hydrogen (H^+)
· **Negative ions:** chlorine (Cl^-) and hydroxide (OH^-)
When there is a mixture of ions, the products formed depend on the reactivity of the elements involved.
Hydrogen is less reactive than sodium, so hydrogen gas (H_2) is produced at the negative electrode.
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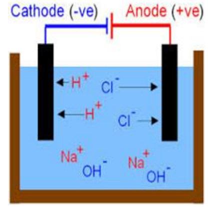

Key Terms	Definitions
Electrolysis	The breaking down of a substance using electricity
Electrolyte	The solution which is being broken down during electrolysis
Oxidation	The loss of electrons
Reduction	The gain of electrons
Anode	The positive electrode
Cathode	The negative electrode

Oxidation, reduction and half equations-Higher

When a positive Ion reaches the negative electrode, it gains electrons. This is a reduction reaction.
When a negative ion reaches the positive electrode, it loses electrons, this is an oxidation reaction.
We can represent these using half equations A half equation can represent the reaction at each electrode. Half equations show how electrons are transferred and an electron is represented in an equation by an e^- symbol
Half equations show electrons (e^-) and how ions become atoms.
E.g, $Cu^{2+} + 2 e^- \longrightarrow Cu$.
1. Write down the ion and atom: $Cl^- \longrightarrow Cl_2$
2. Adjust the number of ions (if needed) and add electrons to balance the charges if required
$2Cl^- \longrightarrow Cl_2 + 2 e^-$
Remember that non metal ions will typically form diatomic molecules.

Ionic equations-Higher

Half equations can be combined to form an ionic equation, which shows the overall reaction. For example in the electrolysis of copper chloride the two half equations are:

At the negative electrode (cathode):
$Cu^{2+} + 2 e^- \longrightarrow Cu$
At the positive electrode (anode):
$2Cl^- \longrightarrow Cl_2 + 2 e^-$
Combing these 2 equations gives us:

$Cu^{2+} + 2 e^- + 2Cl^- \longrightarrow Cu + Cl_2 + 2 e^-$ The electrons either side of the equation cancel out, meaning the final ionic equation is:
$Cu^{2+} + 2Cl^- \longrightarrow Cu + Cl_2$
In an ionic equation it is important to check both the atoms and the charges balance

Chemistry Knowledge Organiser
Topic 11: Chemical changes

Electrolysis

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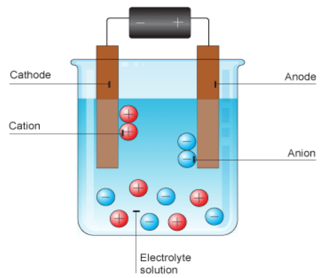

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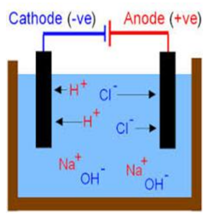

Key Terms	Definitions
	The breaking down of a substance using electricity
	The solution which is being broken down during electrolysis
	The loss of electrons
	The gain of electrons
	The positive electrode
	The negative electrode

Oxidation, reduction and half equations-Higher

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$Cu^{2+} + 2Cl^- \rightarrow Cu + Cl_2$
In an ionic equation it is important to check both the atoms and the charges balance

Chemistry Knowledge Organiser
Topic 11: Chemical changes

Extracting Aluminium

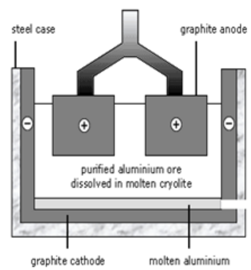
Aluminium oxide is dissolved in molten cryolite .
Cryolite reduces the melting point of aluminium oxide meaning the process requires less energy.
Aluminium ions (Al3+) are attracted to the negative electrode.
Aluminium atoms are formed at the negative electrode (gain 3 electrons)
Oxide ions are attracted to the positive electrode
Oxygen is formed at the positive electrode (each ion loses 2 electrons)
Oxygen reacts with carbon to make carbon dioxide. This electrode needs to be replaced constantly.

At the negative electrode:

$Al^{3+} + 3e^- \longrightarrow Al$

At the positive electrode

$2O^{2-} \longrightarrow O_2 + 4e^-$



Overall equation:
$2Al_2O_3$ ⍰ $4Al+3O_2$

Rules for Aqueous Solutions

On the previous page there are 2 specific examples of the electrolysis of aqueous (dissolved in water) solutions, however below are the general rules for any aqueous solution and remember they may give you questions on unfamiliar contexts during the exam.

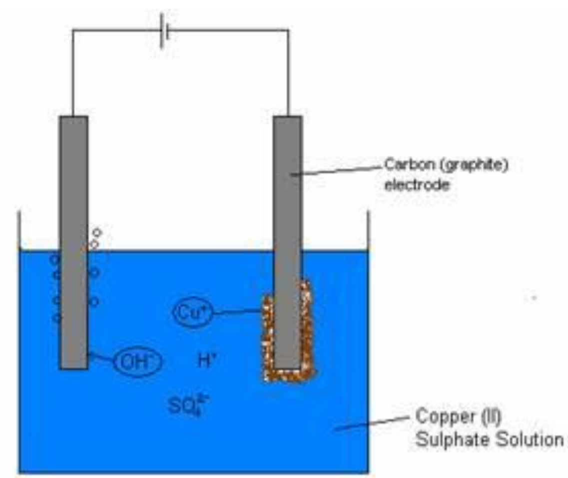
- If the positive ion in the solution is less reactive than hydrogen (for example copper) the metal will form at the negative electrode. If it is more reactive than hydrogen (for example sodium) then hydrogen will form at the negative electrode.
- At the positive electrode oxygen will always form (due to the movement of hydroxide ions) unless there is a halide ion present (F^-,Cl^-, Br^-, I^-), in which case the halogen molecule will be produced at the positive electrode, for example Cl_2
- Remember the reason this happen is because water is in an equilibrium as a water molecule and hydrogen and hydroxide ions.

