Bottisham Village College

KNOWLEDGE ORGANISER

SCIENCE

YEAR 9 ALL YEAR

KNOWLEDGE ORGANISERS

At Bottisham Village College, we are striving to create a five-year curriculum plan that builds effective revision strategies into homework and lessons, to ensure that students are able to place powerful knowledge into their long-term memories. Additionally, we hope that this will help build effective learning strategies from early in their time here at the college.

Based on evidence, we know that regular recall activities are the best way of achieving this goal and committing powerful knowledge into the students' memories.

At the start of each term, we shall publish all the knowledge organisers that students will require for their studies in each curriculum area. These will cover a range of aspects: facts, dates, characters, quotes, precise definitions and important vocabulary. We are clear: if this fundamental knowledge is secured, students can then develop their higher-level skills of analysis and critical understanding with greater depth.

They will be given an electronic A4 Knowledge Organiser (KO) booklet for each term containing all of the knowledge required. In lessons, Bottisham staff will be regularly testing this fundamental knowledge, using short-quizzes or even more formal "Faculty Knowledge Tests".

The best way to use these organisers at home, is to follow a simple mantra:

1. Look at a certain aspects of a particular knowledge organiser

2. Cover up part of their knowledge organiser

3. Write it out from memory

4. Check and correct any spelling mistakes, missing bits or mistakes

So simple but so effective.

Cell Biology Year 9

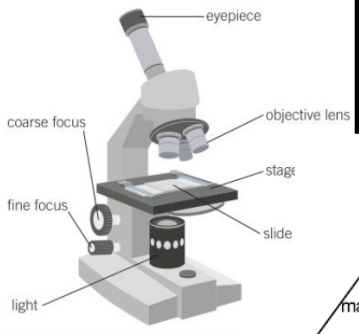
A. Keywords.

Nucleus	Controls the cell, stores genetic information (DNA)
Cell Membrane	Controls what moves in and out of the cell
Cytoplasm	Water based gel where most chemical reactions take place in cell
Chloroplast	The organelle in which photosynthesis takes place
Vacuole	Store of food, nutrients or waste in plants
Cell Wall	Rigid structure around cell in plants and algae
Mitochondria	Found in the cytoplasm. Perform respiration to release energy
Ribosome	Site of protein synthesis
Plasmids	Circular rings of DNA found in bacterial cells separate from main DNA
Eukaryote	Organisms whose cells contain membrane bound organelles (i.e. nucleus)
Prokaryote	Organisms who have a cell membrane but do not membrane bound organelles
Resolution	The ability to distinguish between two separate points
Magnification	How many times bigger an object is under a microscope than its actual size
Particles	A very tiny object, such as an atom or molecule that materials are made from.
Diffusion	The net random movement of particles from an area of high concentration to an area of low concentration
Differentiation	The process where cells become specialised for a particular function
Focus wheel	Part of the microscope used to bring the slide into focus (less blurry)
Eyepiece	The part of the microscope you look through. Magnifies the slide
Objective lens	Lens that also magnifies the slide.

B. Required Practical– Microscopy

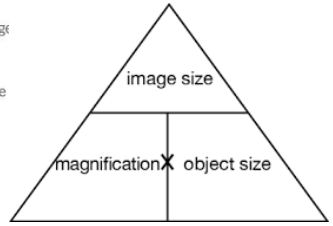
Key Concepts:

1) Parts of the microscope and their function
2) How to use the formula to calculate magnification, actual size and image size
3) Converting between mm, µm and nm



1mm = 1000 micrometres (µm)

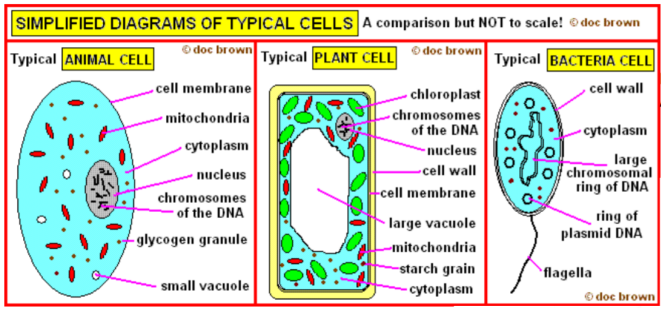
1µm = 1000 nanometres



C. Cell Structure

Key concepts:

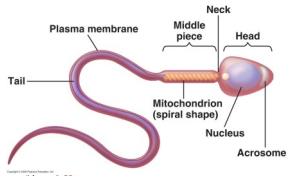
1) Parts and functions of an animal and plant cells
2) Definitions of prokaryotic and eukaryotic cells
3) Differences between prokaryotic and eukaryotic cells

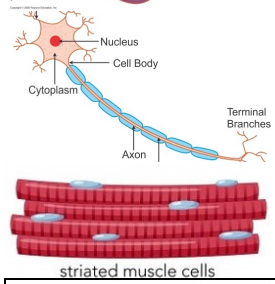


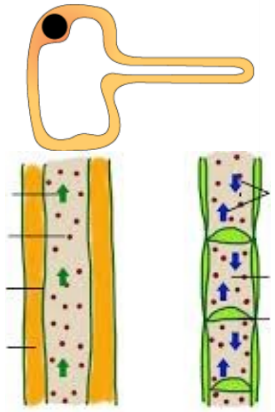
Eukaryotic cells: animals, plants, fungi and protist. Contain a nucleus and other membrane bound organelles

Prokaryotic: bacteria are an example. DNA is not enclosed in nucleus. Instead, it is a single loop of DNA free in the cytoplasm.

D. Differentiation





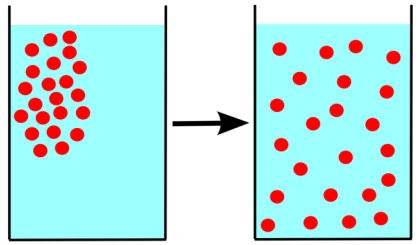


Animals	Plants
Muscle– contract and relax	Root hair– absorb water and ions from soil
Nerve– carry electrical impulses	Xylem– carry water and minerals from roots
Sperm– tail to swim	Phloem– carry glucose to cells

E. Diffusion

Key Concepts:

1) Definition of diffusion
2) Examples of diffusion in plants and animals



3) Factors affecting the rate of diffusion

Animals:

Oxygen from lungs to blood and from blood to cells

Urea from liver to blood

Plants:

Carbon dioxide from air to inside leaf

Factors Affecting Rate of Diffusion:

- Difference in concentration (concentration gradient)
- Temperature
- Surface area to diffusion through

Organisation Year 9

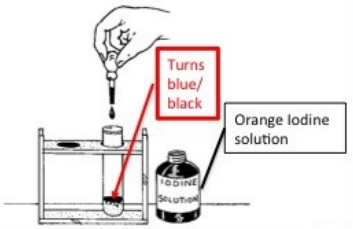
A. Key words.

Qualitative	Data does not have to be in numeric form - it can also be in words and descriptions.—for example colour change in a food test.
Artery	Blood vessels that carry blood away from the heart
Vein	Blood vessels that carry blood towards the heart.
Capillary	The smallest blood vessels they run between and supply individual cells, they only one cell thick
Communicable disease	Disease caused by pathogens that can be passed from person to person
Coronary Heart Disease (CHD)	A condition where the blood vessels supplying the heart become narrowed or blocked, causing the heart not to receive enough oxygen.
Stent	A device placed inside an artery to keep it open so blood can flow.
Statins	A drug that helps treat coronary heart disease by lowering blood cholesterol levels.
Non-communicable disease	Diseases that are not infectious can cannot be caught from another organism.
Xylem	The non-living tissue that transports water and minerals around a plant
Phloem	The living tissues that transports glucose around a plant
Stomata	The openings on a plant leaf that allows gasses to enter and leave the leaf.
Mesophyll	Types of tissue of the inner leaf.

