Year 7 - Cells

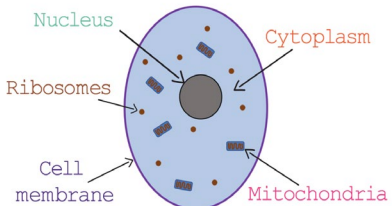
Threshold Concept

Understand that all living things are made of cells

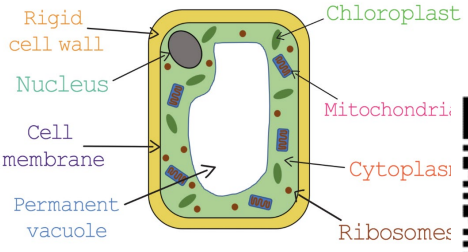
Keywords

Animal Cell - Building block of all animal life
Plant Cell - Building block of plant life
Microscope - Utensil used to enlarge objects
Prokaryote - Cell without nucleus
Eukaryote - Cell containing a nucleus
Cell - Basic building block

Structure of animal cell



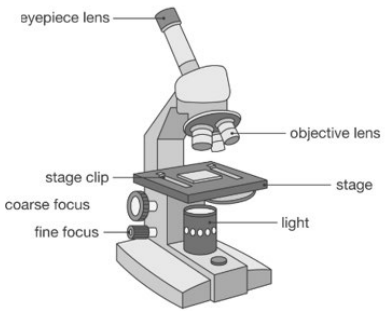
Structure of plant cell



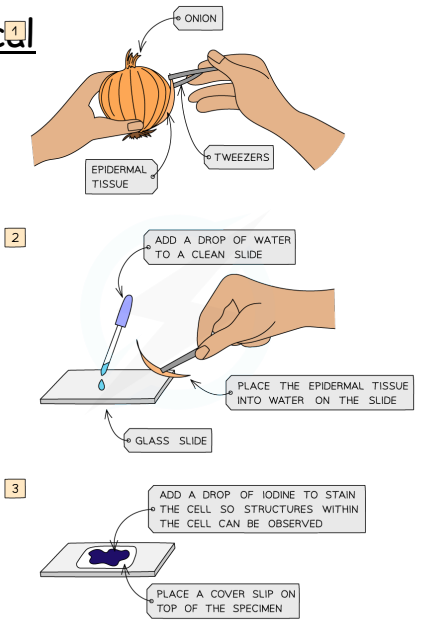
Comparing cells

Organelle	Responsible for
Nucleus	Housing DNA, 'brain' of the cell
Mitochondria	Energy production, 'power house' of the cell
Golgi apparatus	Sorting, packaging and transport of proteins
Endoplasmic reticulum	Synthesis and processing of proteins, lipid expression
Chloroplast	Photosynthesis, only present in plants
Flagellum	Locomotion and sensory functions
Vacuole	Storage and maintaining homeostasis
Lysosome	Digestions of larger molecules
Peroxisome	Degradation of hydrogen peroxide
Ribosome	Synthesis of proteins
Proteasome	Break down of proteins with expired fun

Microscope



Required practical



Specialised cells

Equations for this topic

Image Size = Actual Size x Magnification

Reproduction

Threshold Concept

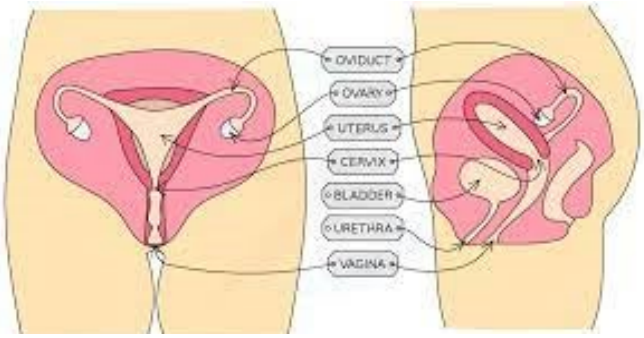
Reproduction can happen sexually and asexually

Keywords

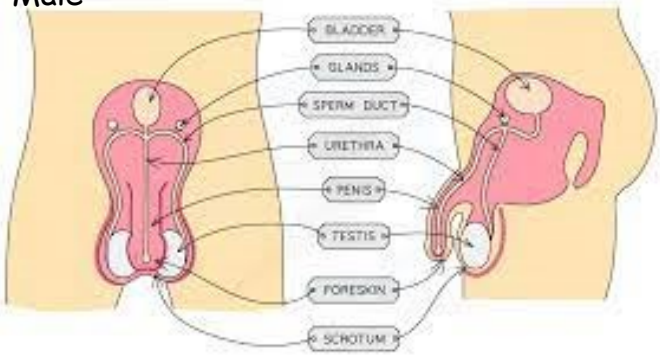
- **Sperm:** male reproductive cell that contains genetic material
- **Egg**: female reproductive cell that contains genetic material
- **Reproduction**: the joining of sex cells (a sperm and egg) to produce offspring
- **Fertilisation:** the joining of a male and female sex cell/genetic material
- **Develop**: build upon given information

Reproductive organs

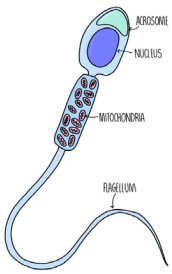
Female



Male



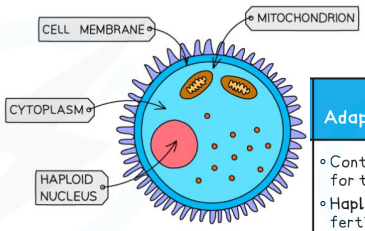
Sperm cell



Adaptations

- The head contains the genetic material for fertilisation in a **haploid nucleus** (containing half the normal number of chromosomes)
- The **acrosome** in the head contains digestive **enzymes** so that a sperm can penetrate an egg
- The mid-piece is packed with **mitochondria** to release **energy** needed to swim and fertilise the egg
- The **tail** enables the sperm to **swim**

Egg cell

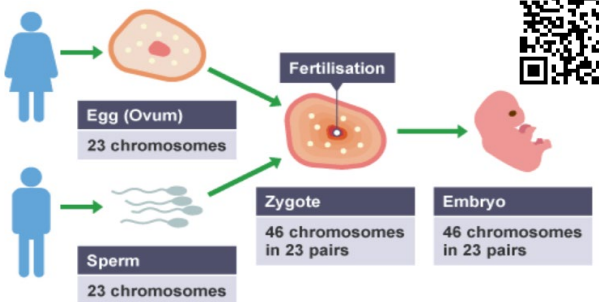


Adaptations

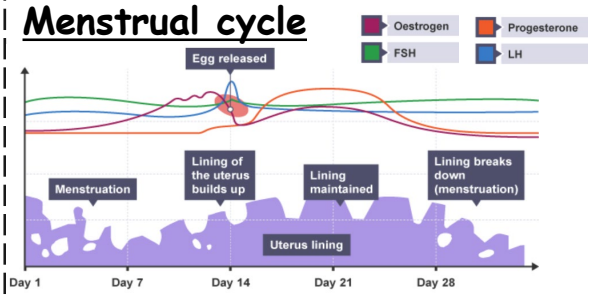
- Contains a **lot of cytoplasm** which has **nutrients** for the growth of the early embryo
- **Haploid nucleus** contains the genetic material for fertilisation
- Cell membrane **changes after fertilisation** by a single sperm so that **no more sperm** can enter

Fertilisation

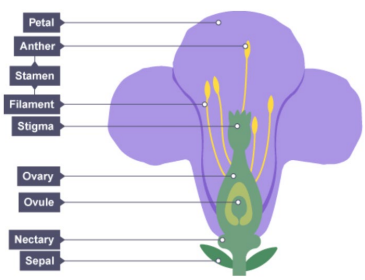
When the sperm and egg nuclei join, they form a ZYGOTE



Menstrual cycle

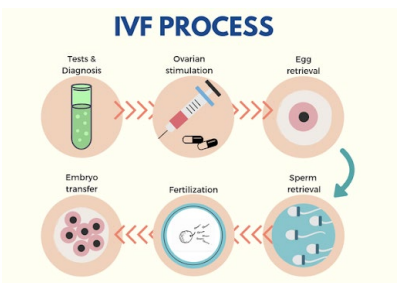


Plant structures



IVF

In Vitro Fertilisation is used to help people with fertility issues conceive



Equations for this topic

Ecology

Threshold Concept

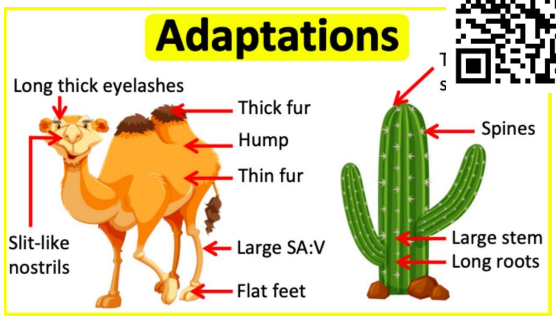
Understand that living things interact with the world around them

Keywords

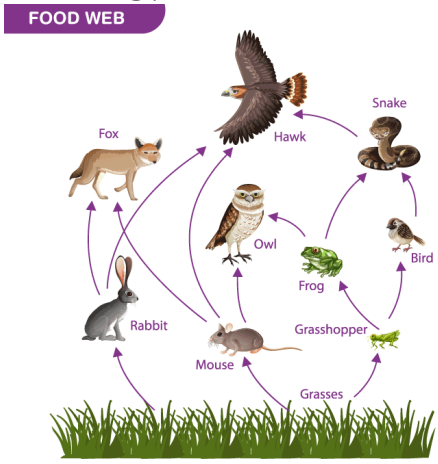
Living – Undertaking the seven processes of living things
Changes – structural, physiological and behavioural changes that allow species to compete
Animal – Living creature of one of seven domains
Plant – Living tissue that is a producer
Energy – The flow through all organisms and food chains

Different Habitat- An area where an organism is at home

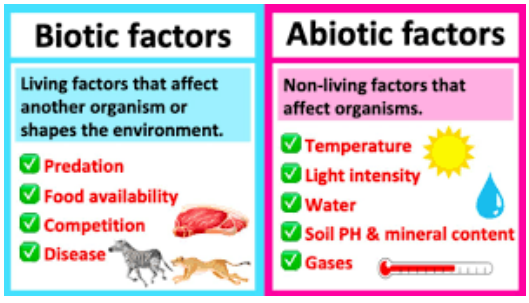
Adaptations



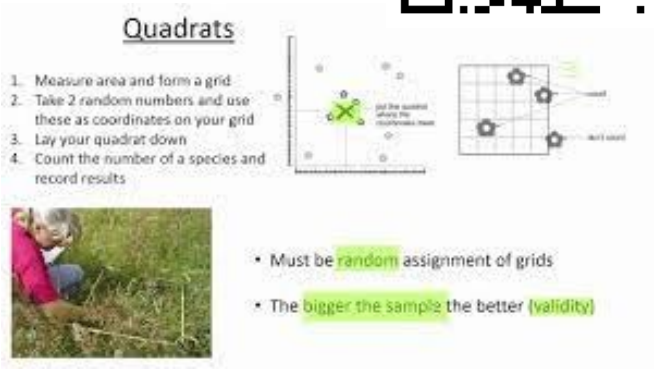
Food Chains/Webs – show the flow of energy



Abiotic and Biotic Factors



Required practical



Producers and Consumers

Equations for this topic

Organisation

Threshold Concept

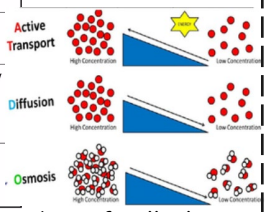
Understand the order of structures and relationships with an organism

Keywords

Organism – any living thing
Organelle – the small, organ-like structures found inside cells
Cell – the structures that make up all living things
Organ system – a group of organs that work together to perform a specific structure
Organ – a group of tissues working together for a specific function
Tissue – a group of cells working together for a shared function

Movement of substances

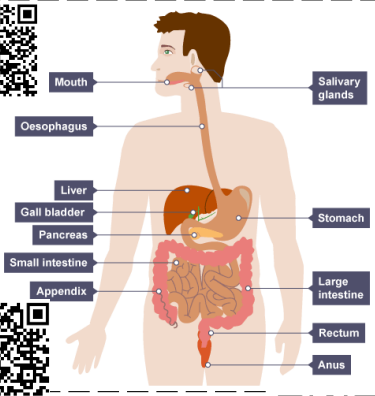
Process	Movement of	Condition	Additional requirements
Diffusion	Molecules/ ions	High conc. to low conc.	Down a conc. gradient
Osmosis	Water molecules	High water potential to low water potential	Across a partially permeable membrane
Active transport	Particles of substances	Low conc. to high conc.	Against a conc. Gradient; Energy required



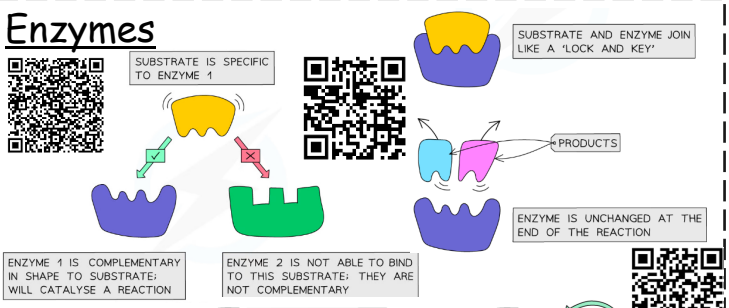
Diffusion –digestion, gas exchange, in/out of cells, liver
Osmosis – water in digestion, in/out of cells, plant roots
Active transport – ions in plant roots, glucose to intestine walls

Digestion

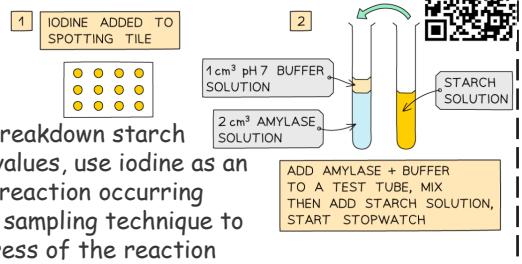
Digestion is the breaking down of the food we eat into other substances that our bodies can absorb and use. There are mechanical and chemical digestive processes.