Electrolysis of Copper Sulphate

Which elements form at which electrode depends on the **reactivity** of the elements involved.
For example, in the electrolysis of aqueous copper sulphate is the electrolysis of copper sulphate, however there are also H^+ and OH^- ions form the water which is used as the solvent. This means there is more than one possible ion that can go to each electrode.
· **Positive ions:** sodium (Cu^{2+}) and hydrogen (H^+)
· **Negative ions:** sulphate(SO_4^{2-}) and hydroxide (OH^-)
When there is a mixture of ions, the products formed depend on the reactivity of the ions involved.
Copper is **less reactive** than hydrogen, so copper (Cu) is produced at the negative electrode.
The half equation is:
$Cu^{2+} + 2e^- \rightarrow Cu$
The hydroxide ion is more reactive than the sulphate ion, therefore this **forms water (H_2O) and oxygen** at the positive electrode.
$4OH^- \rightarrow O_2 + 2H_2O + 4\ 2e^-$

As a rule if a halide ion is present , this will form at the positive electrode, however if no halide is present then oxygen and water will form at the positive electrode.

Electrolysis of Copper Sulphate



Chemistry Knowledge Organiser
Topic 13: Energy Changes

Energy in Reactions

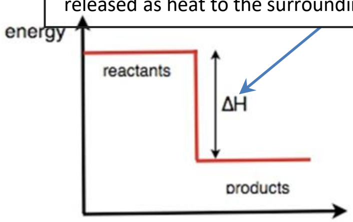
In a chemical reaction, bond breaking and bond making occur. To **break** a chemical bond you need to overcome the force of attraction in the bond, so this process requires energy (therefore it is **endothermic**). The process of bond formation is **exothermic:** energy is released when bonds form. In a chemical reaction the difference between the energy required to break the bonds and the energy gained from making the bonds will decide whether a reaction overall is exothermic or endothermic. Chemical reactions can therefore be divided into exothermic and endothermic chemical reactions.

Type	What happens?	Why?	Example
Exothermic	Heat energy is transferred to the surroundings.	The energy required to break chemical bonds is less than the energy gained from making chemical bonds. Therefore the excess is given off as heat to the surroundings.	Combustion reaction, reactions used in hand warmers
Endothermic	Heat energy is taken in from the surroundings	The energy required to break chemical bonds is more than the energy gained from making chemical bonds. Therefore, heat is	The reaction of citric acid and sodium hydrogencarbonate, the reactions used in ice

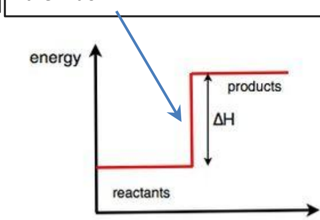
Reaction Profiles

Chemical reactions can occur only when reacting particles collide with each other with sufficient energy. The minimum amount of energy that particles must have to react is called the **activation energy**. **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.

This is the reaction profile of an **exothermic reaction:** the energy of the products is lower than that of the reactants. The difference in energy is released as heat to the surroundings.



This is the reaction profile of an **endothermic reaction:** the energy of the products is higher than that of the reactants. The difference in energy is taken in from the surroundings, cooling them down.

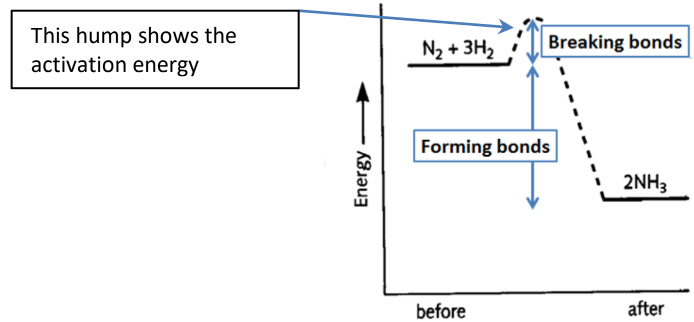


Key Terms	Definitions
reaction profile	A graph which shows the energies of the products and reactants in a chemical reaction
exothermic	A reaction that gives out heat to the surroundings
endothermic	A reaction that takes heat in from the surroundings

Reaction Profiles- In more detail

The profile below shows the reaction which makes ammonia from nitrogen and hydrogen. The equation is given below:

$N_2 + 3H_2 \rightarrow 2NH_3$



There are some key features to highlight on this graph: firstly, the humped section represents the **activation energy** for this reaction. This hump shows how much energy is required to break the bonds in the reactants. To overcome the activation energy we often need to heat our reactants. The products are lower in energy than the reactants; this means it is an **exothermic reaction.** The excess energy is given out to the surroundings as **heat energy.**

Higher Tier: Calculating bond energies

The difference between the sum of the energy needed to break bonds in the reactants and the sum of the energy released when bonds in the products are formed is the overall energy change of the reaction. *(bond breaking **subtract** bond making)*

For example consider the reaction:

$$N_2 + 3H_2 \rightarrow 2NH_3$$

To work out the overall energy change you will need to subtract the energy released while forming the bonds in ammonia from the energy required to break the bonds in nitrogen and hydrogen molecules. This will give you the overall energy change. If the value is negative then the reaction is exothermic. If the value is positive the reaction is endothermic.

Chemistry Knowledge Organiser
Topic 13: Energy Changes

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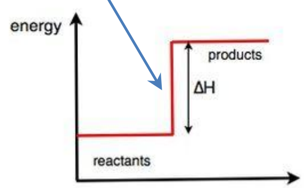

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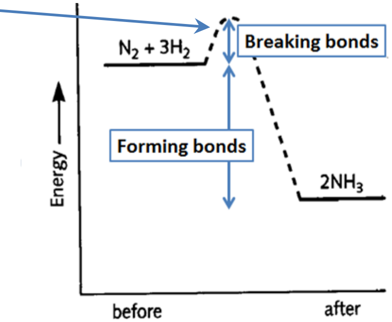
$N_2 + 3H_2 \rightarrow 2NH_3$

This hump shows the activation energy



There are some key features to highlight on this graph: firstly, the humped section represents the **activation energy** for this reaction. This hump shows how much energy is required to break the bonds in the reactants. To overcome the activation energy we often need to heat our reactants. The products are lower in energy than the reactants; this means it is an **exothermic reaction.** The excess energy is given out to the surroundings as **heat energy.**

<u>Higher Tier</u>: Calculating bond energies

The <u>difference</u> between the sum of the energy needed to break bonds in the reactants and the sum of the energy released when bonds in the products are formed is the overall energy change of the reaction. *(bond breaking **subtract** bond making)*

For example consider the reaction:

$$N_2 + 3H_2 \rightarrow 2NH_3$$

To work out the overall energy change you will need to subtract the energy released while forming the bonds in ammonia from the energy required to break the bonds in nitrogen and hydrogen molecules. This will give you the overall energy change. If the value is negative then the reaction is exothermic. If the value is positive the reaction is endothermic.