B. Required Practical: Food tests

Food can be tested with different qualitative reagents to identify the food groups that are contained within it.

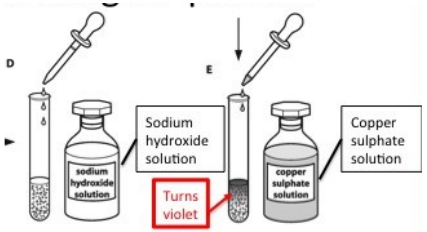
Testing for Starch



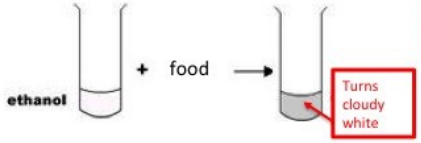
Add iodine solution.
Positive result: turns blue/black

Testing for Protein

Add biuret reagent (sodium hydroxide and copper sulfate)
Positive result: turns purple



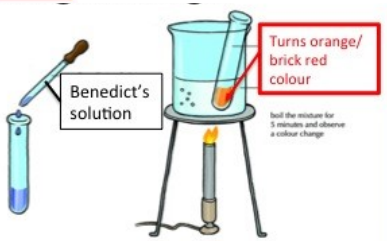
Testing for Fats (Lipids)



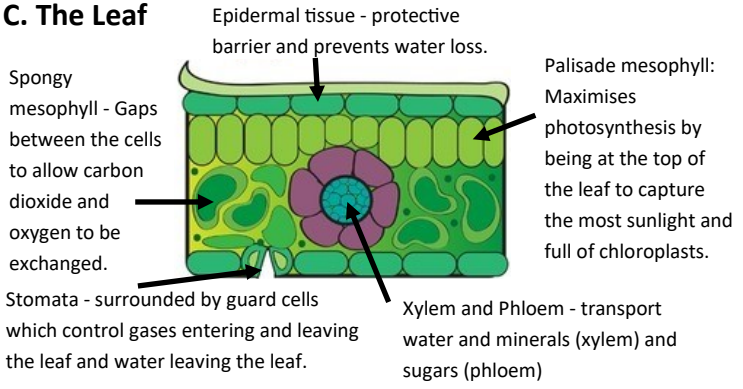
Add ethanol.
Positive result: turns cloudy.

Testing for Sugars

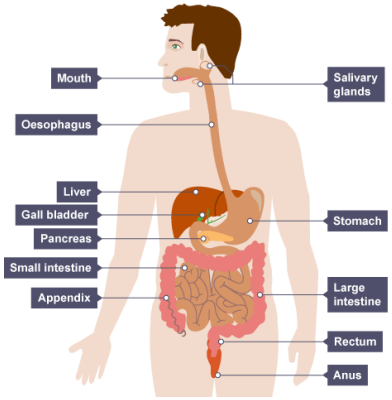
Add Benedict's reagent.
Heat in a water bath.
Positive result: Turns red/ orange.



C. The Leaf



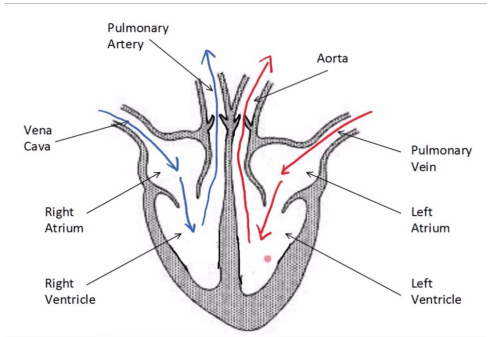
D. Digestive System



The digestive system using mechanical and chemical methods to release nutrients from food.

Enzymes chemically digest food.

E. The Heart and Blood



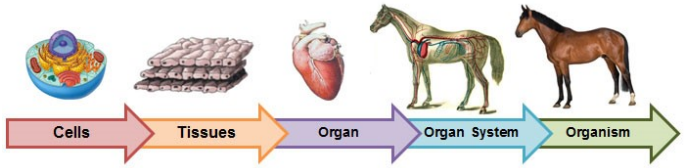
The heart pumps blood around the body. It is in two halves, each half has two chambers.

The blood is made up of four different components:

Plasma	Transports carbon dioxide, digested food, urea, hormones and heat
Red Blood Cells	Transport oxygen
White Blood Cells	Engulf pathogens and produce antibodies
Platelets	Involved in blood clotting

F. Cells, Tissues, Organs and Systems

A group of **cells** together are called a **tissue.** A group of **tissues** together are called an **organ.** A group of **organs** together are called a **system.**



Infection and Response
Year 9

A. Keywords.

Pathogen	A microbe (small living thing) that causes disease. Can be either a bacteria, virus, protist or fungus
Communicable disease	A disease caused by pathogens that can be passed from one organism to another.
Non-communicable disease	A disease that is not infectious and cannot be passed from one organism to another.
Bacteria	A single cell organism that has a cell wall but no nucleus. Can cause disease
Virus	Pathogens that are smaller than bacteria and can only reproduce inside the living cells of other organisms
Toxin	A substance produced by bacteria that makes you ill
Antitoxin	A substance produced by a white blood cell that neutralises the toxin
White Blood Cells	A cell that defends against pathogens by engulfing them, making antibodies and antitoxins.
Antibody	A chemical that binds to antigen of pathogens. A unique antibody is made for each pathogen.
Antigen	A marker on the surface of a pathogen that the antibody binds to
Vector	An animal that passes a disease from person to person

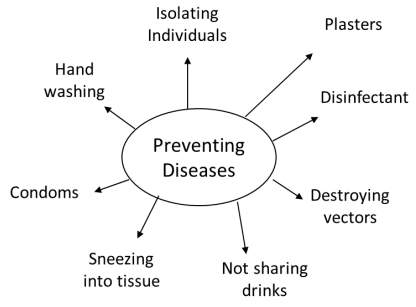
B. Spread and Prevention of Disease

Disease can be spread by:

Air: such as when you cough, sneeze or talk i.e. flu and the common cold.

Direct Contact: disease spread when infected organisms come into contact with a healthy organisms such as touch, sex, cut and scratches, i.e. tobacco mosaic virus, HIV

Water: such as through raw/ uncooked meat or contaminated drinking water i.e. cholera



C. Diseases in Plants

	Tobacco Mosaic Virus	**Rose Black Spot**
Cause	Virus	Fungus
Symptoms	Mosaic pattern of discoloration on leaves	Purple or black spots on leaves
Transmission	Contact between diseased and healthy plants	Spores carried by the wind
Prevention	Good pest control and TMV resistant plants	Removing and burning affected leave and stems

Causing Disease

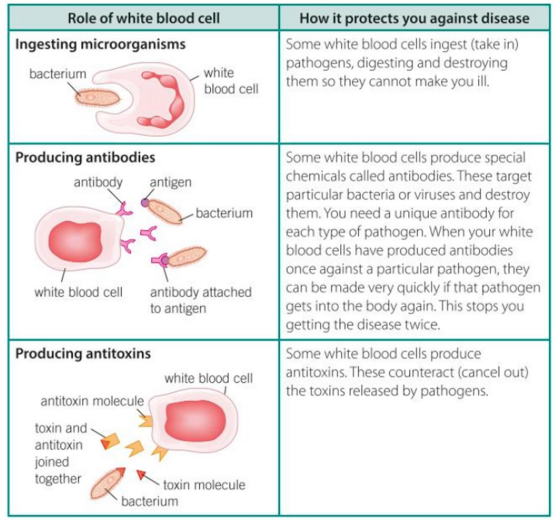
Bacteria and viruses replicate rapidly. Bacteria produce toxins that make you feel ill. Viruses live and reproduce inside your cells, damaging and destroying them.