Enzymes



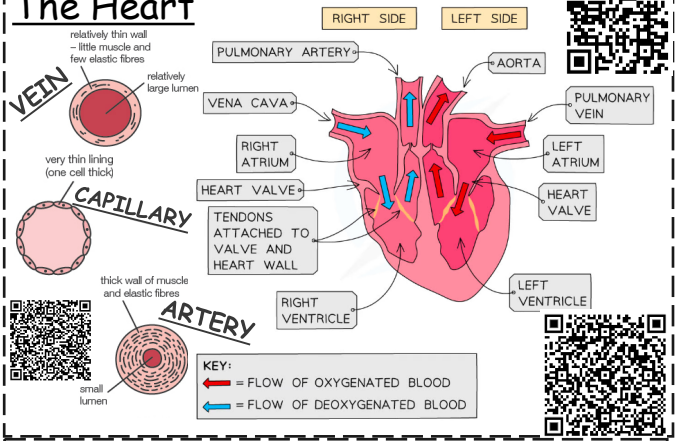
Required practical



- Use amylase to breakdown starch at a range of pH values, use iodine as an indicator for the reaction occurring
- Use a continuous sampling technique to monitor the progress of the reaction

ADD AMYLASE + BUFFER TO A TEST TUBE, MIX THEN ADD STARCH SOLUTION, START STOPWATCH

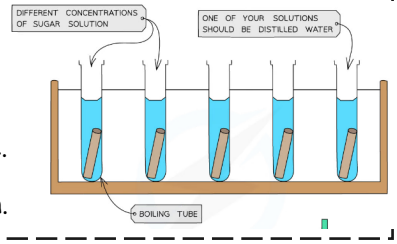
The Heart



Required practical – Osmosis

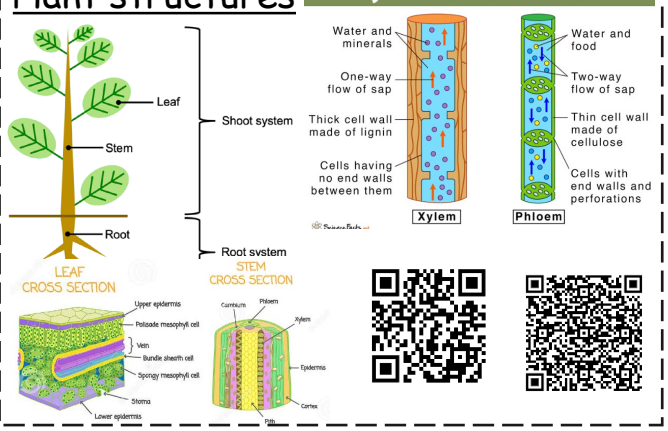
Variables

- **Independent** - concentration of sugar solution.
- **Dependent** - Change of mass of plant tissue
- **Controls**
  - Volume of plant tissue.
  - Surface area of plant tissue.
  - Length of time in solution.
  - Temperature of the solution.

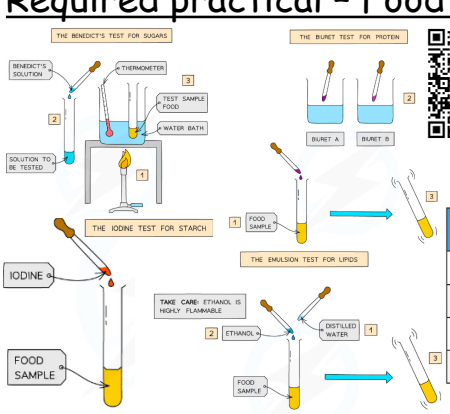


Plant structures

Xylem and Phloem



Required practical – Food tests



Food Test	Colour of reagent	Positive test result	Negative test result
Iodine for starch	orange–brown	blue–black	orange–brown (no change)
Benedict's for sugar	light blue	green to brick–red	light blue (no change)
Ethanol for lipid	colourless	cloudy emulsion	colourless (no change)
Biuret for protein	blue	lilac–purple	blue (no change)

Bioenergetics

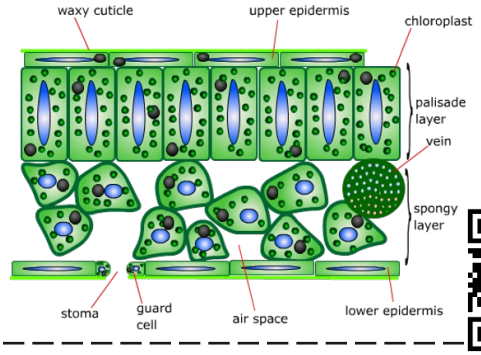
Threshold Concept

Respiration and photosynthesis are chemical processes that provide plants and animals with energy.

Keywords

- **Respiration:** Respiration is the body's way of producing energy from the food we eat. It involves the breakdown of glucose in the presence of oxygen into carbon dioxide and water with the release of energy-generating molecules called ATP.
- **Photosynthesis:** is a chemical reaction that takes place in the chloroplasts of green plant cells, where light energy is used to convert carbon dioxide and water into glucose and oxygen.
- **Energy:** The ability to do work
- **Limiting factors:** Limiting factors affect the rate of a reaction. A limiting factor is a condition, that when in shortage, slows down the rate of a reaction.
- **Reaction:** A chemical reaction is when one or more substances change and produce one or more new chemical substances.

Structure of the leaf



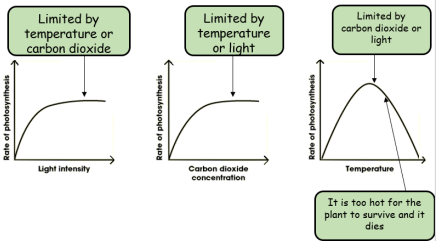
Respiration

GLUCOSE + OXYGEN ⟶ CARBON DIOXIDE + WATER

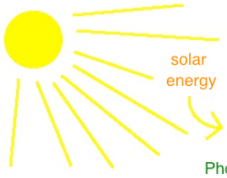
$C_6H_{12}O_6$ + $6O_2$ ⟶ $6CO_2$ + $6H_2O$

GLUCOSE ⟶ LACTIC ACID

Limiting factors of photosynthesis



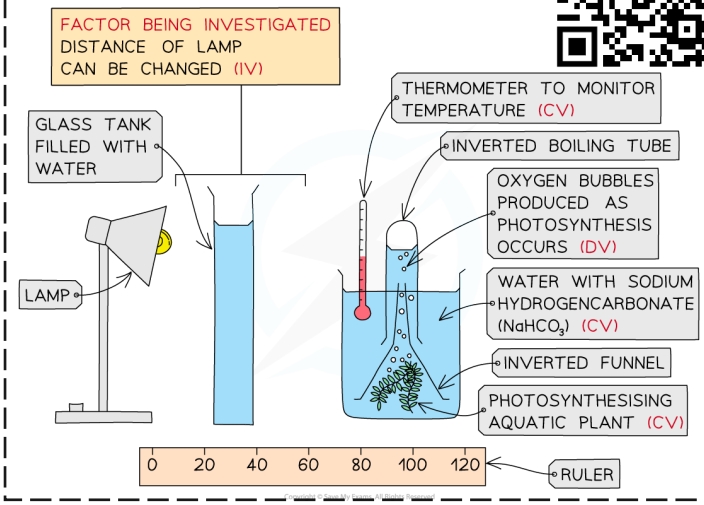
Photosynthesis



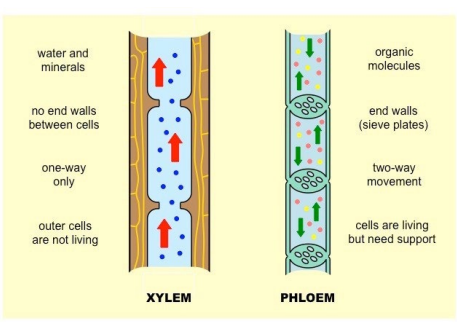
$6CO_2$ + $6H_2O$ → (Photosynthesis) $C_6H_{12}O_6$ + $6O_2$

carbon dioxide | water | glucose | oxygen

Required practical



Xylem and Phloem



Equations for this topic

$$\text{REACTION RATE} = \frac{\text{CHANGE IN MASS OF REACTANT OR PRODUCT}}{\text{TIME}}$$

Homeostasis

Threshold Concept

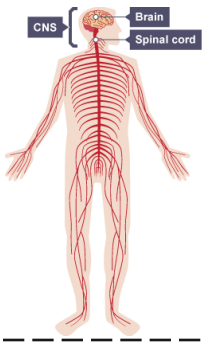
Homeostasis is organisms maintaining a constant internal environment

Keywords

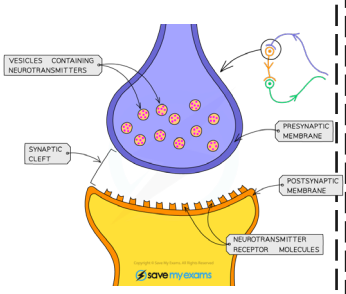
- **Nerves:** Specialised cells which carry electrical impulses
- **Hormones**: Chemical messenger produced in glands and carried by the blood to specific organs in the body.
- **Organism:** Living things that are capable of reacting to stimuli, reproduction, growth, and homeostasis.
- **Regulate**: control or maintain the rate or speed of a process so that it operates properly.
- **Response:** as a result of the stimulus that is detected by the receptor a response is caused

The nervous system:

- The central nervous system (CNS) – the brain and spinal cord.
- The peripheral nervous system – nerve cells that carry information to or from the CNS.



Synapse:



Body controls:

Homeostasis maintains optimal conditions for enzyme action throughout the body, as well as all cell functions.