Chemistry Knowledge Organiser
Topic 13: Energy Changes

Higher Tier: Bond Energies continued

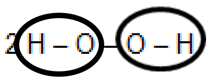
You can calculate the energy change in a reaction from bond energies given to you in a question. For example consider the reaction below:

$$2\,H-O-O-H \rightarrow 2\,H-O-H \quad + \quad O=O$$

This shows that hydrogen peroxide breaks down to make water and oxygen. We can use bond energies to work out the energy change in the reaction.

Bond	Bond energy in kJ per mole
H – O	464
O – O	146
O = O	498

The energy required to break the reactant bonds is:



2 x464 (for the O-H bonds) + 146 (for the O-O bond)=1074
However, as there are two moles of hydrogen peroxide molecules in the equation, this number needs to be doubled. **2 x 1074 = 2148 kJ/mol**

The energy gained from making the product bonds is:

2x464 = 928 but there are two moles of water molecules in this equation, so this doubled to 1856. Then we also need to add the 498 for the double bond forming to make O_2

1856 + 498=2354 kJ/mol

To find the overall energy change, we calculate like this:
energy required to break reactant bonds – energy gained from making product bonds:

2148 – 2354 = -206 kJ/mol

If the value is negative then the reaction is **exothermic**
If the value is positive the reaction is **endothermic.**

KS4 ENERGY

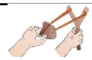
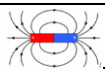
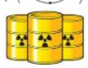
What is an energy system?

An object or group of objects that have the ability to do work (transfer energy).

Law of conservation of energy:

Energy cannot be created or destroyed - only transferred via a force pathway

What are the 8 energy stores?

What are the 8 energy stores?	Examples
Chemical 	In food, fuel, muscles and electric batteries.
Kinetic 	In moving objects
Gravitational potential 	In objects raised above a planet's surface.
Elastic potential 	In a stretched, compressed or twisted object.
Internal (thermal) 	In any heated object.
Magnetic 	In any object with a magnetic field.
Nuclear 	The forces acting between atomic nuclei.
Electrostatic 	In electrostatic forces between charges.

What are the 4 pathways?

Mechanical work done	When a force acts and an object moves.
Electrical work done	When an electric current flows.
Heating	A temperature difference between objects
Radiation	Electromagnetic waves or sound.

Example of an energy transfer (electric shaver)

Battery chemical store → Electrical pathway → **Blades** Kinetic store

Energy is transferred from the chemical store of the battery to the kinetic store of the blades along an electrical pathway.

What is the unit of energy?

The unit of energy is the joule (J).

Since work done = energy transferred, therefore the unit of work done is also the joule (J).

1kJ = 1000 J   1MJ = 1 000 000 J

How to calculate work done?

Mechanical work is the amount of energy transferred by a force.

work (J) = force (N) x distance (along the line of the force) (m)

$$W = F s$$

How to calculate work done in an electrical circuit?

Electrical work is the amount of energy transferred by current.

energy transferred (J) = charge flow (Q) x potential difference (V)

$$E = Q V$$

How to calculate amount of energy in a kinetic energy store?

kinetic energy (J) = 0.5 x mass (kg) x speed^2

$$E_k = \frac{1}{2} m v^2$$

How to calculate amount of energy in a elastic potential energy store?

EPE (J) = 0.5 x spring constant (N/m) x extension^2 (m)

$$E_e = \frac{1}{2} k e^2$$

Specific Heat Capacity

The energy required to raise the temperature of 1kg of a substance by 1^{o}C

Change in energy = mass x specific heat capacity x temp.change
(J) = (kg) (J/kg^{o}C) (^{o}C)

$$\Delta E = mc\Delta\Theta$$

Dissipation

When energy is transferred to the surroundings to a store that is **not useful or difficult to get back** is described as 'wasted'.

Dissipation can be reduced by:

- **Insulating -** to prevent transfer to the thermal store of the surroundings
- **Lubricating** to prevent friction and transfer to the thermal store of the surroundings.

How to calculate power?

Power is the **rate at which energy is transferred** or the rate at which work is done.

$$\text{power (W)} = \frac{\text{energy transferred (J)}}{\text{time (s)}}$$

$$P = \frac{E}{t}$$

How to calculate power?

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$$\text{power (W)} = \frac{\text{work done (J)}}{\text{time (s)}}$$

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What is the unit of power?

The watt is the unit for power.

One watt is one joule transferred in one second - or 1 J/s (1 joule per second).

How to calculate amount of energy in a gravitational potential energy store?

GPE (J) = mass (kg) x gravitational field strength (N/kg) x height (m)

$$E_p = m g h$$

How to calculate the efficiency of an energy transfer ?

$$\text{efficiency} = \frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$$

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

These calculations will result in a decimal value which can be multiplied by 100 to give a percentage efficiency. Since there is always some wasted energy, efficiency must always be less than 1 or less than 100% if you convert the efficiency to a percentage.

Efficiency does not have a unit.

KS4 ENERGY

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Law of……………

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	In moving objects
	In objects raised above a planet's surface.
	In a stretched, compressed or twisted object.
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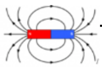	In any object with a magnetic field.
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KS4 ENERGY

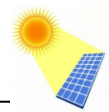
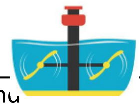
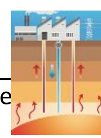
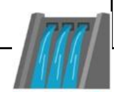
What are the two types of energy resources?

Non-renewable	These cannot be replenished.
Renewable	Energy resources that can be easily replenished.

What are energy resources used for?	Examples
Transport	cars, trains, buses, planes etc.
Electricity generation	Industry, homes, business, lighting etc.
Heating	Homes, industrial processes, schools and hospitals etc.