D. Diseases in Humans

	Cause and Transmission	Symptoms and treatment	Prevention
Measles	Virus, air	Fever and skin rash; none	Vaccination, isolating infected individuals
HIV/AIDs	Virus, unprotected sex	Flu like at start; antiretrovirals, no cure	Condoms, antiretrovirals
Salmonella	Bacteria, undercooked food	Fever, vomiting, diarrhoea; antibiotics for young and old	Keep raw chicken away from uncooked food
Gonorrhoea	Bacteria, unprotected sex	Green discharge from vagina or penis; antibiotics	Condoms
Malaria	Protist, mosquitos	Recurrent fever and shaking; combination of drugs	Insect nets, removing standing water, antimalarials

E. Human Defence Responses

The first line of defence includes your skin (forms scabs, antimicrobial), mucus that traps pathogens, cilia that waft pathogens to back of throat and stomach acid

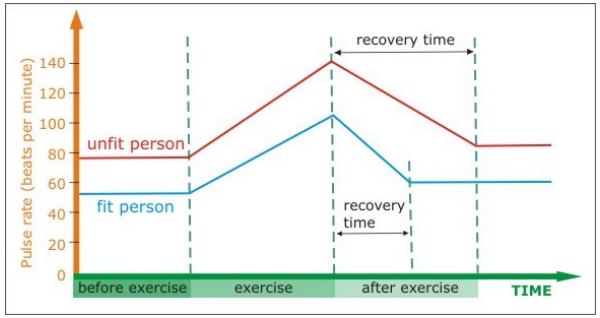


Bioenergetics Year 9 Foundation

A. Keywords.

Photosynthesis	The process by which plants make food using carbon dioxide, water and light. Carbon + Water → Glucose + Oxygen dioxide
Aerobic Respiration	Chemical reaction releasing energy from glucose in the presence of oxygen
Anaerobic Respiration	Chemical reaction releasing energy from glucose in the absence of oxygen
Endothermic	A chemical reaction that takes in energy from the surroundings e.g. photosynthesis
Exothermic	A chemical reaction that releases energy to the surroundings e.g. respiration
Chlorophyll	The green pigment contained in chloroplasts
Chloroplast	The organelle in which photosynthesis takes place
Respiration	The process by which living things release energy from glucose.
Mitochondria	Found in the cytoplasm. Perform respiration to release energy
Product	A substance made in a chemical reaction
Reactant	A starting substance in a chemical reaction
Oxygen Debt	The amount of extra oxygen the body needs after exercise to break down lactic acid
Lactic Acid	A waste product of anaerobic respiration in animal cells

B. Required Practical: Respiration and Exercise: Investigate the relationship between breathing rate and heart rate



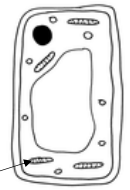
Breathing rate and heart rate both **increase** during exercise. More **energy** is needed during exercise so more **oxygen** and **glucose** are needed. Increasing heart and breathing rate supplies **more** oxygen and glucose to muscles for **respiration** to occur. Muscles need energy to contract.

Carbon dioxide and lactic acid can also be removed quicker when breathing rate and heart rate increases

C. Photosynthesis

Carbon dioxide+ water → Glucose + Oxygen

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



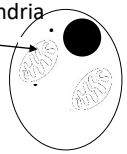
- Photosynthesis is how plants make their food. Glucose is essential for respiration in all living things.
- It takes place in the chloroplasts

Investigating Photosynthesis:

- We test for starch to investigate photosynthesis because glucose is soluble and plants store some glucose as starch.
- The test for starch is **iodine solution.** If starch is present, iodine solution turns **blue/black.**
- Destarch leaves by leaving them in the dark for 24 hours before practical. The iodine should stay orange.

D. Aerobic Respiration

Occurs in mitochondria



Oxygen + Glucose → Carbon Dioxide + Water

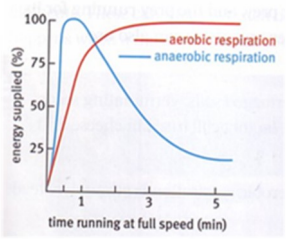
$6O_2 + C_6H_{12}O_6 \rightarrow 6CO_2 + 6H_2O$

Product	Test	Positive Result
Carbon Dioxide	Limewater	Colourless —> Cloudy
Water	Cobalt chloride paper	Blue—> Pink

Respiration:

- Releases energy for living organisms
- Energy used for muscle contraction, transporting chemicals, absorbing food, building cells for growth, sending messages along nerves etc.
- Lots of mitochondria found in sperm cells, muscle cells, nerve cells, liver cells as these cells need lots of energy

E. Anaerobic Respiration



In animals:

Glucose → Lactic Acid

- Lactic acid is toxic and causes cramp
- Lactic acid broken down by oxygen– the amount of oxygen needed is 'oxygen debt'
- Releases less energy than aerobic respiration

In yeast and plants:

Glucose → Ethanol + Carbon Dioxide

- Carbon dioxide used to make bread rise
- Ethanol used in production of alcohol

Bioenergetics Year 9 Higher

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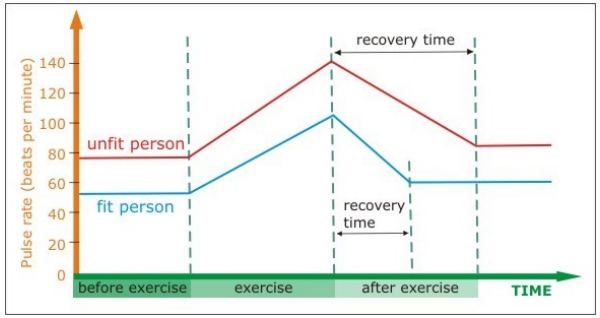

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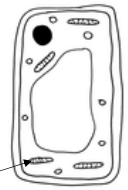

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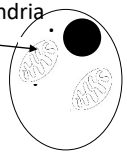

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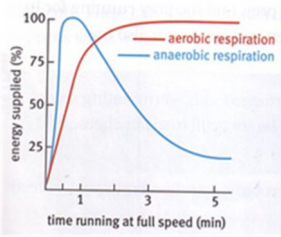
E. Anaerobic Respiration



In animals:

Glucose → Lactic Acid

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- Lactic acid is converted back into glucose in the liver.
- Releases less energy than aerobic respiration

In yeast and plants:

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- Carbon dioxide used to make bread rise
- Ethanol used in production of alcohol

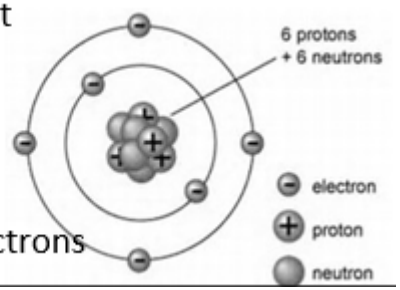
Atomic Structure and Periodic Table Year 9

A. Keywords.

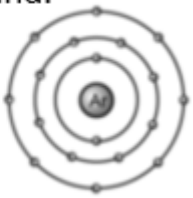
Atom	The smallest part of an element that can
Molecule	Two or more atoms chemically bonded
Element	A substance made up of only one type of atom.
Compound	A substance made up of two or more different elements chemically bonded together
Nucleus	The centre of the atom. Contains neutrons
Proton	Charge of +1. Mass of 1. Found inside the
Neutron	Charge of 0. Mass of 1. Found inside the
Electron	Charge of -1. Mass of almost 0. Found in
Mixture	Two or more substances together that are
Group	Columns in the Periodic Table. Elements in the same group have similar properties
Period	Rows in the periodic table
Isotope	Isotopes of the same element have the same number of protons but different numbers of neutrons.