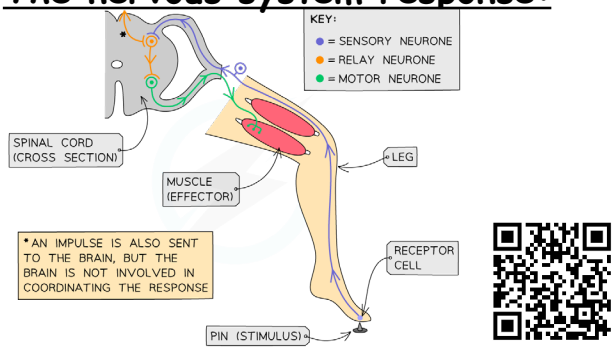
In the human body, these include the control of:

1. Blood glucose concentration
2. Body temperature
3. Water levels

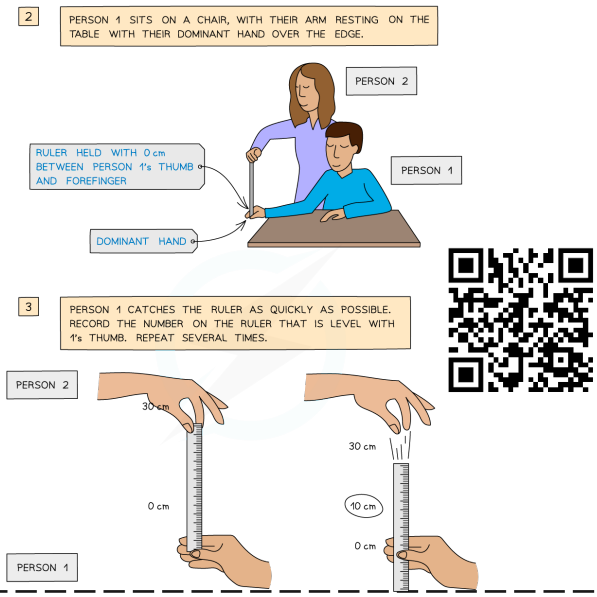
The menstrual cycle:

1. The menstrual cycle is the reproductive cycle in women, which starts with a period (menstruation), if the woman is not pregnant.
2. There are four hormones involved: follicle stimulating hormone, luteinising hormone, oestrogen & progesterone.
3. FSH (released by the pituitary gland) causes eggs to mature in the ovaries.
4. FSH stimulates ovaries to produce oestrogen.
5. Oestrogen inhibits further release of FSH and stimulates release of LH.
6. LH (released by the pituitary gland) stimulates the release of an egg (ovulation) from an ovary.
5. LH stimulates secretion of progesterone by the empty follicle.
6. Progesterone inhibits the release of LH and FSH.
7. Oestrogen and progesterone maintain the lining of the uterus.

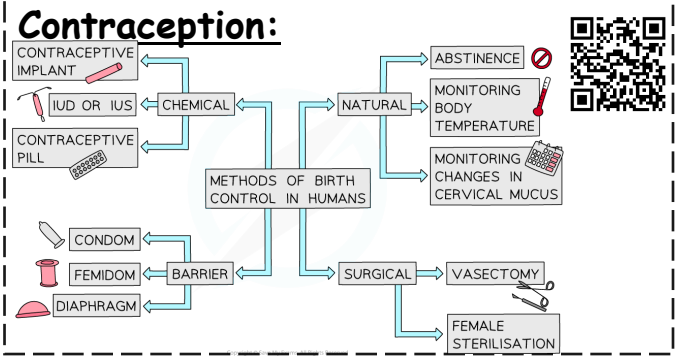
The nervous system response:



Required practical: Reaction time



Contraception:



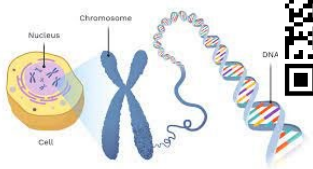
Equations for this topic

Inheritance

Threshold Concept

Organisms pass on their DNA in order to survive.

DNA

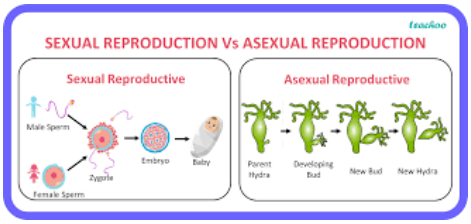


DNA is found in the nucleus of cells and contains all the genetic material to make the organism

Keywords

Cell……. The smallest unit that can live on its own and makes up all living organisms
Nucleus ……. The organelle inside cells that contains the cells genetic material
DNA……. The molecule inside cells that contains all the genetic information responsible for the development and function of an organism
Chromosomes……. A structure made up of proteins and DNA organised into genes inside the nucleus of a cell
Gene ……. Genes carry information that determine what characteristics are inherited from an organism's parents
Reproduction……. The production of offspring

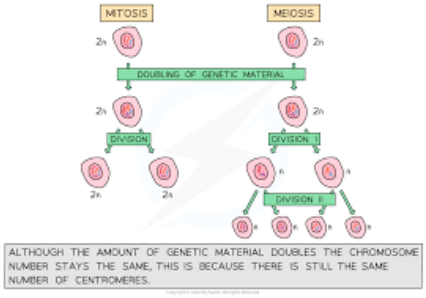
Sexual and asexual reproduction



There are two main forms of reproduction: sexual and asexual reproduction. In sexual reproduction, an organism combines the genetic information from each of its parents and is genetically unique. In asexual reproduction, one parent copies itself to form a genetically identical offspring

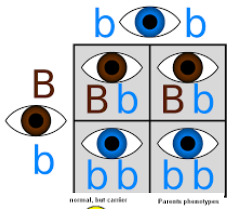
Mitosis / Meiosis

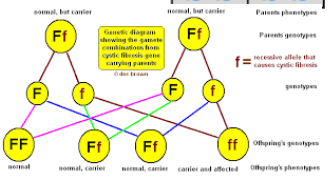
Mitosis is a form of cell division which produces two identical, diploid body cells. Meiosis is a form of cell division which produces four non-identical, haploid sex cells or gametes (sperm and ova in humans



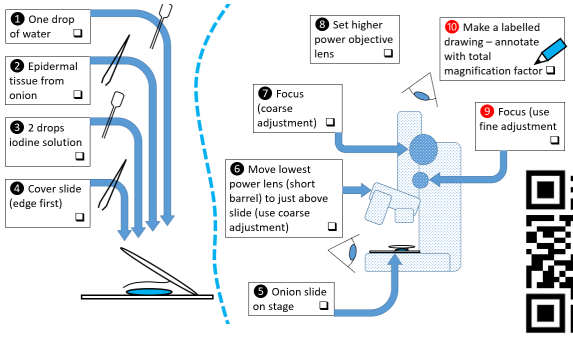
Genetic cross diagrams

Genetic crossing describes breeding two selected individuals so their offspring can be studied to understand how a particular trait is inherited down the generations.





Required Practical



Equations for this topic

Image size = actual size x magnification

Variation

Threshold Concept

All living things need to change to live.

Keywords

Variation……. any difference between the individuals in a species or groups of organisms of any species

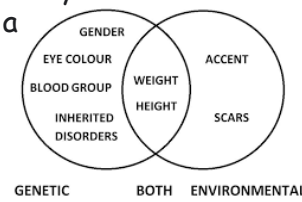
Evolution ……. the change in the characteristics of a species over several generations and relies on the process of natural selection

Adaptation……. the adjustment of organisms to their environment in order to improve their chances at survival in that environment

Natural Selection……. the process through which populations of living organisms adapt and change

Variation

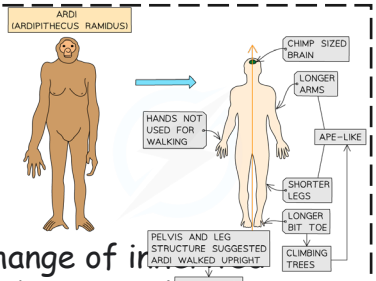
Individuals in a population are usually similar to each other, but not identical. Some of the variation within a species is genetic , some is environmental - the conditions in which they have developed and some is a combination of both



Natural Selection

In any environment, the individuals that have the best adaptive features are the ones most likely to survive and reproduce

Evolution

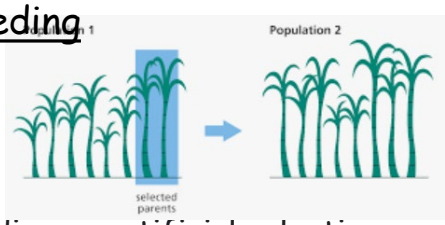


Evolution is the change of inherited characteristics within a population over time through natural selection, which may result in the formation of a new species

Five main processes that lead to evolution:

-mutation
-non-random mating
-gene flow
-finite population size (genetic drift)
-natural selection.

Selective Breeding



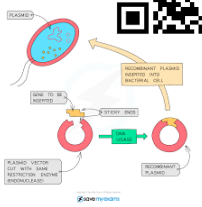
Selective breeding or artificial selection is when humans breed plants and animals for particular genetic characteristics. Humans have bred food crops from wild plants and domesticated animals for thousands of years

Fossils

A fossil is the preserved remains of a dead organism from millions of years ago. **Evidence for early forms of life comes from fossils**. By studying fossils, scientists can learn how much (or how little) organisms have changed as life developed on Earth

Genetic Engineering

Genetic engineering involves modifying the genome of an organism by introducing a gene from another organism to result in a desired characteristic



Required Practical

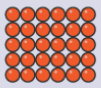
Equations for this topic

Foundations of chemistry

Threshold Concept

All matter is made of particles

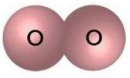
States of matter:

State	Solid	Liquid	Gas
Closeness of particles	Very close	Close	Far apart
Arrangement of particles	Regular pattern	Randomly arranged	Randomly arranged
Movement of particles	Vibrate around a fixed position	Move around each other	Move quickly in all directions
Energy of particles	Low energy	Greater energy	Highest energy
2D diagram			

Atoms and compounds:

Elements contain just **one type of** atom.

Oxygen (O_2)



Compounds contain **different types of** atom bonded together.

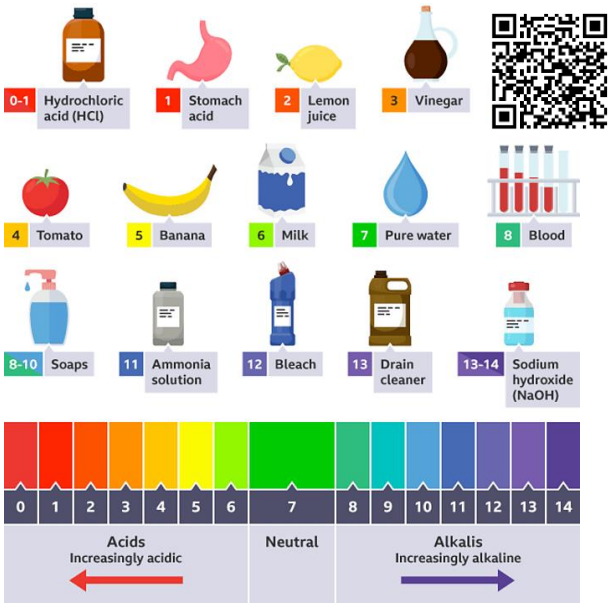
Carbon dioxide (CO_2)

Pure substances:

Pure substances are made from only one chemical element or one compound.

For example, salt is a pure substance made only of sodium chloride.

The pH scale:

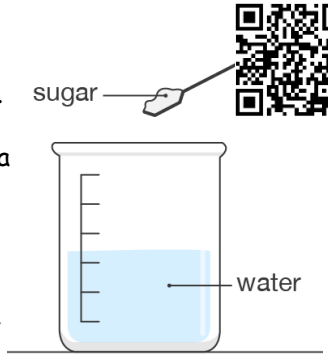


Keywords

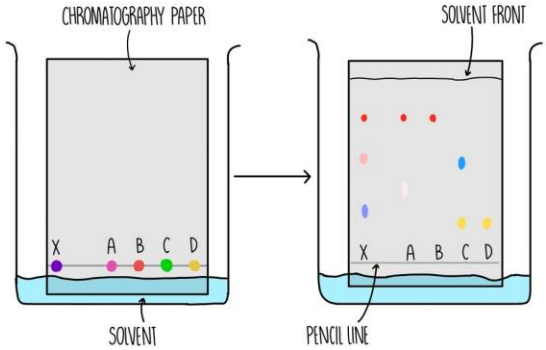
- **Particles:** The tiny things that all materials are made from. The smallest unit of matter.
- **Atom:** Atoms are the building blocks of all matter. Everything is made of atoms - even yourself. They are the smallest particle of an element, which are far too small to see.
- **Solid:** Have a fixed shape and cannot flow, because their particles cannot move from place to place, cannot be compressed (squashed), because their particles are close together and have no space to move into.
- **Liquid:** Flow and take the shape of their container, because their particles can move around each other, cannot be compressed, because their particles are close together and have no space to move into
- **Gas:** Flow and completely fill their container, because their particles can move quickly in all directions, can be compressed, because their particles are far apart and have space to move into

Solubility:

- Some solids dissolve in water to make a solution.
- These solids are soluble.
- A solution is made from a solute (usually a solid) and a solvent (liquid).
- Some gases, such as oxygen and carbon dioxide, can also dissolve in water.



Required practical: Chromatography



Equations for this topic:

$$R_f \text{ value} = \frac{\text{distance travelled by substance } (B)}{\text{distance travelled by solvent } (A)}$$

Periodic Table

Threshold Concept

All elements fit within the Periodic Table

Link to information on most of the topic, consisting of slides, videos, and quizzes

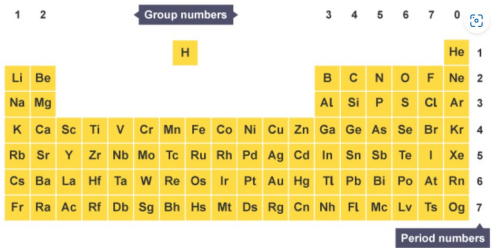
Keywords

Elements - a substance that cannot be broken down into any other substance.
Periodic Table - a table showing every element that is known to exist.
Symbol - a sign/letter/character that is used to represent something

Periodic Table & Developing the Periodic Table

Task 1 & 2

Mendeleev redesigned Newlands periodic table by organising the periodic table by atomic weights and the properties of the elements. Some gaps were left based on his predictions of other elements that hadn't been discovered yet.
As more elements were found, the modern periodic table took from organised by atomic number.