What are the 4 non-renewable energy resources?	Examples
Coal	Fossil fuels - these are becoming more difficult to find and extract.
Oil	
Gas	
Nuclear	Plentiful but difficult to extract/purify.

What are the 7 renewable energy resources?	Examples
Biofuel	Plant matter usually used as a fuel.
Wind	Turbines spin a generator to produce electricity.
Hydroelectric	Falling water spins a turbine to produce electricity.
Geothermal	Hot rocks underground produce steam.
Tides	Rise and fall of the tide can be used to turn a turbine.
Solar	To directly heat things or to produce electricity.
Waves	Up and down movement can turn turbines.

Energy resource	Advantages	Disadvantages
Fossil fuel 	• there are a lot of fossil fuel power stations already built • reliable	• fossil fuels are non-renewable and are running out • produce carbon dioxide, which causes global warming • coal produces polluting gases that cause acid rain
Nuclear 	• no polluting gases released as fuel is not 'burned' • reliable	• nuclear fuels are non-renewable • expensive to decommission • produce nuclear waste • accidents can have extremely bad consequences for the environment and for human life
Solar 	• renewable • can be used in remote locations • no pollution • no fuel costs	• unreliable – not always sunny
Tidal 	• renewable • reliable • no pollution • no fuel costs	• only works in areas where there is a coastline and tides • flooding areas damages habitats
Wind 	• renewable • no pollution • no fuel costs	• unreliable – it's not always windy • not all locations are suitable for wind turbines • noisy
Wave 	• renewable • no pollution • no fuel costs	• unreliable (wave strength varies) • expensive to install • difficult to maintain • not much electricity generated
Biofuel 	• renewable • very reliable - can be stored and used when needed	• releases carbon dioxide when burnt • takes up land that could be used for growing food
Geothermal 	• renewable • very reliable • no pollution • no fuel costs	• expensive to build • most parts of the world don't have areas suitable to build these power stations
Hydroelectric 	• renewable • reliable • no pollution • no fuel costs	• expensive to build • flooding areas damages habitats

Security and Reliability of Energy Resources

In the UK, a mix of energy supplies are used so should one supply become unavailable, others can be used without disruption to supplies.

Coal, oil, gas and nuclear are more reliable than others as they can supply a continuous flow of electricity.

Trends in Use of Energy Resources

The total amount of energy used in the world is increasing as the population increases and each person is using more energy.

As fossil fuel reserves dwindle, an increase in the use of renewable energies is likely.

KS4 ENERGY

What are the two types of energy resources?	
	These cannot be replenished.
	Energy resources that can be easily replenished.

What are energy resources used for?	Examples
Transport	
Electricity generation	
Heating	

renewable energy resources?	Examples
	Fossil fuels - these are becoming more difficult to find and extract.
	Plentiful but difficult to

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Wind	
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Geothermal	
Tides	
Solar	
Waves	

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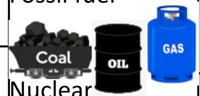
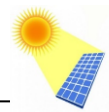
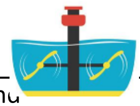
Fossil fuel 		• fossil fuels are non-renewable and are running out • produce carbon dioxide, which causes global warming • coal produces polluting gases that cause acid rain
Nuclear 	• no polluting gases released as fuel is not 'burned' • reliable	• • • •
Solar 	• • • •	• unreliable – not always sunny
Tidal 	• renewable • reliable • no pollution • no fuel costs	
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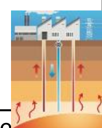
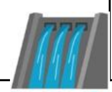
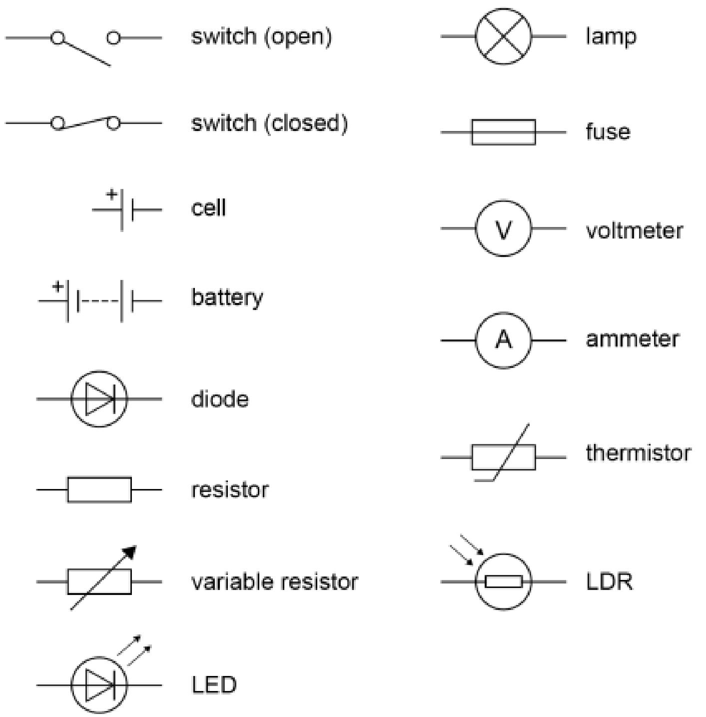
Geothermal 	• renewable • very reliable • no pollution • no fuel costs	
Hydroelectricity 	• • •	• expensive to build • flooding areas damages habitats

Security and Reliability of Energy Resources	Trends in Use of Energy Resources
In the UK, a mix of energy supplies are used so should one supply become unavailable, others can be used without disruption to supplies. Coal, oil, gas and nuclear are more reliable than others as they can supply a continuous flow of electricity.	The total amount of energy used in the world is increasing as the population increases and each person is using more energy. As fossil fuel reserves dwindle, an increase in the use of renewable energies is likely.