B. Atomic Structure

- Electrons orbit
- Protons and neutrons in nucleus
- Number of protons = electrons

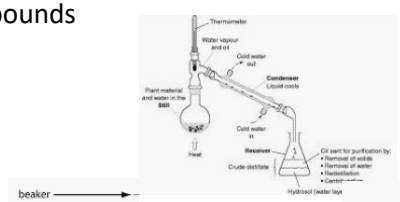


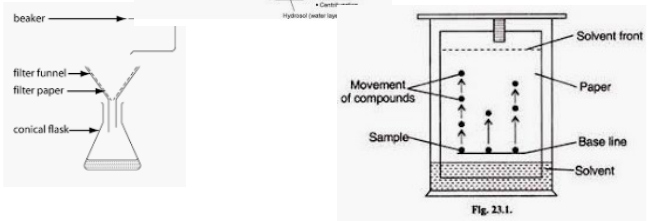
Where electrons are found.
The shells can each hold this many electrons maximum: 2,8,8



C. Separation Techniques

Used to separate mixtures. Ones you need to know:
Filtration - get an insoluble solid from a liquid
Crystallisation - get a soluble solid from a liquid by evaporating liquid off
Distillation - get a pure liquid from a mixture of liquids
Chromatography - separate mixtures of coloured compounds



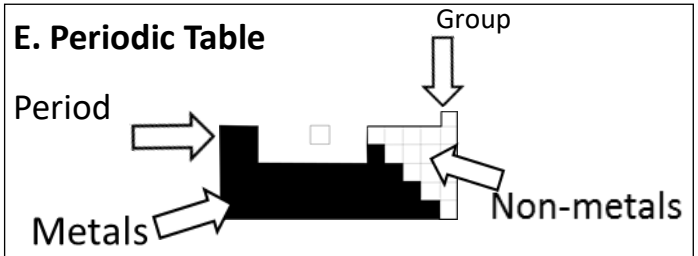


D. Atomic Structure

Particle	Charge	Mass
Protons	Positive (+)	1
Neutrons	Neutral (o)	1
Electrons	Negative (-)	nothing

15. Mass number	Number of neutrons + protons	*6 Neutrons + 5 Protons* → $^{11}_{5}B$
16. Atomic number	Number of protons	*5 Protons*

E. Periodic Table



Mendeleev—Russian chemist who ordered the elements in the Periodic Table.
Important points:

- He left gaps for undiscovered elements
- He predicted properties of undiscovered elements

F. Group 1, Alkali Metals

- Li, Na, K, Rb, Cs, Fr
- Very reactive, only one electron in their outer shell
- Reactivity increases as you go down the group
- Reacts with oxygen to give metal oxides e.g. MgO
- React with water to give metal hydroxides (alkali) and hydrogen e.g. MgOH
- React with chlorine to give metal chlorides e.g. MgCl

Bonding, Structure and Properties of Matter

Year 9

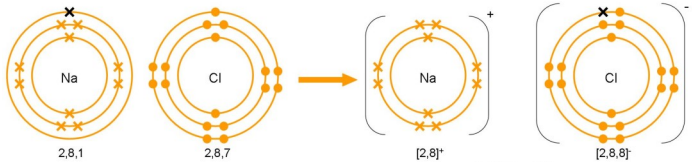
A. Keywords.

States of matter (states)	Whether a substance is a solid, liquid or gas at room temperature.
Solid	Substance with a fixed shape and volume. Cannot be compressed.
Liquid	Substance with affixed volume, but flows and can change shape. Cannot be compressed.
Gas	Substance with no fixed shape or volume. Easily compressed.
Ion	An atom that has lost or gained electrons. An ion has a positive or negative charge.
Bonding	The changes atoms go through during a reaction to give them a stable arrangement
Compound	A substance made up of two or more different elements chemically bonded together
Electrostatic attraction	A strong force of attraction between oppositely charged objects.

B. Ionic Bonding

Atoms **transfer electrons** and form charged particles called **ions**.

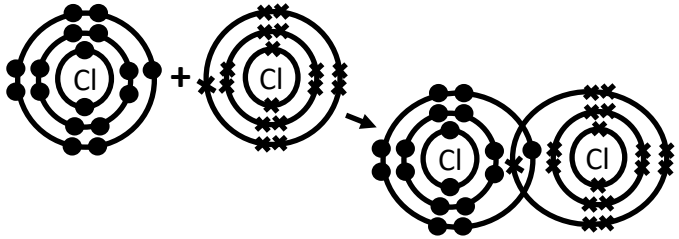
Ionic bonding is the result of **electrostatic attraction** between oppositely charged ions.



Ionic bonding occurs between a metal and non-metal.

C. Covalent Bonding:

Atoms **share electrons**.



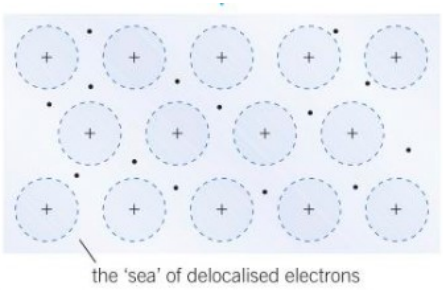
Covalent bonding occurs between non-metals only.

Strong bonds between atoms, but weak forces between other covalent molecules.

D. Metallic Bonding:

All metals make positive ions.

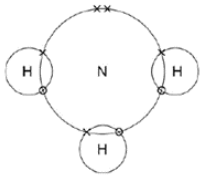
Metals form a giant structure made of positive ions surrounded by delocalised or freely-moving electrons.

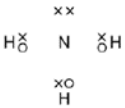


Strong **electrostatic attraction** between the positive ions and negative electrons.

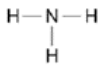
E. Models/diagrams of bonding:

Dot and cross diagrams:

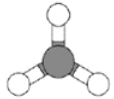




Displayed formula:



Ball and stick:



Each shows the covalent bonding in Ammonia NH_3

Quantitative Chemistry Year 9

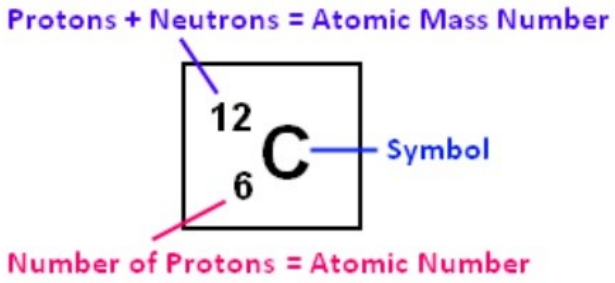
A. Keywords.