RAM & Isotopes

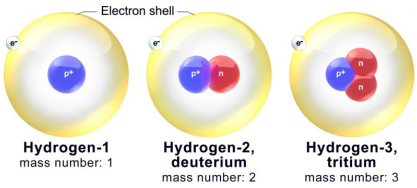
Task 10

RAM

Isotopes

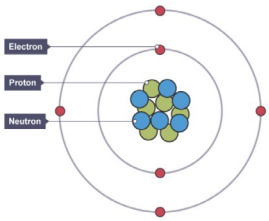
Atoms of the same element must have the same number of **protons**, but they can have different numbers of **neutrons**. Atoms of the same element with different numbers of neutrons are called **isotopes**. Isotopes of an element have:

- the same **atomic number**
- different **mass numbers**



Atomic Structure

Task 8

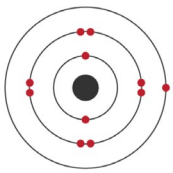


Subatomic particle	Relative mass	Relative charge
Proton	1	+1
Neutron	1	0
Electron	Very small	-1

Electronic Configuration

Task 9

Example, using an atom of sodium



No. of electrons per shell
1st shell: up to 2
2nd shell: up to 8
3rd shell: up to 8
etc

Group 1 – Alkali Metals

Task 4

1

Li
Na
K
Rb
Cs
Fr

All share similar properties:
- Are soft (can be cut)
- Have relatively low MP
- Have low densities

The further down the group you go, the more reactive the elements become.
- They will react will air and tarnish quite quickly.
- They will react with water to produce an alkaline solution (hence the name) and turn universal indicator blue/purple

Group 7 - Halogens

Task 5

7

F
Cl
Br
I
At
Ts

All have 7 electrons in outer shell.
All diatomic (made up of two atoms bonded together.

The further down the group you go, the less reactive the elements become.
The further down the group you go, the higher its MP and BP, because:
- Molecules become larger
- Intermolecular forces become stronger
- More energy is needed to overcome these forces

Group 0 – Noble Gases

Task 3

0

He
Ne
Ar
Kr
Xe
Rn
Og

All have full outer shells.
All unreactive (inert).

All have low boiling points. Lower down the group, the higher it gets.
This is because, going down the group:
- Atoms become larger
- Intermolecular forces between atoms become stronger
- More energy is needed to overcome these forces

Metals

Threshold Concept

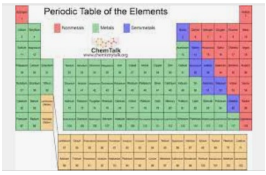
Identify most metals have similar properties

Keywords

Metal…… DEFINITION
Non metal ……. DEFINITION
Property ……. a characteristic of a particular substance
Reaction ……. a process that leads to the change of one set of chemical substances into another
Alloy ……. a mixture of two or more metals, or a metal and a non-metal
Displacement ……. A more reactive metal will displace a less reactive metal from its compound.

Metals and non metals

Most elements on the periodic table are metals. They are grouped together in the middle to the left-hand side of the periodic table.
Non metals are on the right-hand side.

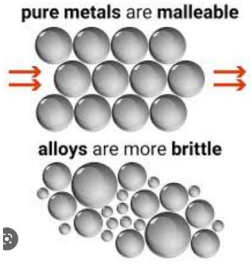


Physical properties of metals

Properties	Metals	Non-metals
Appearance	Shiny	Dull
Hardness	Very hard or hard	
Malleability	Malleable	Non
Ductility	Ductile	No
Heat conduction	Good conductor	Bad
Conduction of electricity	Good conductor	Bad
State	Solid	Solids
Density	Higher	

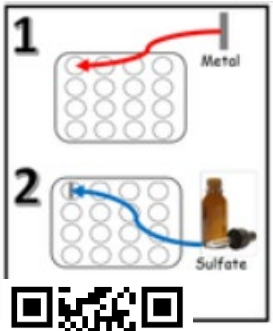
Metals and alloys

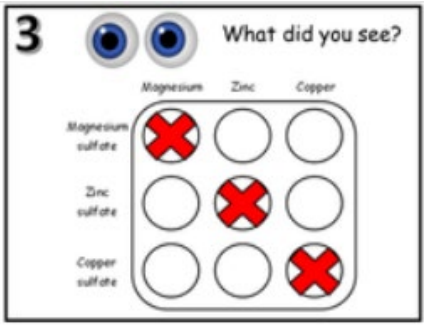
Making alloys changes the metals properties by changing its structure. Alloying is done for many reasons, typically to increase strength, increase corrosion resistance, or reduce costs



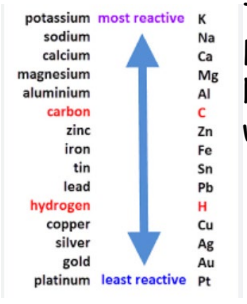
Chemical properties of metals

Practical





The reactivity series



The Reactivity Series lists metals in order how easily they react with other substances

Equations for this topic

Metal + acid → salt + hydrogen
Metal + oxygen → Metal oxide
Metal + water → Metal hydroxide + hydrogen

Rock Cycle

Threshold Concept

Understand that rocks change within 3 types over time.

Types of rocks

Sedimentary rocks

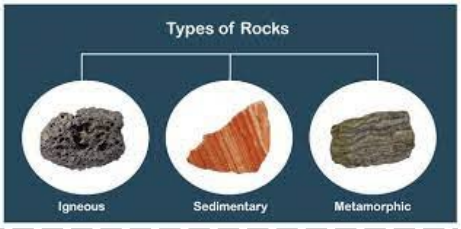
Sedimentary rocks are formed from sediments that have settled at the bottom of a lake, sea or ocean, and have been compressed over millions of years.

Metamorphic rocks

Metamorphic rocks are formed from other rocks which change due to **heat** or **pressure**.

Igneous rocks

Igneous rocks are formed from molten (liquid) rock that has cooled and solidified.



Types of weathering

1. Biological weathering

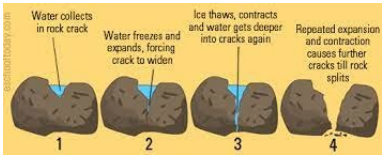
This describes rocks being broken up by the roots of plants, or animals burrowing into them.

2. Chemical weathering

This describes rocks being broken up because substances in rainwater, rivers and seawater or the air, react with the calcium carbonate $CaCO_3$ in the rocks.

3. Physical weathering

This describes rocks being broken up by changes in temperature, freezing and thawing of trapped water or the action of waves and rivers.



Keywords

- **Rock:** The solid mineral material forming part of the surface of the earth and other similar planets, exposed on the surface or underlying the soil.

- **Earth:** The planet on which we live; the world.

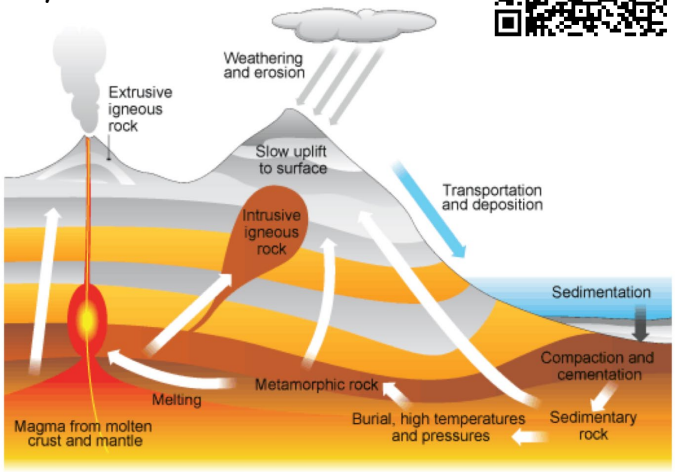
- **Cycle:** Move in or follow a regularly repeated sequence of events.

- **Temperature:** The degree or intensity of heat present in a substance or object.

- **Pressure:** Continuous physical force exerted on or against an object by something in contact with it.

The rock cycle

Rocks on earth do not always stay the same.



Rocks are continually changing due to processes such as, weathering, erosion and large earth movements. The rocks are gradually recycled over millions of years, changing between the different rock types.

Required practical

Equations for this topic

Chemistry of the atmosphere

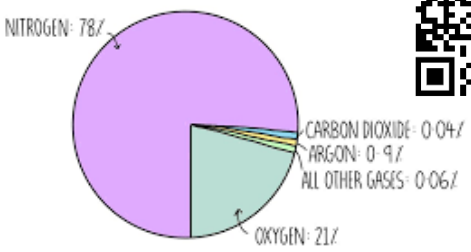
Threshold Concept

The Earth's atmosphere is made of different gases.

Keywords

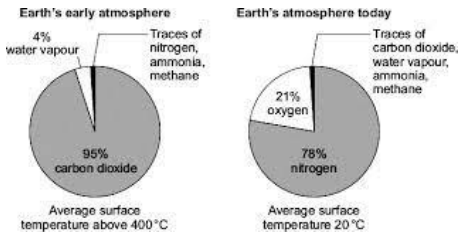
- **Atmosphere**: An atmosphere is the layers of gases surrounding a planet.
- **Pollutants**: A pollutant is a chemical. or biological substance which harms water, air, or land quality.
- **Climate change**: Climate change refers to long-term shifts in temperatures and weather patterns.
- **Combustion**: Combustion is another name for burning. In a combustion reaction, fuel is burned and reacts with oxygen to release energy.
- **Global Warming**: Global warming is the long-term warming of the planet's overall temperature.

The Proportion of gases in the earths atmosphere



History of the earths atmosphere

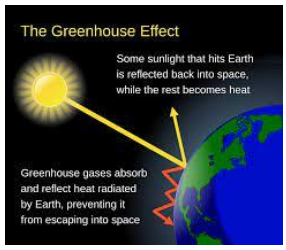
- The proportion of oxygen increased because of **photosynthesis** by plants and algae.
- The proportion of ammonia decreased as it reacted with the newly formed oxygen in the atmosphere to form nitrogen and water vapour.
- The proportion of methane decreased as it reacted with the newly formed oxygen to form carbon dioxide and water.



Greenhouse gases

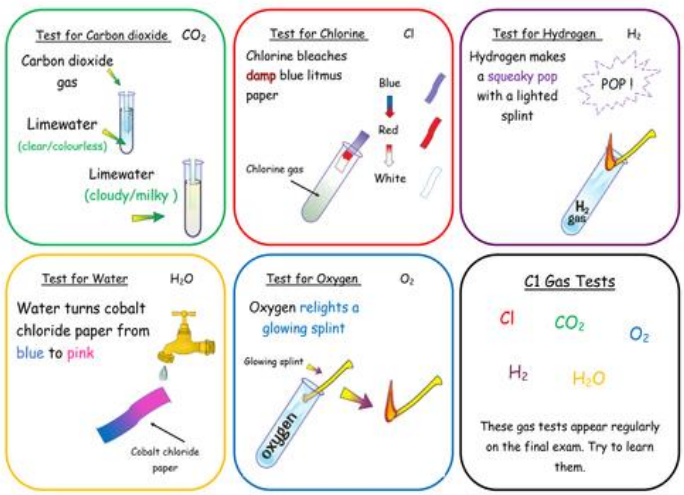
Greenhouse gases present in the atmosphere include:

- water vapour
- carbon dioxide
- methane



Required practical

Testing for gases



Combustion

Complete combustion:

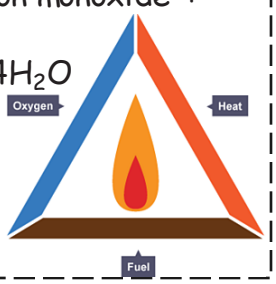
Propane + oxygen → carbon dioxide + water

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

Incomplete combustion:

Propane + oxygen → carbon monoxide + carbon + water

$C_3H_8 + 3O_2 \rightarrow 2CO + C + 4H_2O$



Equations for this topic

Bonding Part 2

Threshold Concept

How do 100 elements make up everything in the universe?