KS4 ELECTRICITY

Circuit diagrams use standard symbols



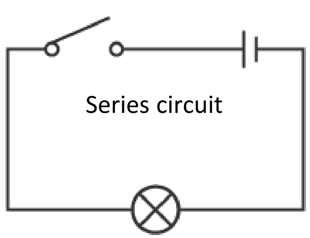
Electrical Current

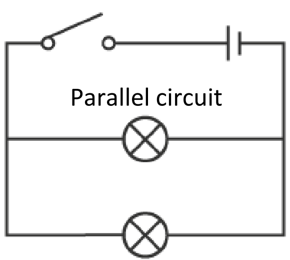
- The size of the electric current is the **rate of flow of electrical charge.**
- For electrical charge to flow through a closed circuit the circuit must include a source of potential difference e.g. a cell/batteries/mains electricity. .

How to calculate charge flow?

Charge flow (C)= current (A) x time (s)

Q = I t





Current, Resistance and Potential Difference

potential difference (V) = current (A) x resistance (Ω)

V = I R

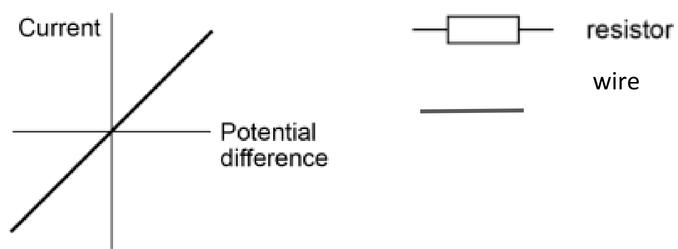
(potential difference is also known as voltage)

Resistors

Ohmic conductors

Ohm's Law states "The current through an ohmic conductor (at a constant temperature!) is **directly proportional** to the potential difference across the resistor."

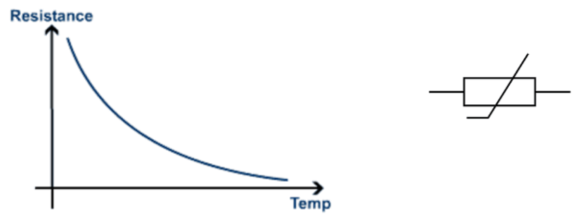
This means that the resistance remains constant as the current changes.



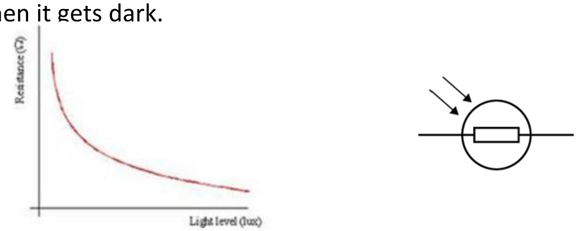
Resistors

Thermistor

The resistance of a thermistor decreases as the temperature increases. Thermistors are used in thermostats to control temperature in the home.



The resistance of an LDR decreases as light intensity increases. DLRs are used in light-sensing circuits e.g. switching on light when it gets dark.



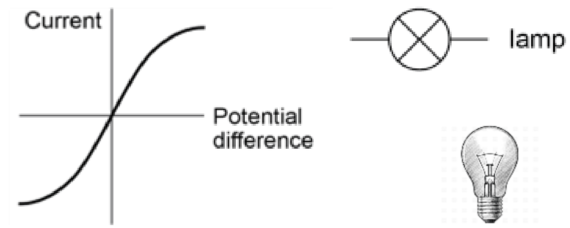
Resistors

Non-ohmic conductors

The resistance of components such as lamps, diodes, thermistors and LDRs is not constant; it changes with the current through the component.

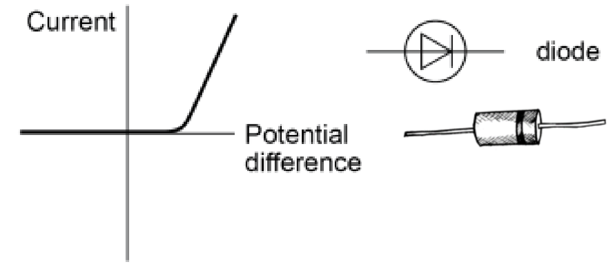
Filament lamp

The resistance of a filament lamp increases as the temperature of the filament increases.



Diode

The current through a diode flows in one direction only. The diode has a very high resistance in the reverse direction.



Type of circuit	Series	Parallel
Current	Same through each component	Shared across branches
Potential difference	Total p.d. of the power supply is shared between components	Same across each component
Resistance	The sum of each component: $R_{total} = R_1 + R_2$	Total resistance of two resistors is less than the resistance of the smallest individual resistor.

KS4 ELECTRICITY

Circuit diagrams use standard symbols

switch (open)	lamp
switch (closed)	fuse
cell	voltmeter
battery	ammeter
diode	thermistor
resistor	LDR
variable resistor	
LED	

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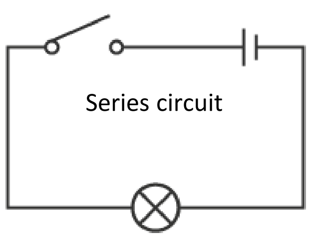

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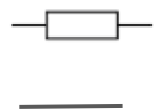

resistor

wire

Resistors

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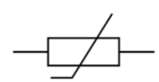

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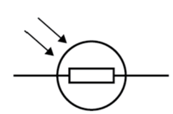

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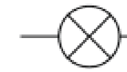

lamp

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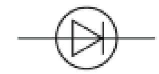


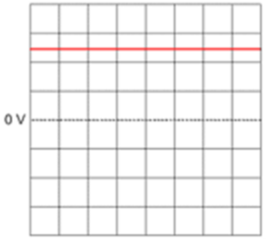
diode

Type of circuit	Series	Parallel
Current	Same through each component	
Potential difference	Total p.d. of the power supply is shared between components	
Resistance	The sum of each component: $R_{total} = R_1 + R_2$	

KS4 ELECTRICITY IN THE HOME

Direct and Alternating Potential Difference

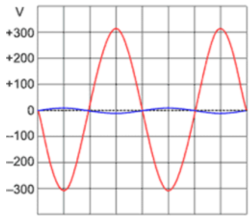
A direct potential difference will produce a direct current (dc) - a current in which the charge carriers move in one direction only.



Batteries are dc.

A direct pd does not go below 0 V

An alternating potential difference will produce an alternating current (ac) - a current in which the charge carriers move backwards and forwards.



Main electricity is ac.