Atom	Smallest part of an element that can exist
Molecule	Two or more atoms chemically bonded together
Element	A substance made up of only one type of atom.
Compound	A substance made up of two or more elements chemically bonded together.
Mass number	Number of neutrons + protons—the top number
Atomic number	Number of protons—the bottom number
Relative atomic mass	A_r The mass number of an atom. E.g. A_r of O is 16 and H is 1
Relative formula mass	M_r The mass of all the atoms of a molecule added together.
Conservation of mass	In a chemical reaction the total mass of reactants = total mass of products
Closed system	A system that cannot exchange matter with its surroundings
Open system	A system where mass can be lost to the surroundings

B. Mass Number and Atomic Number

The **mass number** is the sum of the protons and neutrons found in the nucleus of the atom

The **atomic number** is the number of protons found in the nucleus of the atom

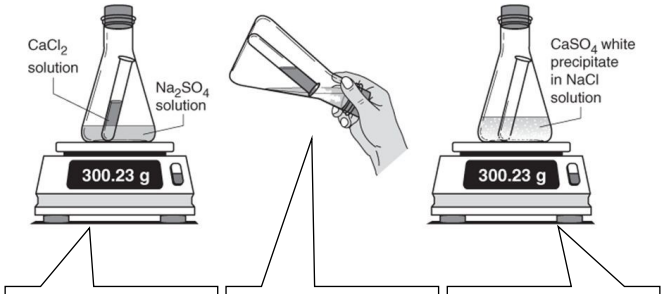


C. Conservation of Mass

The law of conservation of mass states:

In a chemical reaction mass is neither lost or gained.

The mass of reactants will equal the mass of the products.



1. A test tube containing one reactant is placed inside a sealed flask of the other reactant. The total mass is recorded.

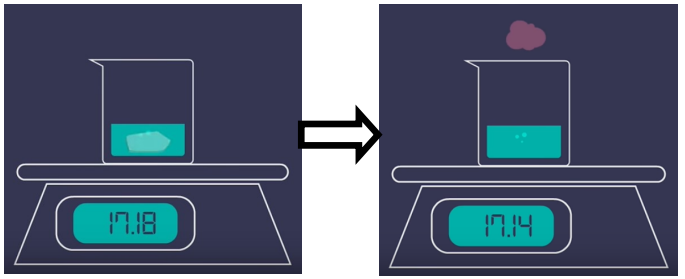
2. The flask is gently tipped upside down so the chemical in the test tube flows out. The reactants mix and react.

3. The flask is re-weighed and the mass recorded. The mass will the same as the starting mass.

D. Open and Closed Systems

The conservation of mass can easily be proved in a **closed system** as no products can escape.

An **open system** is more difficult because a product will be lost. However conservation of mass still applies.



Magnesium + Hydrochloric acid → Magnesium Chloride + Hydrogen

Solid magnesium and a solution of hydrochloric acid react. The mass of both is measured.

A solution of magnesium chloride and hydrogen **gas** is produced. The mass of the gas cannot be measured.

E. Relative Formula Mass

The sum of the relative atomic masses of the atoms in a compound.

There are no units for relative atomic mass because it a way of measuring the mass of atoms compared to each other.

E.g. Relative atomic masses:

Carbon = 12 and Hydrogen = 1

This means carbon is 12 times heavier than hydrogen.

Calculate the relative formula mass of Carbon dioxide (CO_2)

Relative atomic masses: Carbon = 12 and Oxygen = 16

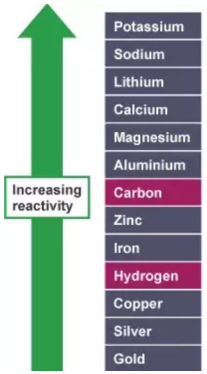
$CO_2 = (12 \times 1) + (16 \times 2) = 44$

Chemical Changes
Year 9 Foundation

A. Keywords.

Reactivity	How likely a substance is to react with another substance.
Reduction	The loss of oxygen.
Oxidation	The gain of oxygen.
Redox reaction	A reaction where one species is oxidised and another reduced.
Electron	Charge of -1. Mass of almost 0. Found in shells, orbiting around the nucleus
Soluble	A substance that will dissolve
Insoluble	A substance that does not dissolve
Crystallisation	A separation technique used to separate a soluble solid from a liquid by evaporating the liquid to form crystals.
Displacement reaction	A reaction where a more reactive element takes the place of a less reactive element in a compound.

C. Reactivity Series



- The reactivity series puts metals in order of the most to least reactive.

- Metals below carbon can be extracted by carbon reduction.

E.g. Iron oxide + Carbon → Iron + Carbon dioxide

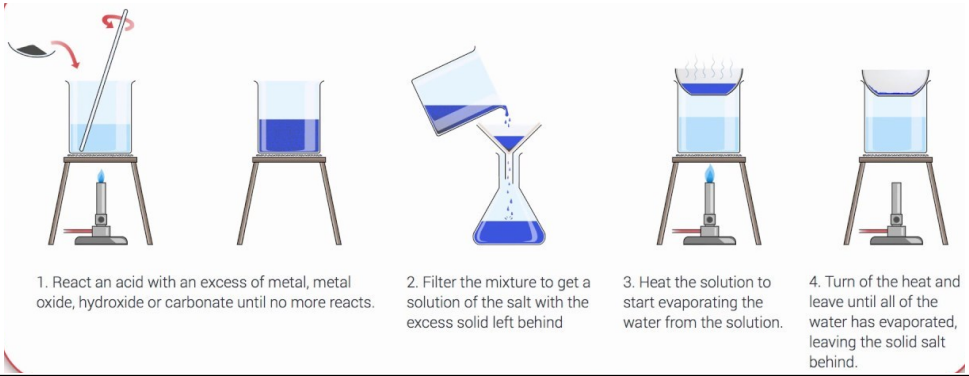
- Metals below hydrogen can be extracted hydrogen reduction.

E.g. Copper oxide + Hydrogen → Copper + Water

- A more reactive metal will displace a less reactive one from its compound.

E.g. Copper sulfate + Zinc → Zinc sulfate + Copper

B. Required Practical: Making a Soluble Salt



D. Reactions of Acids

General Equations:

Acid + Metal → Salt + Hydrogen

Acid + Metal Hydroxide → Salt + Water

Acid + Metal Carbonate → Salt + Water + Carbon Dioxide

- Hydrochloric acid produces chloride salts.
- Sulfuric acid produces sulfate salts.
- Nitric acid produces nitrate salts.

Iron + Hydrochloric acid → Iron chloride + Hydrogen

Iron + Sulfuric acid → Iron sulfate + Hydrogen

Iron + Nitric acid → Iron nitrate + Hydrogen

Metal hydroxides neutralise the acid.

- Insoluble metal hydroxides are called bases
- Soluble metal hydroxides are called alkalis

E. Oxidation and Reduction

Magnesium + Oxygen → Magnesium oxide

The Magnesium has been **oxidised** because it has gained oxygen.

Copper oxide + Carbon → Copper + Carbon dioxide

The Carbon has been **oxidised** because it has gained oxygen.

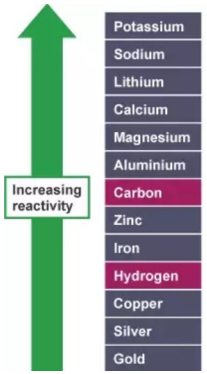
The Copper has been **reduced** because it has lost oxygen.