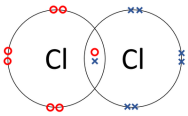
Keywords

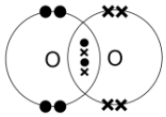
Electron - a subatomic particle with a negative charge
Electrostatic attraction - strong attraction between oppositely charged ions
Weak intermolecular forces - force of attraction between atoms, elements and molecules
Delocalised electron - free moving electron that isn't a part of any atom
Ion – a charged particle

Covalent bonds

Two non-metals will form a covalent bond. The atoms share electrons to make themselves stable.

Cl — Cl





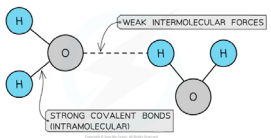
O=O

- 1 shared pair = a single bond
- 2 shared pairs = a double bond
- 3 shared pairs = a triple bond

Simple Covalent compounds

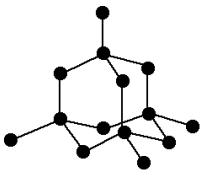
Simple covalent compounds have strong covalent bonds between atoms and weak intermolecular forces between molecules.

Properties – low m.p and b.p
- cannot conduct electricity

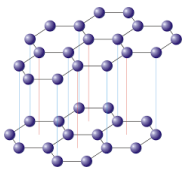


Giant Covalent Structures

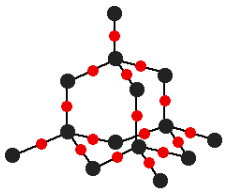
Diamond



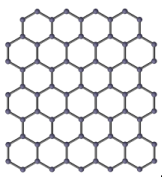
Graphite



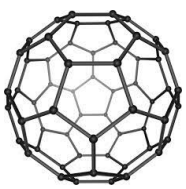
Silicon dioxide



Graphene

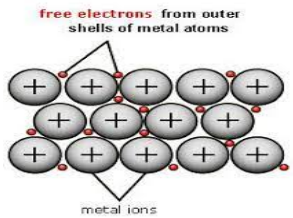


Fullerenes

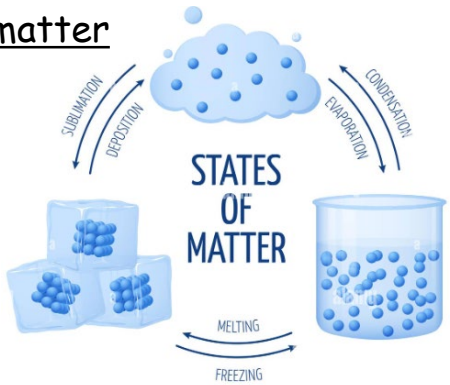


Metallic bonding

Metals consist of a giant metallic structure. They are positive metal ions surrounded by a sea of delocalised electrons

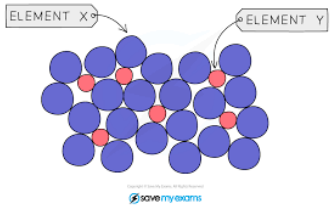


States of matter



Alloys

Alloys are a mixture of metals and another element.
Alloys are stronger than metals as the different sized atoms distort the layers



Rates of Reaction

Threshold Concept

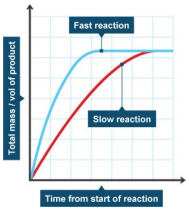
All particles must collide with a minimum amount of energy in order to react

Keywords

Particle - A particle is the smallest possible unit of matter
Energy - Energy is what holds the atoms in a molecule together
Collision - If the two molecules A and B are to react, they must get close enough to break and make the new bonds that are needed in the products
Reactant - A substance put into a chemical reaction
Product - A substance made in a chemical reaction

Rate of reaction

Rate of reaction is how fast reactants are changed into products



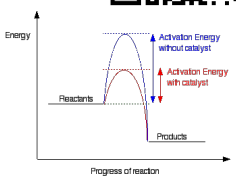
Collision theory and activation energy

The rate of reaction is directly proportional to the number of successful collisions.

- **To react**: particles must first **collide**
- with enough **activation energy** to be successful.

Catalysts

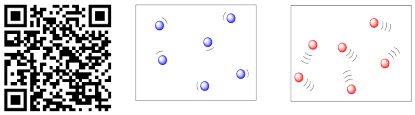
- Catalysts: increase the rate of a reaction without getting used up.
- Catalysts decrease the activation energy required to begin the reaction.
- Catalysts are often used in industry to speed up chemical processes.



Factors affecting rate of reaction

Effect of Temperature:

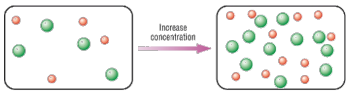
- Increasing the temperature increases the speed that particles are moving
- This means there are more frequent collisions, and those collisions have more energy



Video of all

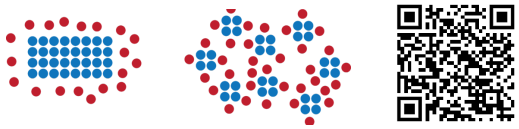
Effect of Concentration:

- Increasing concentration increases the number of reacting particles.
- This increases the frequency of collisions



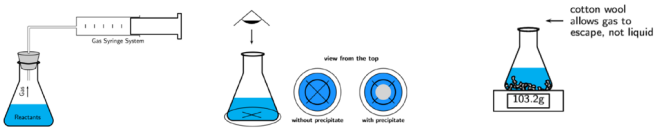
Effect of Surface Area:

- Increasing the surface area increases the proportion of (solid) particles available to react.
- This increases the frequency of collisions.



Measuring rate of reaction

- There are various ways to measure quantity of reactant used or quantity of product formed. Measuring the volume of gas collected can be the easiest way to measure.

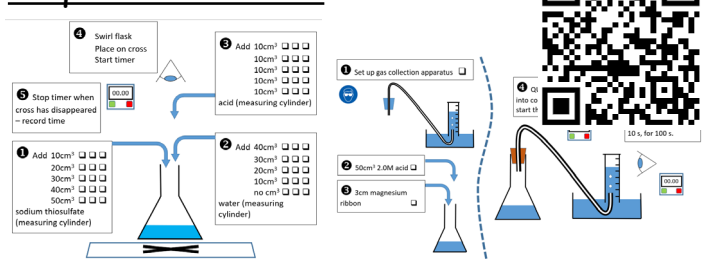


- The units of rate depend on what you are measuring. For example, when measuring gas in cm^3 you will end up with rate units of cm^3/s. When measuring the change in mass (g), you will end up with units of g/s

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

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

Required Practical



Equations for this topic

Using Resources

Threshold Concept

Understand how to reduce, re-use and recycle the Earth's resources.

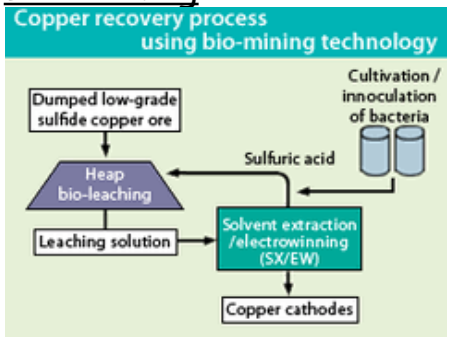
Resources and sustainability

Reducing doesn't just reduce the use of that specific material, but also reduces the use of any materials used to manufacture it in the first place.

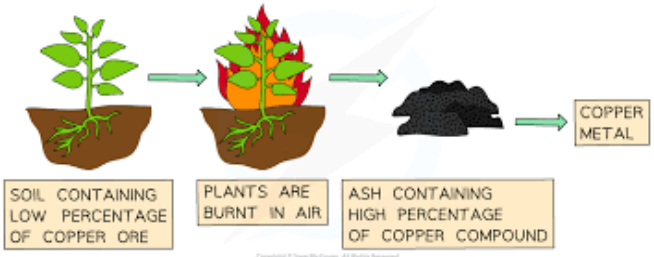
Keywords

Reduce – using materials/resources less
Reuse – using materials/resources again
Recycle – converting waste into reusable material
Renewable – when a resource is produced at least at the same rate that it is being used
Non-renewable – when a resource is being used at a faster rate than it can be made
Sustainable – fulfilling the needs of the current generation without compromising the needs of future generations

Bioleaching

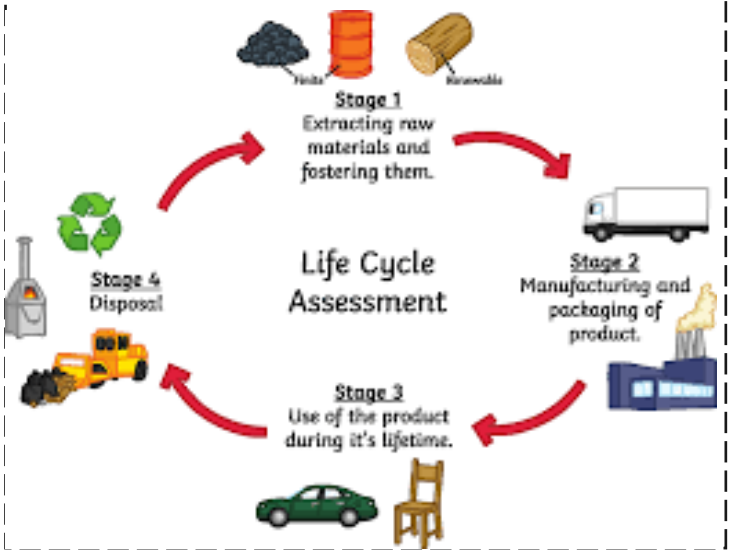


Phytomining



Life Cycle Assessments

A 'cradle to grave' analysis of the impact of a manufactured product on the environment.

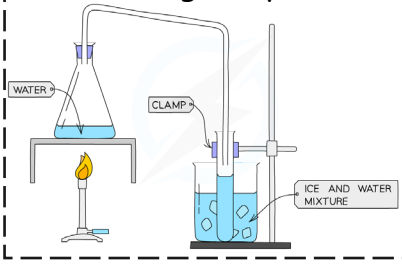


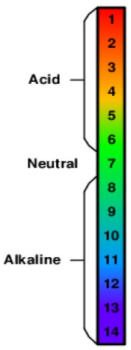
Potable Water (inc Required Practical)

Don't forget to click on the worksheet tab to try some tasks.

Required Practical involves:

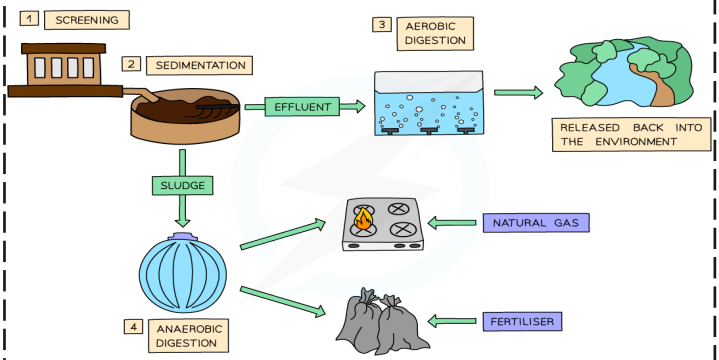
- pH testing using a pH meter, then neutralisation using titration, if needed.
- Ion testing (flame testing)
- Distillation
- Retesting for pH and ions.





Waste Water Treatment

Don't forget to click on the exam questions tab to try some tasks.



Chemical analysis Triple

Threshold Concept

What other organic compounds are made out of?

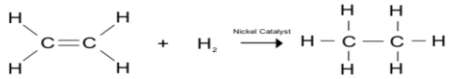
Keywords

Functional group – a group of atoms that are responsible for how a compound reacts
Homologous series – a group of compounds that share a functional group and react similarly
Alcohol – a group of compounds with the functional group OH
Carboxylic acids – a group of compounds with the functional group COOH
Esters – a group of compounds with the functional group COO

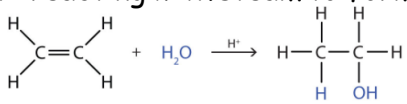
Reactions of Alkenes

Alkenes will go through a number of different addition reactions to form new products.

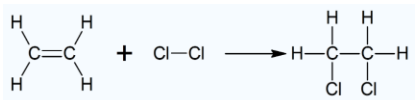
Hydrogenation – reacting with hydrogen to form alkanes



Hydration – reacting with steam to form alcohols

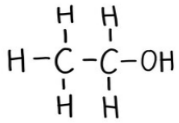


Halogenation – reacting with halogens to form a haloalkane



Alcohols

Alcohols are a group of compounds with the functional group is OH.
The general formula is $C_nH_{2n+1}OH$



Ethanol

Uses:
- Alcoholic drinks
- Solvents
- Fuels

Fermentation

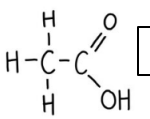
Ethanol can be produced by fermentation.
Glucose is converted into ethanol using enzymes in yeast.

glucose $\xrightarrow{yeast}$ ethanol + carbon dioxide

$C_6H_{12}O_{6(aq)} \xrightarrow{yeast} 2C_2H_5OH_{(aq)} + 2CO_{2(aq)}$

Carboxylic acids

Carboxylic acids are weak acids with the functional group COOH.