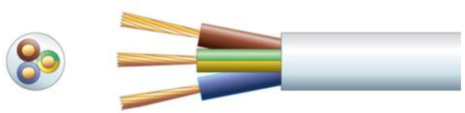
An alternating pd goes below 0 V

Mains electricity is an ac supply

In the United Kingdom, the domestic electricity supply has a frequency of 50 Hz and ~230 V.

Wiring in the home

Most electrical appliances are connected to the mains using three-core cable:



Name	Colour	Function
Live	Brown	Carries alternating potential difference from the supply. p.d. between the live wire and earth is ~ 230 V.
Neutral	Blue	Completes the circuit. At 0 V.
Earth	Green and yellow stripes	Safety wire to stop appliance becoming live. At 0 V. Only carries a current if there is a fault.

Power

When electrical appliances are connected into a circuit, energy is transferred to the appliance.

The rate at which energy is transferred to the appliance is the power rating of the appliance.

How to calculate energy transferred by electrical work?

energy transferred (J) = power (W) x time (s)

$$E = P\,t$$

energy transferred (J) = charge flow (C) x potential difference (V)

$$E = Q\,V$$

How to calculate power?

power (W) = current (A) x potential difference (V)

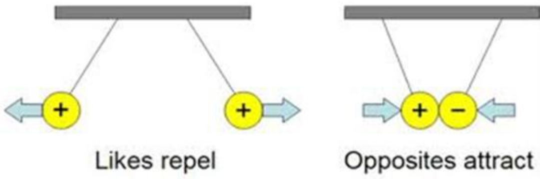
$$P = I\,V$$

power (W) = current^2 (A) x resistance (Ω)

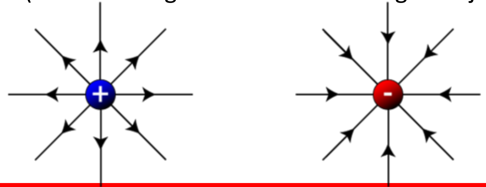
$$P = I^2\,R$$

Static Electricity (Triple Only)

When two electrical charges (+ or -) are placed nea each other, they exert a force on one another Electrostatic forces are non-contact forces.



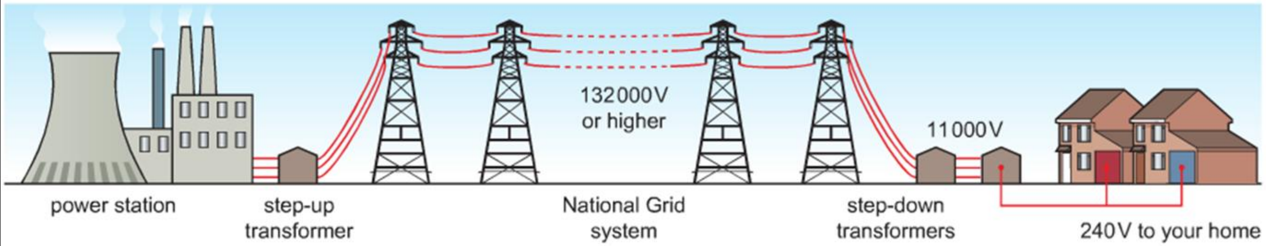
A charged object creates and electric field around itself (field is strongest close to the charged object)



The National Grid

A **system of cables and transformers** linking power stations to consumers e.g. homes, shops, factories and schools.

Electrical power is transferred from power station to consumers using:



Why are transformers used?

- Electric current generates heat as it moves through electrical wires
- If electricity is transmitted at a very high potential difference and low current, less energy is wasted, making the whole system more efficient.

Step- up transformers

- Increase the potential difference and decrease the current

Step- down transformers

- Decrease the potential difference (to a safer value) and increase the current

KS4 ELECTRICITY IN THE HOME

Direct and Alternating Potential Difference

A direct potential difference will produce a direct current (dc) - a current in which the charge carriers move in one direction only.

Batteries are dc.

A direct pd does not go below 0 V

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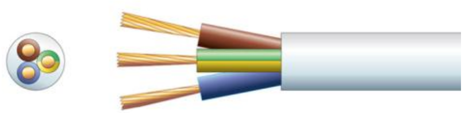

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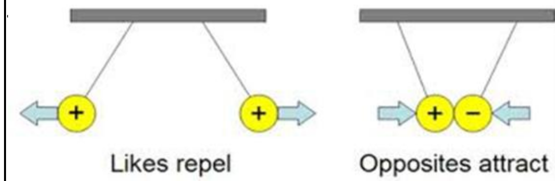

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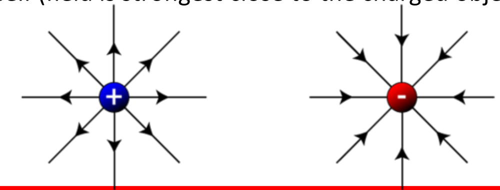

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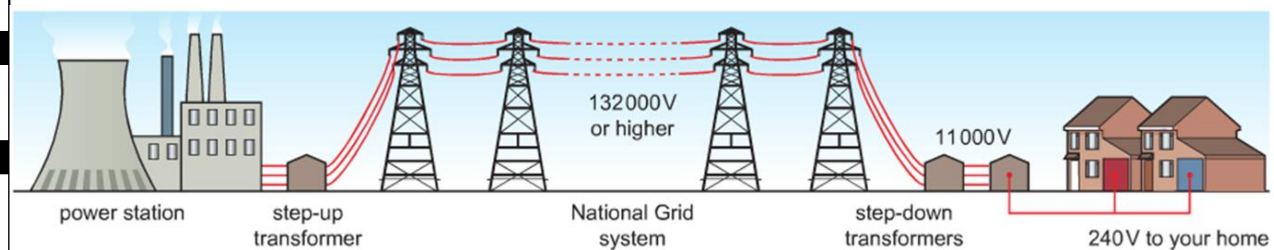

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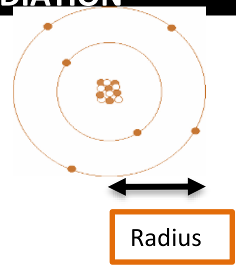
Step- down transformers

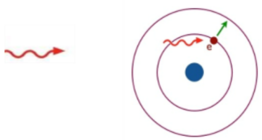
- Decrease the...............