Chemical Changes
Year 9 Higher

A. Keywords.

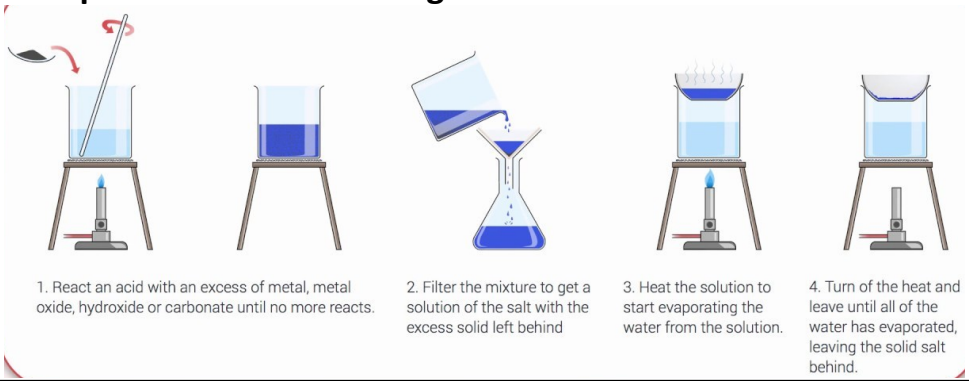
Reactivity	How likely a substance is to react with another substance.
Reduction	1. The loss of oxygen. 2. The gain of electrons.
Oxidation	1. The gain of oxygen. 2. The loss of electrons.
Redox reaction	A reaction where one species is oxidised and another reduced.
Electron	Charge of -1. Mass of almost 0. Found in shells, orbiting around the nucleus
Soluble	A substance that will dissolve
Insoluble	A substance that does not dissolve
Crystallisation	A separation technique used to separate a soluble solid from a liquid by evaporating the liquid to form crystals.
Displacement reaction	A reaction where a more reactive element takes the place of a less reactive element in a compound.

C. Reactivity Series



- The reactivity series puts metals in order of the most to least reactive.
- Metals below carbon can be extracted by carbon reduction.
- Metals below hydrogen can be extracted by steam reduction.
- A more reactive metal will displace a less reactive one from its compound.

B. Required Practical: Making a Soluble Salt

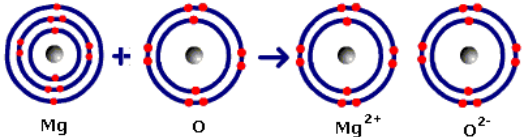


E. Oxidation and Reduction

Magnesium + Oxygen → Magnesium Oxide

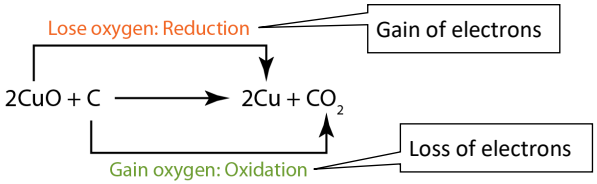
The Magnesium has been **oxidised** because it has gained oxygen.

The Magnesium has lost electrons because it has made an ionic bond with oxygen.



O.I.L.R.I.G

Oxidation Is Loss (of electrons), Reduction is Gain (of electrons)



D. Reactions of Acids

General Equations:

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Acid + Metal Hydroxide → Salt + Water

Acid + Metal Carbonate → Salt + Water + Carbon Dioxide

- Hydrochloric acid produces chloride salts.
- Sulfuric acid produces sulfate salts.
- Nitric acid produces nitrate salts.

Iron + Hydrochloric acid → Iron chloride + Hydrogen

Iron + Sulfuric acid → Iron sulfate + Hydrogen

Iron + Nitric acid → Iron nitrate + Hydrogen

Metal hydroxides neutralise the acid.

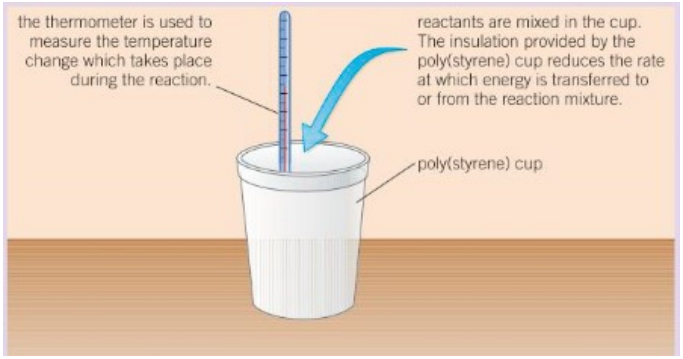
- Insoluble metal hydroxides are called bases
- Soluble metal hydroxides are called alkalis

Energy Changes Year 9

A. Keywords.

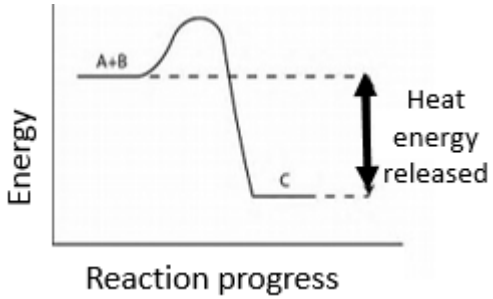
Exothermic Reaction	One that transfers energy to the surroundings so the temperature of the surroundings increases
Endothermic Reaction	One that absorbs energy from the surroundings so the temp. of the surroundings decreases
Reactants	A starting substance used in a chemical reaction
Products	A substance made in a chemical reaction
Energy Level Diagram	A diagram to show if a reaction is exo or endothermic

B. Temperature Change Required Practical



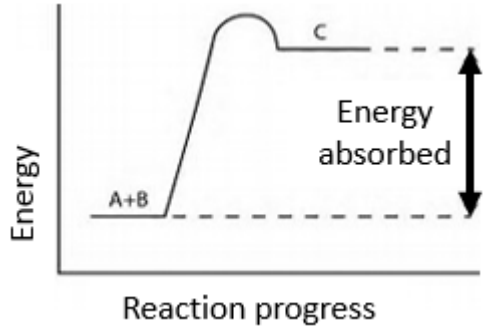
Monitor the temperature rise as small volumes of sodium hydroxide solution are added to dilute hydrochloric acid. The acid will be contained in an insulated cup.

C. Exothermic Reactions



An exothermic reaction gives out energy, so products have less energy than reactants, but temperature of the surroundings goes up.

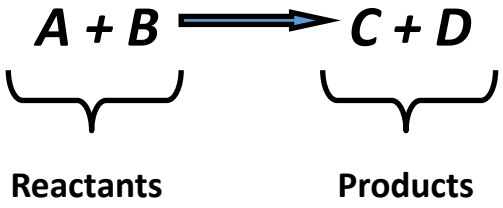
D. Endothermic Reactions



An endothermic reaction takes in energy, so products have more energy than reactants, but temperature of the surroundings goes down

E. Reactions

In every chemical reaction, bonds need to be broken before new bonds can be formed.