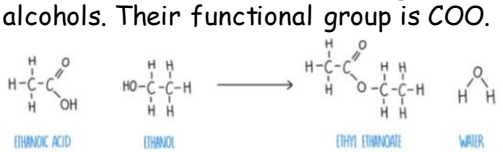
Ethanoic acid

Carboxylic acids behave like other acids and react with metals/metal compounds to form salts.

CARBOXYLIC ACID + METAL ⟶ SALT + HYDROGEN

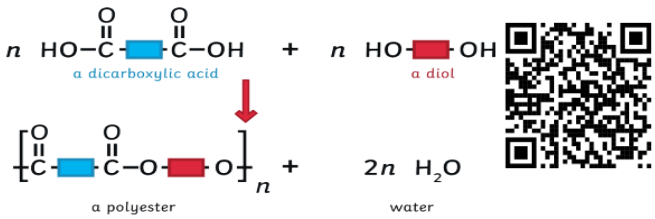
ETHANOIC ACID + CALCIUM ⟶ CALCIUM ETHANOATE + HYDROGEN

Esters are formed from reacting carboxylic acids and alcohols. Their functional group is COO.



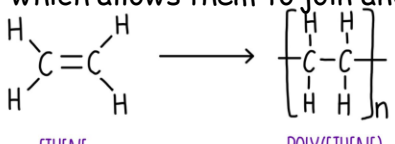
Condensation polymerisation

Condensation polymerisation requires 2 monomers; a diol and a dicarboxylic acid.
Water is always a by-product of this type of polymerisation.



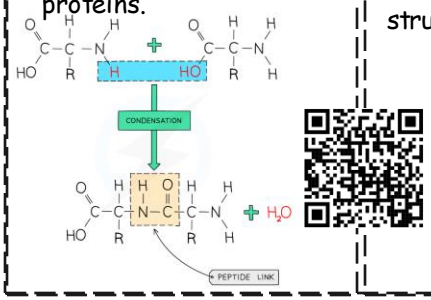
Addition polymerisation

Addition polymerisation involves breaking the carbon-carbon double bond of the monomer which allows them to join and form a polymer.

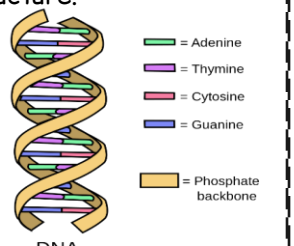


Naturally occurring polymers

Amino acids can join to form a polypeptide. These long chains form proteins.



DNA is a large natural polymer. It's monomers are called nucleotides and the form a double helix structure.



Organic Chemistry

Threshold Concept

Hydrocarbons are chains of hydrogen and carbon

Keywords

Hydrogen - a non-metallic element that is the simplest and lightest of the elements
Carbon - a non metallic chemical element with atomic number 6
Formula - a chemical formula is a way of presenting information about the chemical proportions of atoms that make up a particular chemical compound or molecule
Equation - A word or symbol representation of a reaction.

Crude oil and hydrocarbons

Crude oil is a fossil fuel. It's formed from the remains of plants and animals, mainly plankton, that died millions of years ago.

- It is a non-renewable fuel; one day it will run out.
- Crude oil is a mixture of lots of different hydrocarbons,
- Hydrocarbons are the simplest organic compounds.

There are two types of hydrocarbon:

- Alkane
- Alkene

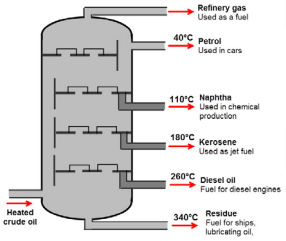
Hydrocarbon properties changes as the chain gets longer.

The shorter the chain the:

1. Less viscous the substance is (this means they are more runny)
2. More volatile the substance is (this means they have a lower boiling point)
3. More flammable the substance is (this means they are easier to ignite)

Fractional distillation

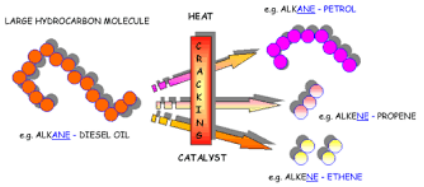
Crude oil can be used to make thousands of useful things but first the different 'fractions' need to be separated out. This is done by fractional distillation.



Video

Method and uses

Cracking



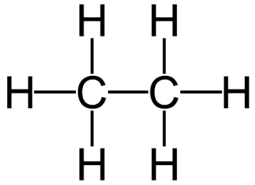
- This is the process of breaking long chain hydrocarbons down into shorter ones.
- Shorter chains are more flammable and therefore make better fuels.
- Cracking will produce alkanes and alkenes.

Alkanes

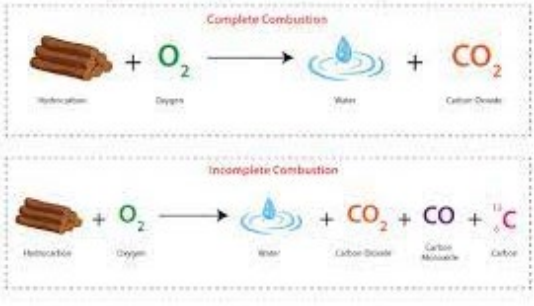
Contain only single c-c bonds.

Have the general formulc C_nH_{2n+2}

Are 'saturated' – each carbon forms 4 single covalent bonds.

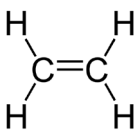


Combustion

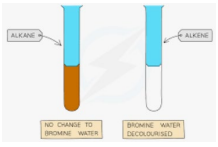


Alkenes

- An alkene will contain at leas one c=c double bond.
- Have the general formula C_nH_{2n}.
- Are 'unsaturated'.



Bromine water is used to test for alkenes.



Required Practical

Equations for this topic

Quantitative chemistry

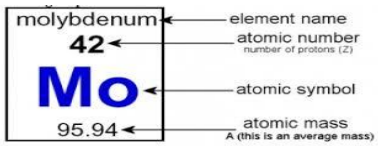
Threshold Concept

To understand that total mass of reactants equals total mass of products

Keywords

Conservation – the mass of the reactants must equal the mass of the products in a chemical reaction
Formula mass – the combined mass numbers of an element or compound
Concentration – the amount of substance dissolved in a solution
Equation – symbol representation of a chemical reaction
Loss – the process of losing something
Gain – the process of gaining something

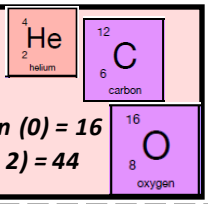
RFM



RAM is atomic mass of an element

RFM is the combination of all elements **Ar** in a compound or Molecule

Work example
Helium (He) Ar = 4
Carbon dioxide = CO_2
Carbon (C) = 12 Oxygen (0) = 16
Mr of CO_2 = 12 + (16 x 2) = 44



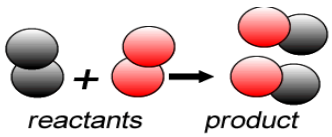
Balancing Equations

As the same number of elements are at the start and the end of reactions. The Equation needs to be balanced.

$Mg + O_2 \rightarrow MgO$ **(Unbalanced)**

2$Mg + O_2 \rightarrow$ **2**MgO **(Balanced)**

Conservation of Mass



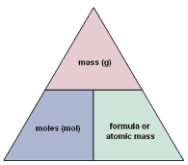
The reactants mass must always equal the mass of the products

2g + 2g —> 4g

We can not destroy atoms.

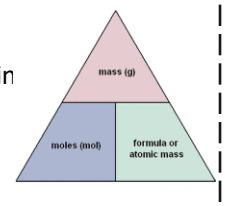
Moles

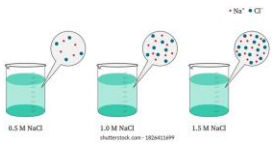
Chemical amounts are measured in moles. One mole of a substance contains **6.02×10^{23} particles (Avagadro's number)**



Concentration

Concentration is the amount of substance in a certain volume of solution (g/dm3)





Percentage by mass

The amount of an element in a compound is called its percentage composition. It can be calculated using the mass of the given element in the compound and the **RFM** of the Compound.

$$\text{Mass \%} = \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100\%$$

Limiting reactions

The reactant that gets used up first in a reaction is called the limiting reactant. This reactant is not in EXCESS

Reacting masses

The mass of a product or reactant can be determined from having a balanced symbol equation. Once balanced, the equation tells you how many moles of each substance react with each other : Mg + **2**HCl —> **$MgCl_2$ + H_2** **(Balanced)**

This equation states that: 1 : Mg 2 : HCl to form 1 : $MgCl_2$ 1 : H_2

Using the formula and moles you can use this information to work out how much product you will make

Making salts

Threshold Concept

How do metals and acids react to make salts and water

Keywords

Reactivity – the ability for an atom or molecule to undergo a chemical reaction
Salt – a substance made of positive and negative ions
Sulphuric acid – an acid that contains sulphate ions
Nitric acid – an acid that contains nitrate ions
Hydrochloric acid – an acid that contains chloride
Balanced – equal on both sides
Symbol equation – a chemical equation using chemical symbols
Acidic – a solution that contains H^+ ions
Alkaline – a solution that contains OH^- ions

Neutralisation

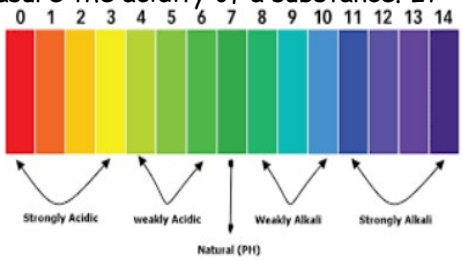
When an acid and alkali react they form neutral product water.
The H+ ions from the acid react with the OH- ions from the alkali to form water.
This can be represented using the following ionic equation:

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

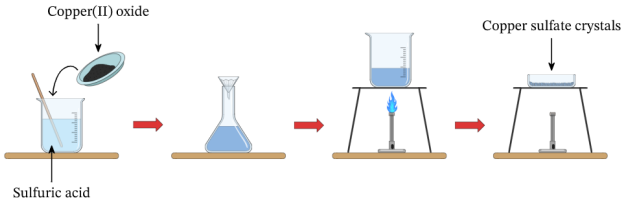
The pH scale

Acids contain H^+ ion and alkalis contain OH^- ions. The pH scale is used to measure the acidity of a substance. It ranges from 0-14.

Acidic = pH < 7
Neutral = pH 7
Alkaline = pH > 7



Making salts required pract



$$CuO(s) + H_2SO_4(aq) \longrightarrow CuSO_4(aq) + H_2O(l)$$

Reactions of acids

Acids react with metals, alkalis and carbonates to form a salt and either hydrogen, water or water and carbon dioxide. Each acid forms a different salt.

Acid Used	Salt Produced
hydrochloric	chloride
nitric	nitrate
sulfuric	sulfate

acid + metal → salt + hydrogen

hydrochloric acid + zinc → zinc chloride + hydrogen

$2HCl + Zn \rightarrow ZnCl_2 + H_2$

acid + alkali → salt + water

nitric acid + sodium hydroxide → sodium nitrate + water

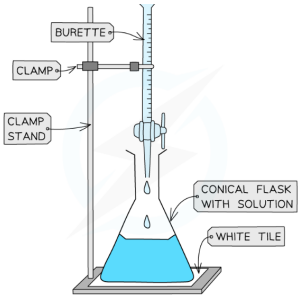
$HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$

acid + carbonate → salt + water + carbon dioxide

sulfuric acid + zinc oxide → zinc sulfate + water

$H_2SO_4 + ZnO \rightarrow ZnSO_4 + H_2O$

Titration req prac (triple)



Redox reactions (higher tier)

Redox reactions are when oxidation and reduction (in terms of electron transfer) take place at the same time.

For example:

$2H^+ + Ca \longrightarrow Ca^{2+} + H_2$

The ionic equation can be further split into two half equations.

$Ca \longrightarrow Ca^{2+} + 2e^-$

Oxidation is loss of electrons.

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

Reduction is gaining of electrons.