KS4 ATOMIC STRUCTURE & NUCLEAR RADIATION

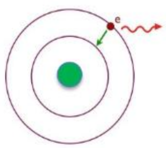


Radius of an atom 1×10^{-10} m

The radius of the nucleus is less than 1/10 000 the radius of the atom.



Electromagnetic radiation absorbed by the electron causes it to move to a higher energy level.

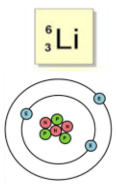


The electron can emit this stored energy as electromagnetic radiation.
As it loses energy the electron returns to its original energy level.

What is an isotope?

Isotopes is an element with the same number of protons but different numbers of neutrons. E.g. lithium - 6 and lithium - 7

Lithium 6 has
3 protons
3 neutrons



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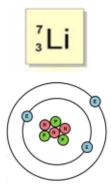
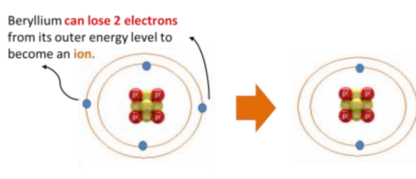


What is an ion?

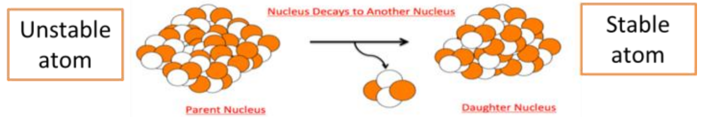
Atoms can form ions if they lose or gain electrons. They do this to have a full outer shell



$$^{9}_{4}Be \rightarrow {}^{9}_{4}Be^{2+}$$

What is radioactive decay?

The nuclei of some atoms are unstable. To become more stable, these nuclei give out radiation. This process is called radioactive decay.

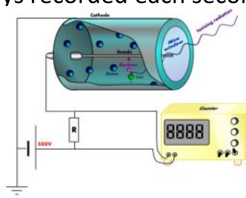


What is meant by activity of a radioactive source?

Activity = rate at which a source of unstable nuclei decays, measured in becquerels (Bq).

What is meant by count-rate of a radioactive source?

Count rate= number of decays recorded each second by a detector e.g. Geiger-Muller tube



Nuclear Radiation

There are 3 types of radioactive decay

1) **Alpha** (symbol α or $^{4}_{2}He$) consist of 2 protons and 2 neutrons emitted from the nucleus. They have a positive charge as they contain 2 (+) protons. E.g:

$$^{238}_{92}U \longrightarrow {}^{234}_{90}Th + {}^{4}_{2}He$$

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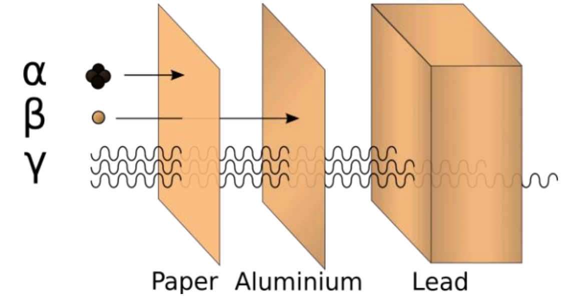
$$^{14}_{6}C \longrightarrow {}^{14}_{7}N + {}^{0}_{-1}e$$

1) **Gamma** (symbol γ) are electromagnetic radiation emitted from the nucleus. Gamma radiation has no mass and no electrical charge.E.g:

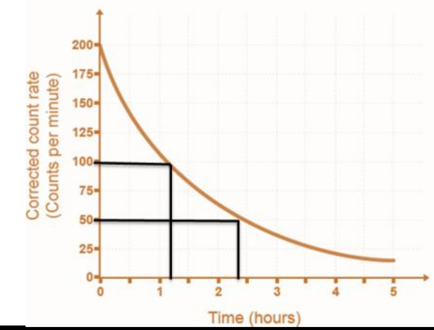
$$^{99}_{43}Tc \longrightarrow {}^{99}_{43}Tc + \gamma$$

Name	Speed	Range in air	Pene+trating power	Ionising power
Alpha (+2)	Slowest	6 - 8 cm	Low - easily stopped by paper	High
Beta (-1)	Medium	1 - 2 m	Medium - stopped by think aluminium	Medium
Gamma (no charge)	Fastest	100 m+	High - stopped by thick lead or several metres of concrete	Low



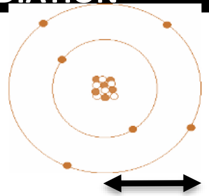
What is meant by half-life of an isotope?

The half-life of a radioactive isotope is the **time** it takes for the **number** of nuclei of the isotope in the sample to **halve**, or the time it takes for the **count rate** from a sample containing the isotope **to fall to half its initial level.**



Irradiation	Contamination
When an object or person is exposed to nuclear radiation. Prevent by using lead shields or increasing distance.	When a radioactive source is in contact with an object or person. Prevent by wearing gloves or using tongs when handling sources.

KS4 ATOMIC STRUCTURE & NUCLEAR RADIATION



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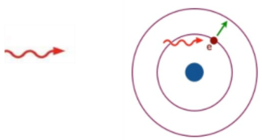

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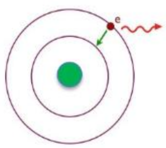

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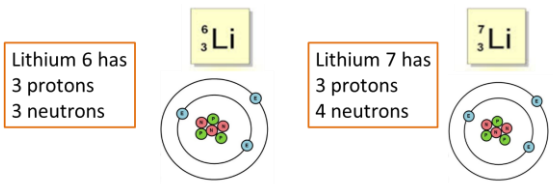

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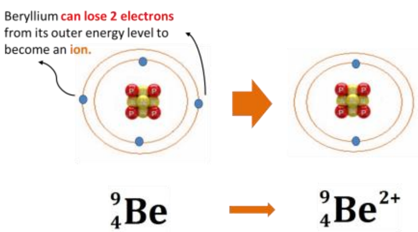