Energy Year 9

A. Keywords.

Energy system	An object or group of objects that when changed there is a change in the way the energy is stored.
Kinetic energy	The energy of a moving object
Elastic potential energy	The amount of energy stored in a stretched spring
Gravitational Potential Energy	The amount of energy gained by an object raised above the ground
Renewable energy source	A resource that is replenished as it is used.
Non-renewable energy resource (finite)	A resource that will run out.
Work Done	When a force causes an object to move through a distance
Velocity	The speed and direction of an object

B. Equations

Kinetic energy	= 0.5 x mass x (velocity)^2 $\left[E_k = \frac{1}{2} m v^2\right]$
Elastic potential energy	= 0.5 x spring constant x (extension)^2 $\left[E_e = \frac{1}{2} k e^2\right]$
Gravitational Potential Energy	= mass x gravity x height $\left[E_p = m g h\right]$

C. Energy Stores and Systems

A system changes when an object is:

- Projected upwards
- Moving and hits an obstacle
- Accelerated by a constant force
- Slowing down

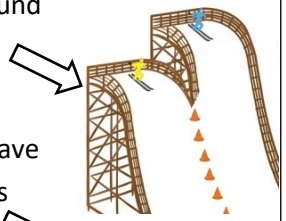
Another example of a change in a system is bringing water to boil in an electric kettle.

A system can be changed by:

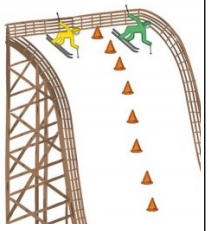
- Heating
- Work done by forces
- Work done when a current flows

D. Gravitational Potential Energy and Kinetic Energy

The higher an object is above ground level the greater the **gravitational potential energy (GPE).**

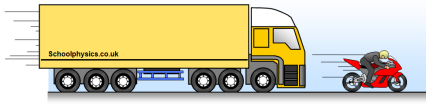


An object with a large mass will have more **GPE** than an object with less mass held at the same height.



An object which falls (a change in the system) will transfer **GPE** into **kinetic energy.**

An object with a large mass will have more **kinetic energy** than an object with less mass moving at the same velocity.

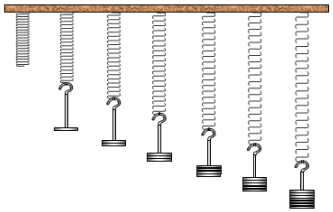


E. Elastic Potential Energy

The more a spring is stretched the greater the **elastic potential energy.**

The spring constant is a value that defines how difficult it is to stretch the spring.

If a spring is stretched beyond the limit of proportionality then it will not return to its original shape and the formula for elastic potential energy no longer applies.



F. Work Done and Power

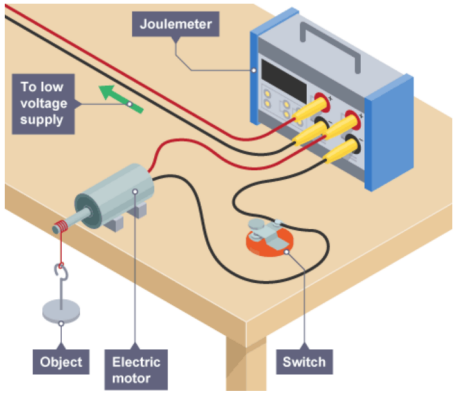
A more powerful device will be able to move an object faster than less powerful one.

A more powerful device transfers more energy per second.

Two electric motors are used to lift a 2 N weight through a vertical height of 10 m.

Motor one does this in 5 seconds.

Motor two does this in 10 seconds.



G. Energy Resources

Energy resources are used for transport, generating electricity and heating.

Energy resources are selected based on their reliability and environmental impact.

Finite (Non-renewable)

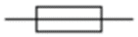
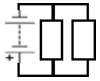
Coal, Oil, Gas and Nuclear fuel.

Renewable

Biofuel, Wind, Hydroelectricity, Geothermal, Tides, Water waves, The Sun.

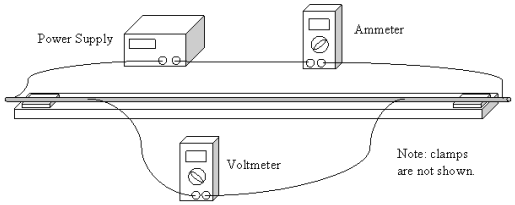
Electricity Year 9

A. Keywords.

Alternating current (ac)	Current that constantly changes direction (back and forth).
Ammeter 	Used to measure the current flowing through a component/ part of a circuit. Must be connected in series.
Cell/battery 	Component that provides the potential difference to make a current flow (charges to move around the circuit).
Current	Rate of flow of electric charge. Measured in amps (A).
Direct current (dc)	Current that flows in one direction only
Fuse 	Resistor that melts if the current is too high.
Mains electricity	UK mains electricity is an ac supply (used when plugging appliances in). It is 230V and has a frequency of 50 Hz.
Ohmic conductor 	A conductor in which the resistance remains constant. This means the current flowing through it will be directly proportional to the potential difference.
Parallel circuit 	There are two or more parallel 'branches' providing more than one path the electrons can follow around the circuit.
Potential difference	The potential difference between two points in a circuit is the work done when a coulomb of charge passes between the points. Measured in volts (V). A potential difference is needed for a current to flow.
Power	The rate at which energy is tranferrred (energy transferred per second).
Resistance	A measure of how hard it is for electrons to flow. Measured in ohms (Ω). If the resistance increases it is harder for electrons to flow so current decreases.
Series circuit	All of the components are in a single loop. There is only one path that electrons can follow around the circuit.
Voltmeter 	Used to measure the potential difference across a component. Must be connected in parallel to the component being measured.

B. Required Practical: Resistance of a wire

You need to know how to set up a circuit to investigate how resistance changes with the length of a piece of wire.

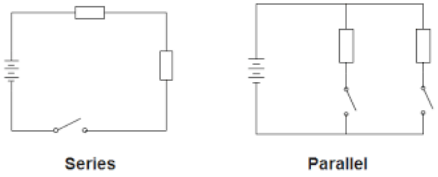


Vary the length of the wire, measuring potential difference and current each time. Then calculate resistance for each wire length.

C. Series and Parallel Circuits

Series and parallel circuits:

Circuits can be wired in series, where there is only one path for the charge (electrons), or in parallel, where there are 2 or more paths.



In series circuits, the current is the same all the way round, but the potential difference of the cell/battery is equal to the sum of the potential difference of the components.

In parallel circuits, the current splits in the branches. The potential difference across each branch is equal to the potential difference across the cell/battery.

D. Equations

Q = I x t

Charge = Current x time

[C] [A] [s]

V = I x R

Potential difference = Current x Resistance

[V] [A] [W]

Resistance = potential difference / current

[Ω] [V] [A]

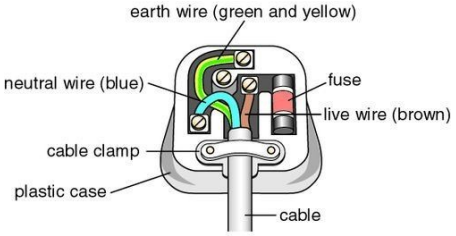
Power = current x potential difference

[W] [A] [V]

Power = current^2 x resistance

[W] [A] [Ω]

E. Wires in a Plug



Wires in 3 -core cable:

Live wire (brown) - carries the current from the supply to the appliance. Potential difference between the live wire and earth is 230V.

Neutral wire (blue) - completes the circuit by carrying the current from the appliance back to the supply. The neutral wire is at or close to 0V.

Earth wire (green & yellow) - safety wire which stops the appliance becoming live. The earth wire is at 0V. It only carries current if there is a fault. It is only needed if the appliance has a metal case e.g. toaster.