Strong and weak acids

Strong acids are acids that fully ionise in water

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

Weak acids are acids that partially ionise in water

$$CH_3COOH \rightleftharpoons H^+ + CH_3COO^-$$

Electrolysis

Threshold Concept

Know ionic compounds can be split into separate elements

Keywords

Compound……. a substance made from two or more different elements that have been chemically joined

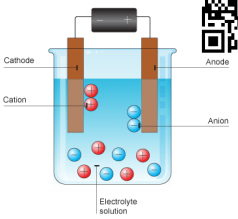
Ionic……. an atom or small group of atoms that has an electrical charge because it has added or lost one or more electrons

Electrolysis ……. a process that uses the power of electricity to split elements and compounds into their ions

Molten ……. **melted or made liquid by being heated to very high temperatures**

Aqueous ……. Dissolved in water

Electrolysis

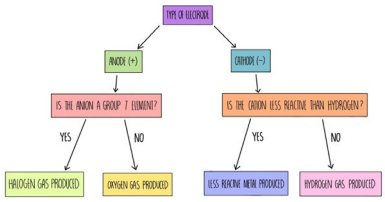


Electrolysis uses electricity to break down ionic compounds that are made up of positive and negative ions

When using electrolysis to extract metals, the metal needs to be melted or dissolved.

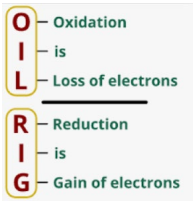
Positive ions in the electrolyte move towards the cathode, gain electrons and are reduced to form an uncharged element.
Negative ions move towards the anode, lose electrons and are oxidised.

Rules at the electrodes



Oxidation and reduction

- Oxidation means gain of oxygen. Reduction means loss of oxygen.
- When we are referring to electrons, we refer to them as redox reactions.
- This is where electrons are lost or gained.
- A redox reaction is where **RED**uction and **OX**idation happen at the same time.



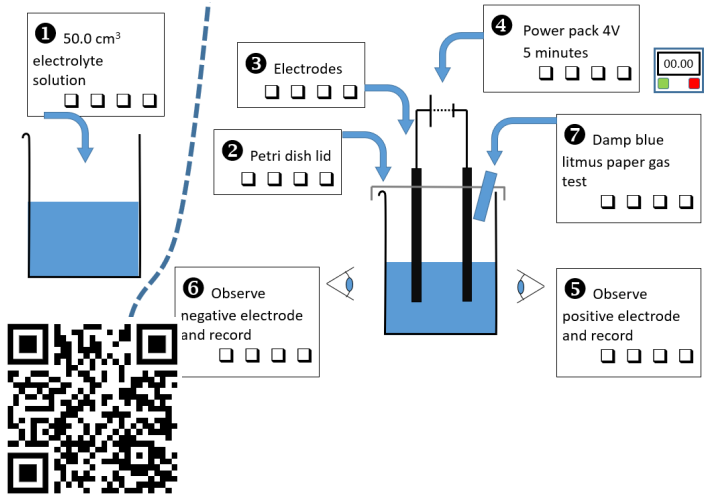
Half equations

A half equation is used to represent the reaction that happens at an electrode during electrolysis. It shows what happens when ions gain or lose electrons

REDUCTION AT THE CATHODE:
GENERAL EQUATION: $X^+ + e^- \longrightarrow X$
EXAMPLE: $2H^+ + 2e^- \longrightarrow H_2$

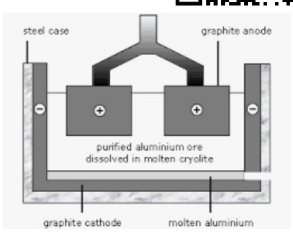
OXIDATION AT THE ANODE:
GENERAL EQUATION: $X^- \longrightarrow X + e^-$
EXAMPLE: $2Cl^- \longrightarrow Cl_2 + 2e^-$

Required Practical



Extraction of metals

Metals higher than carbon on the reactivity series need to be extracted using electrolysis. For example aluminium needs to be extracted from it's ore, bauxite, using electrolysis



Equations for this topic

Energy changes

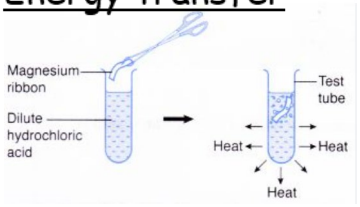
Threshold Concept

Know that reactions absorb or release energy

Keywords

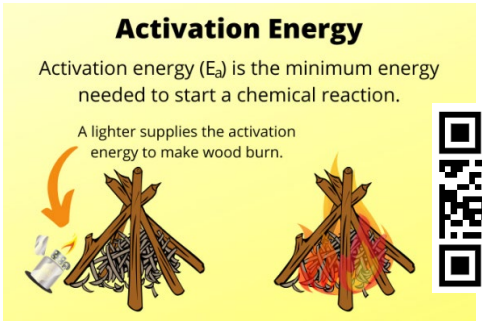
Energy……. Energy is stored in the bonds of chemical compounds, that is absorbed or released in chemical reactions
Bond……. an attraction between atoms or ions and allows for the formation of compounds or molecules
Activation energy ……. The minimum amount of energy required to start a reaction and turn a reactant into a product
Energy change……. The energy absorbed or released when bonds are made or broken
Reaction profile ……. A diagram that shows the energy changes in a reaction.
.

Energy transfer

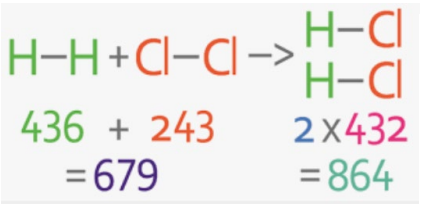


During a chemical reaction, energy is transferred to or from the surroundings

Activation energy



Bond energy

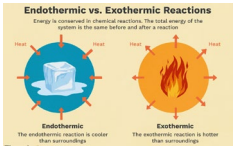


Bond	Bond energy (kJ/mole)
H–H	436
Cl–Cl	243
H–Cl	432

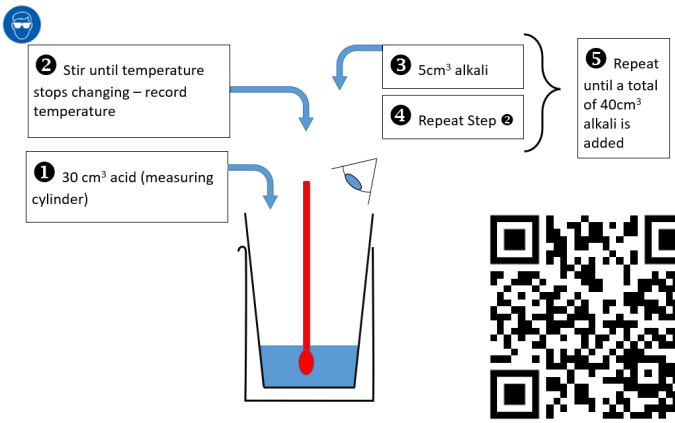
The energy change in a reaction can be calculated using **bond energies**. A bond energy is the amount of **energy** needed to break one **mole** of a particular **covalent bond**.
Energy change = total bond energy of reactants – total bond energy of products

Endothermic / Exothermic reactions

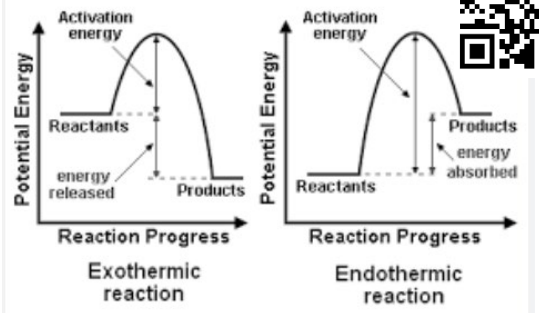
- Exothermic reactions transfer energy to the environment
- Endothermic reactions transfer energy from the environment



Required Practical



Reaction profiles



Equations for this topic

Chemical analysis

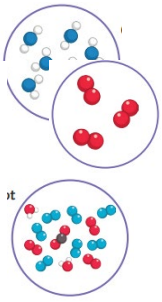
Threshold Concept

How do we identify a substance?

Keywords

Pure – a substance made from just one element of compound
Impure – a substance made from more than one element or compound
Analyse – to find the chemical composition of a substance
Sample – a portion of a substance taken from a larger amount

Pure and impure



Pure substances are made up of just one type of element or compound. They will have one set melting or boiling point.

Impure substances are a mixture of elements or compounds and have a range of melting/boiling points.

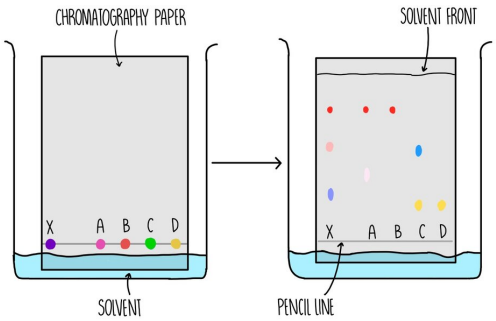
Formulations

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

- Fuels
- Cleaning products
- Paints

Chromatography required practical

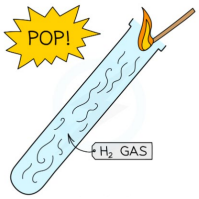
Chromatography is a method used to separate the substances in a mixtures.



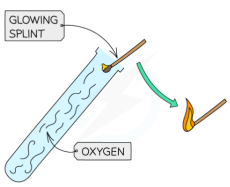
Stationary phase – where the molecules can't move (chromatography paper)
Mobile phase – where the molecules can move (the solvent)

Test for gases

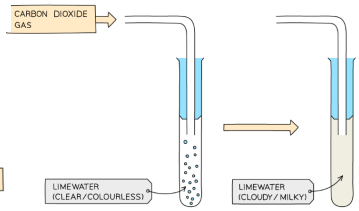
Test for Hydrogen



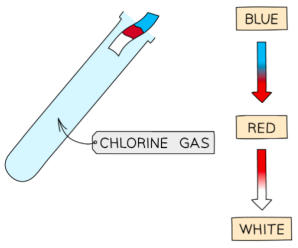
Test for Oxygen



Test for Carbon Dioxide

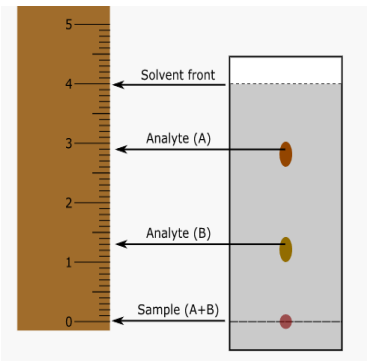


Test for Chlorine



Rf Value

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



Chemical analysis Triple

Threshold Concept

How do we identify a substance?

Keywords

Pure – a substance made from just one element of compound

Impure – a substance made from more than one element or compound

Analyse – to find the chemical composition of a substance

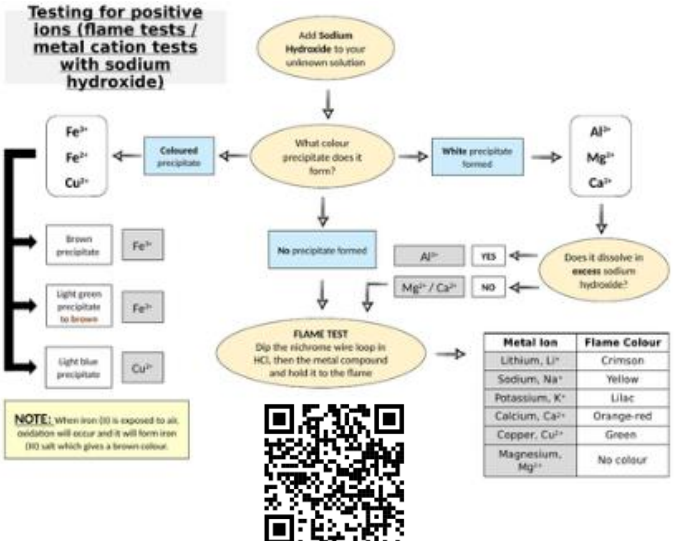
Sample – a portion of a substance taken from a larger amount

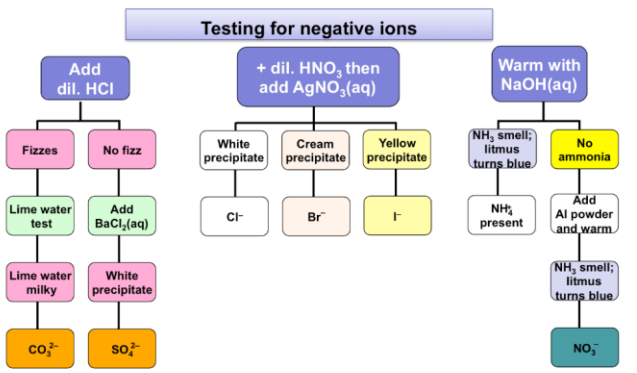
Testing for metal ions

Metal ions will form coloured precipitates when they react with sodium hydroxide.