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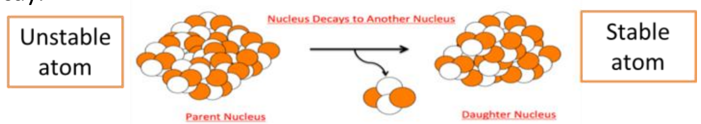

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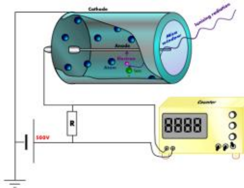

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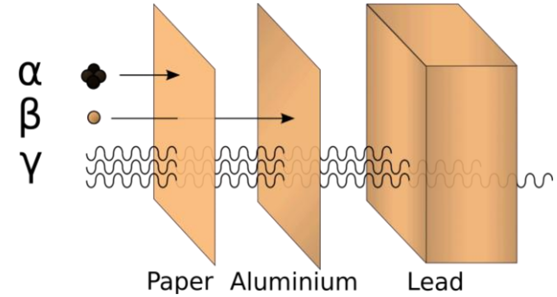

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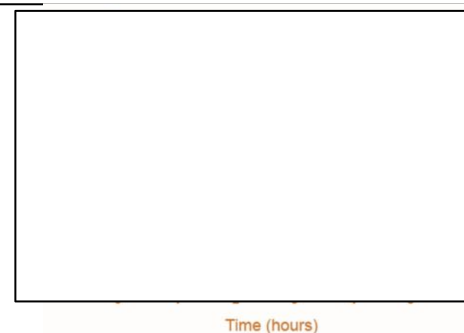


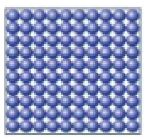
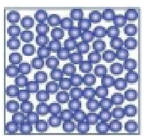
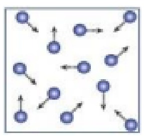
Irradiation	Contamination
When an object or person is exposed to nuclear radiation. Prevent by using lead shields or increasing distance.	

AQA P3 Particle model of matter
Combined foundation

The following required practicals are covered in this topic: RP5 Density

Quantities are things that can be measured or calculated.

Quantity	Symbol	Unit
density	p	kg/m^3
mass	m	Kg
volume	V	M^3
change in thermal energy	ΔE	J
specific heat capacity	c	J/kg °C
specific latent heat	L	J/kg
temperature change	Δθ	°C
pressure	P	Pa

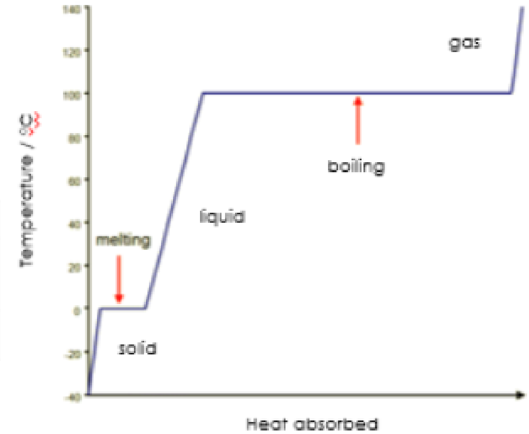
Solid	Liquid	Gas
		
Very high density	High density	Low density
Retains it's own shape	Assumes shape of container	Assumes shape of container
Fixed volume - not compressible	Fixed volume – not compressible	No fixed volume - Highly compressible
Vibrates about a fixed point	Moves randomly by sliding past each other	Constant random motion, with a range of fast speeds.

Here are the equations you need to memorise:

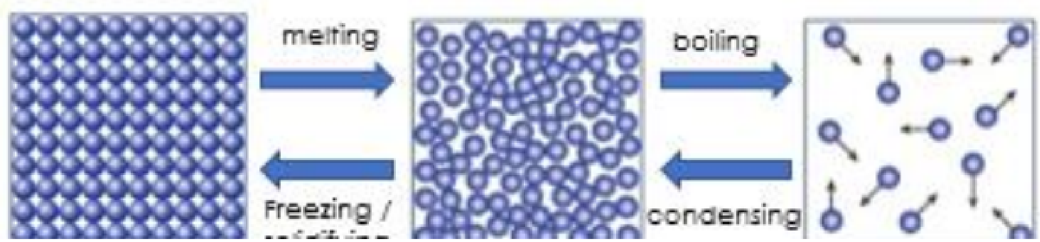
Word equation	Symbol equation
density = mass / volume	**P = m / V**

These equations are provided for you but you need to be able to select and apply them:

Word equation	Symbol equation
change in thermal energy = mass x specific heat capacity x temperature change	$\Delta E = m\ c\ \Delta \theta$
energy for a change of state = mass × specific latent heat	**E = mL**



Key word	Definition	Examples / additional information
change of state	A **reversible** change of a substance from one physical state e.g. solid to liquid. **Mass is conserved** when a change of state happens	Melt is solid to liquid. Condense is gas to liquid. **Sublimate** is from solid straight to gas
internal energy	Energy is stored inside a system by the particle that make up the system (the total kinetic energy and potential energy of all the particles)	When objects are heated the internal energy always increases (due to particles increasing their kinetic energy). This either raises the temperature or changes the state.
specific heat capacity	The amount of energy required to increase the temperature of 1 kg of a substance by 1 °C	Water has a specific heat capacity of 4,200 J/kg °C. It takes 4,200 J to increase the temperature of 1 kg of water by 1°C.
specific latent heat	The amount of energy required to change the state of one kilogram of the substance with no change in temperature	It is also the energy released into the surroundings when objects condense or freeze.
specific latent heat of fusion	The amount of energy required to change the state from solid to liquid	E.g. amount of energy required to change ice to water
specific latent heat of vaporization	The amount of energy required to change the state from liquid to gas	E.g. amount of energy required to change water to steam
gas pressure	The pressure of a gas is due to the particles colliding with the wall of the container that the gas is held in.	An increase in temperature increases the kinetic energy (speed) of the particles. It also increases the pressure.



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	P	Pa

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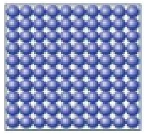	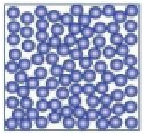	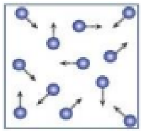
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