Particle Model Year 9

A. Keywords

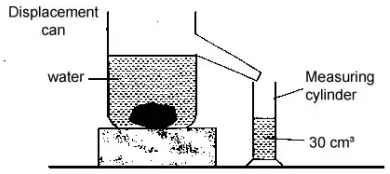
Boiling	The change of state from liquid to gas that occurs when bubbles of the substance in its gas state form throughout the liquid.
Condensing	Change in state from a gas to a liquid. It can happen at any temperature below the boiling point.
Density	Density is defined by the equation mass/volume. It is usually measured in kg/m^3 (can be in g/cm^3).
Evaporating	Change in state from a liquid to a gas that occurs when particles leave the surface of the liquid only.
Freezing	Change in state from a liquid to a solid at the melting point of a substance.
Gas pressure	Pressure is force per unit area. The pressure of a gas is due to the force the gas particles exert on the walls of the container.
Internal energy	The total kinetic and potential energy of all of the particles that make up the system.
Melting	Change in state from a solid to a liquid at the melting point of a substance.
Particle motion in a gas	Particles in a gas move randomly.
Sublimation	Change in state from a solid to a gas or a gas to a solid (missing out liquid phase).

B. Required Practical - Density

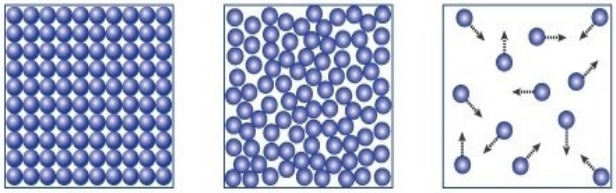
1.Use mass balance to find the mass of the object.

2.Calculate the volume of the object. If it is a regular shape like a cuboid, use a ruler to measure the length, width and height. Calculate the volume using l x w x h. If the object is irregular like a rock, set a eureka can of water and measuring cylinder under the spout. Gently submerge the object in the water and collect the water that is displaced to find the volume.

3.Use the equation: Density = mass / volume to calculate the density of the object.



C. Particle Model



Solid	Liquid	Gas
Not very compressible	Not very compressible	Highly compressible
High density	High density	Low density
Definite volume	Definite volume	Fills container completely
Retains it's own shape	Assumes shape of container	Assumes shape of container
Particles vibrate around a fixed position	Particles can move passed one another	Particles more randomly all the time

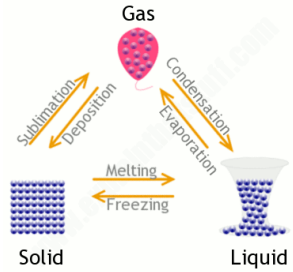
D. Changes of State

When particles gain energy:

	Melting	Evaporating or boiling
Description	Solid to liquid	Liquid to gas
Closeness of particles	Stay close together	Become much further apart
Arrangement of particles	Regular to random	Stay random
Motion of particles	Start to move around each other	Become able to move quickly in all directions

When particles lose energy:

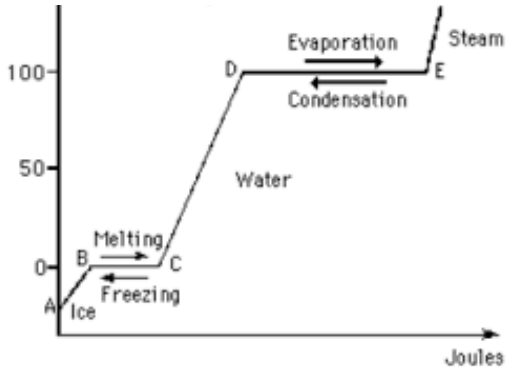
	Condensing	Freezing
Description	Gas to liquid	Liquid to solid
Closeness of particles	Become much closer together	Stay close together
Arrangement of particles	Stay random	Random to regular
Motion of particles	Stop moving quickly in all directions, and can only move around each other	Stop moving around each other, and only vibrate on the spot



E. Heating Curve

A steep line shows particles gaining energy.

A flat line shows when the substance is changing state.



Atomic Structure

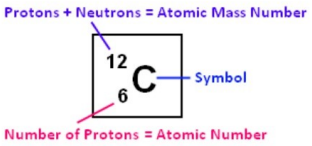
Year 9

A. Keywords	
Activity	The rate at which a source of unstable nuclei decays. Measured in becquerel (Bq).
Alpha particle	Made up of two protons and two neutrons (the same as a helium nucleus).
Atomic number	The number of protons in an atom
Beta particle	A fast moving electron given out by the nucleus
Electron	Charge of -1. Mass of almost 0. Found in shells, orbiting around the nucleus
Gamma ray	Electromagnetic radiation given out by the nucleus.
Ion	An atom that has lost or gained electrons. An ion has a positive or negative charge.
Isotopes	Isotopes of the same element have the same number of protons but different numbers of neutrons.
Mass number	The number of protons and neutrons in the nucleus.
Neutron	Charge of 0. Mass of 1. Found inside the nucleus
Nucleus	The centre of the atom. Contains neutrons and protons.
Proton	Charge of +1. Mass of 1. Found inside the nucleus.

B. Protons, neutrons, electrons

Particle	Relative Mass	Relative Charge
Proton	1	+1
Neutron	1	0
Electron	(almost) 0	-1

- The Mass number is the **large** number, it is the total number of protons and neutrons.
- The Atomic number is the **small** number, it is the number of protons alone.



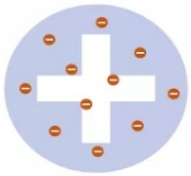
C. History of the Atom

SOLID SPHERE MODEL

JOHN DALTON

- Discovered by John Dalton
- Atoms are a solid spherical ball.

PLUM PUDDING MODEL



J.J. THOMSON

- Discovered by JJ Thomson.
- A ball of positive charge
- Negative electrons embedded throughout.

- Discovered by Ernest Rutherford through the alpha scattering experiment:

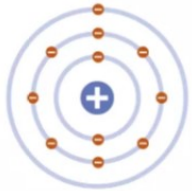
NUCLEAR MODEL

ERNEST RUTHERFORD

♦most alpha particles travelled straight through gold foil showed the atom was mainly empty space.
♦some alpha particles were deflected by small angles and some by large angles. This showed there was a small central, positively charged nucleus, where most of the mass was concentrated.

- Adaptation by Niels Bohr
- Suggested electrons orbit in shells.

BOHR MODEL

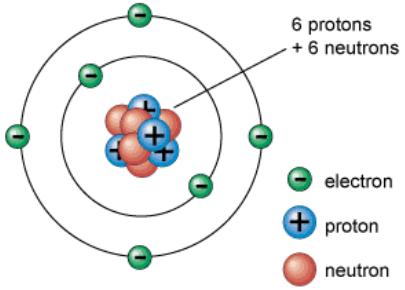


NIELS BOHR

- James Chadwick later discovered the neutron

D. Model of the atom

- Radius of an atom is approx. 1 x 10^{-10} metres.
- The radius of the nucleus is approx. 1/10,000 of the radius of the atom.
- The protons and neutrons make up the nucleus.
- The electrons are found in shells orbiting the nucleus. The first shell can hold a maximum of 2 electrons, the second and third shells can hold a maximum of 8 electrons.



Carbon atom

E. Alpha, Beta and Gamma Radiation

- Some atomic nuclei are unstable, they give out radiation to become more stable. This is called radioactive decay.
- Radioactive decay happens randomly.

	Alpha	Beta	Gamma
What it is	2 protons and 2 neutrons	High speed electron	Electromagnetic wave
Penetrating Power	Least – stopped by paper	Medium—stopped by thin sheet of aluminium	Most—Stopped by a thick sheet of lead
Ionising Power	Strong	Moderate	Very weak
Range in Air	A few cm	Approx. 1 m	At least 1 km