Metal Cation	Effect of adding NaOH
Aluminium (Al^{3+})	White precipitate, dissolves in excess NaOH to form a colourless solution
Magnesium (Mg^{2+})	White precipitate, incoluble so remains in excess NaOH
Calcium (Ca^{2+})	White precipitate, insoluble so remains in excess NaOH
Copper (II) (Cu^{2+})	Light blue precipitate, insoluble in excess
Iron (II) (Fe^{2+})	Green precipitate, insoluble in excess
Iron (III) (Fe^{3+})	Red–brown precipitate, insoluble in excess

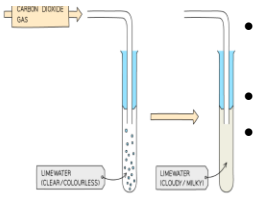
Identifying ions required practical





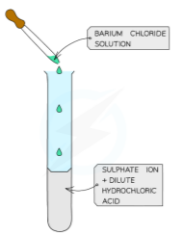
Testing for carbonate ions CO_3^{2-}

$K_2CO_3 + 2HCl \rightarrow 2KCl + CO_2 + H_2O$



- Metal carbonate and hydrochloric acid
- Forms Carbon dioxide
- Turns lime water cloudy

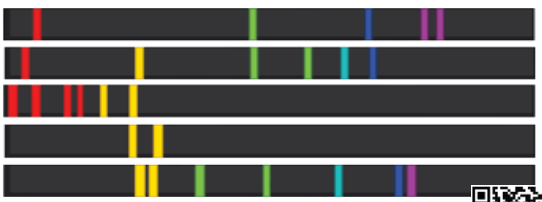
Testing for Sulphate ions (SO_4^{2-})



$Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$

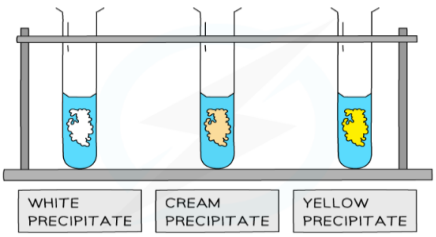
- Add barium chloride
- White precipitate formed

Flame emission spectroscopy



An instrumental technique used to identify metal ions.

Testing for Halide ions (Cl^-, Br^-, I^-)



$Ag^+ + Cl^- \rightarrow AgCl$

- Add nitric acid
- Add a few drops of silver nitrate
- Chloride forms a white precipitate
- Bromide forms a cream precipitate
- Iodide forms a yellow precipitate

Energy

Threshold Concept

Energy can't be created or destroyed, it can only be transferred from one store to another in a closed system

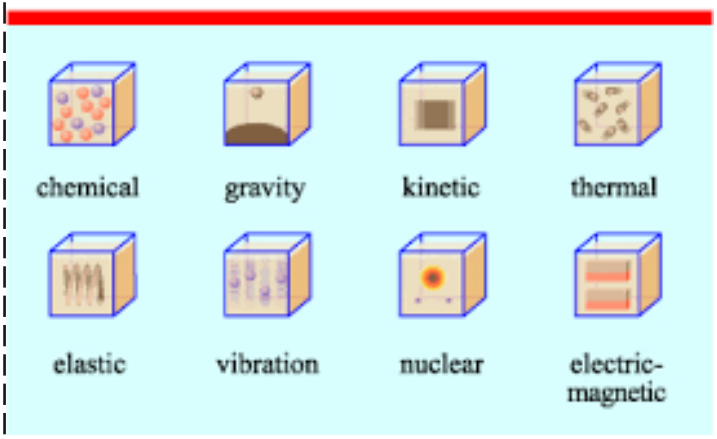
Keywords

Energy – moved between stores during transfers
Store – A temporary housing for energy
Transfer – The movement of energy between stores
Useful – The energy store that you wish for the energy to flow into
Dissipated – The store that energy flows into that is not useful or wasted

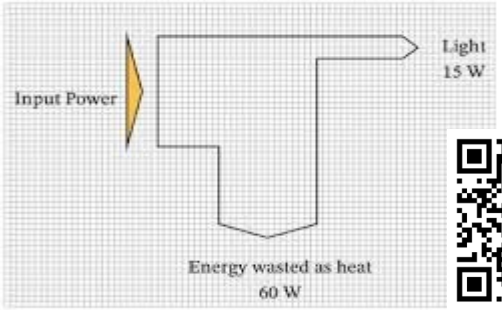
Movement between stores

Energy Transfer	Description
Mechanical	When a force acts on a body e.g. a collision
Electrical	Electricity can transfer energy from a power source, such as a cell, delivering it to components within a circuit
Heating	Thermal energy can be transferred by conduction, convection or radiation
Radiation	Light and sound carry energy and can transfer this between two points

Energy Stores

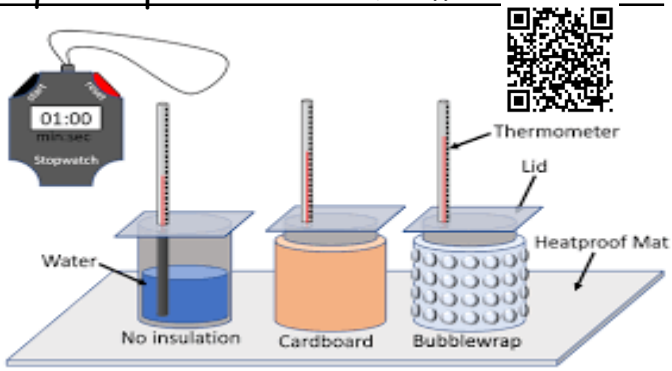


Sankey Diagrams

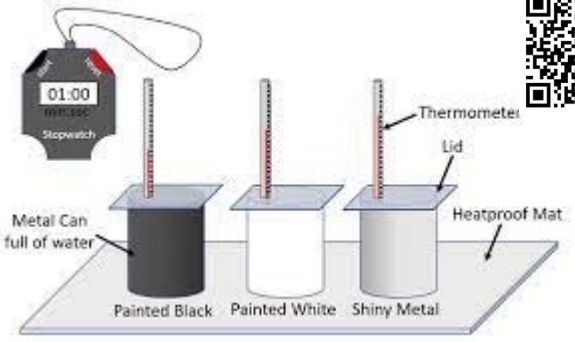


Conservation of energy

Required practical – Thermal Insulation



Required Practical - Radiation



Equations for this topic

Work = Force x Distance

Power = Work done/ time

Efficiency = useful energy output/total energy input

Forces

Threshold Concept

Every action has an equal and opposing action .

Keywords

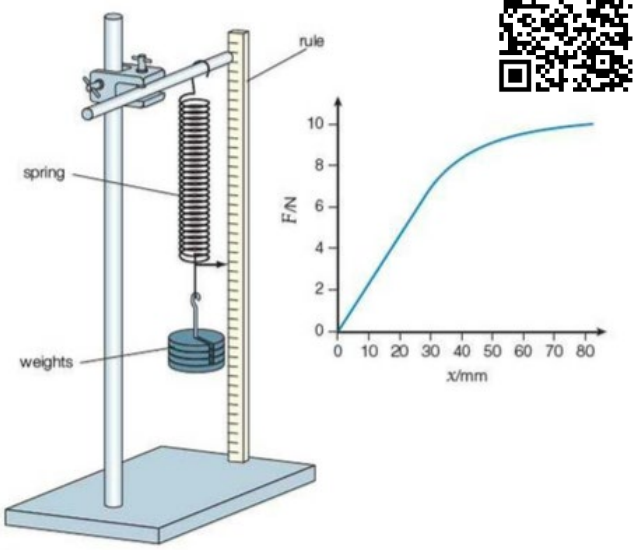
- **Contact:** Contact forces are forces that act between two objects that are physically touching each other.
- **Non contact:** Non-contact forces are forces that act between two objects that are not physically touching each other.
- **Balanced:** When the total force in opposite directions are equal in magnitude.
- **Unbalanced:** When the total force in opposite directions aren't equal in magnitude.
- **Force:** A push or a pull. The unit of force is the newton (N).

Contact and non contact forces

Contact Force	Non-Contact Force
A **contact force** involves a force between two objects in contact.	A **non-contact force** involves a force between objects not touching. You can't 'see' anything physically touching, but there is still an attraction or repulsion.
For example, **friction** between your feet and the ground can be present.	For example, **magnetic** forces between two magnets can happen when the magnets are near but not touching.

Required practical

When you apply a force to a material it can extend. The extension is the amount the length has increased by.



Scalar and vector quantities

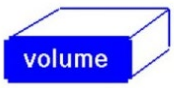
A scalar quantity has only magnitude.
A vector quantity has both magnitude and direction.

Scalar Quantities

length, area, volume
speed
mass, density
pressure
temperature
energy, entropy
work, power

Vector Quantities

displacement
velocity
acceleration
momentum
force
lift , drag , thrust
weight

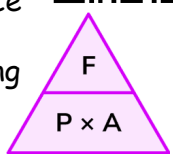


Free body diagrams

A free body diagram models the forces acting on an object.
The object or 'body' is usually shown as a box or a dot. The forces are shown as thin arrows pointing away from the centre of the box or dot.

Pressure:

Pressure is the amount of force applied to a specific area. It is caused when objects exert a force on another object. It can be on a visible level (pushing a door, rolling out cake icing) or at a molecular level (gas particles in a can)



Equations for this topic

weight = mass × gravitational field strength	$W = m\,g$
work done = force × distance (moved along the line of action of the force)	$W = Fs$
force = spring constant × extension	$F = ke$
moment of a force = force × distance (perpendicular to the direction of the force)	$M = Fd$
pressure = $\frac{\text{force normal to a surface}}{\text{area of that surface}}$	$p = \frac{F}{A}$
distance travelled = speed × time	$s = vt$
resultant force = mass × acceleration	$F = ma$

Space

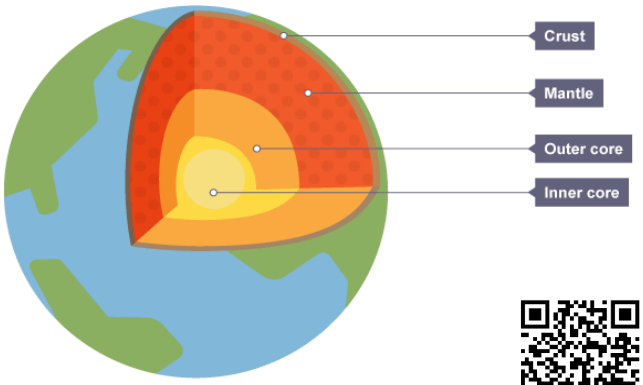
Threshold Concept

The Sun is the centre of the Solar system

Keywords

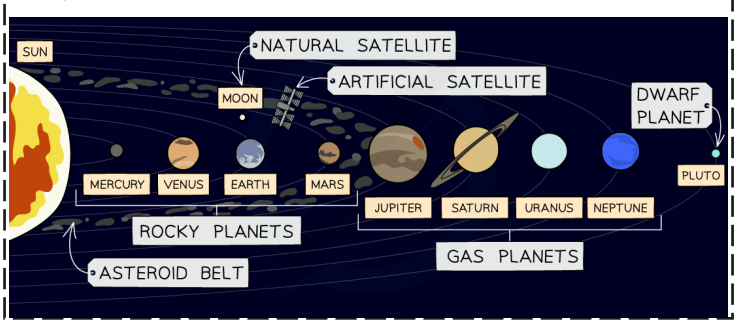
- **Earth**: The Earth is a planet and is roughly the shape of a sphere. There are three layers that make up the Earth's structure.
- **Planet**: A sphere of rock or gas orbiting a star.
- **Sun**: The Sun is our nearest star. It is a relatively small star when compared to other stars in the universe. Our Solar System contains the Sun and everything that orbits it.
- **Gravity**: Gravity is an attractive force that acts on all matter.

The earth:



Solar system:

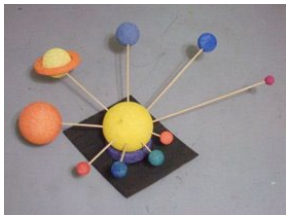
Our solar system consists of eight planets orbiting a star, our sun. Most planets have at least one moon orbiting it. In addition, there is an asteroid belt between Mars and Jupiter. Numerous comets also orbit the sun in elongated elliptical orbits



The earths rotation and revolution:

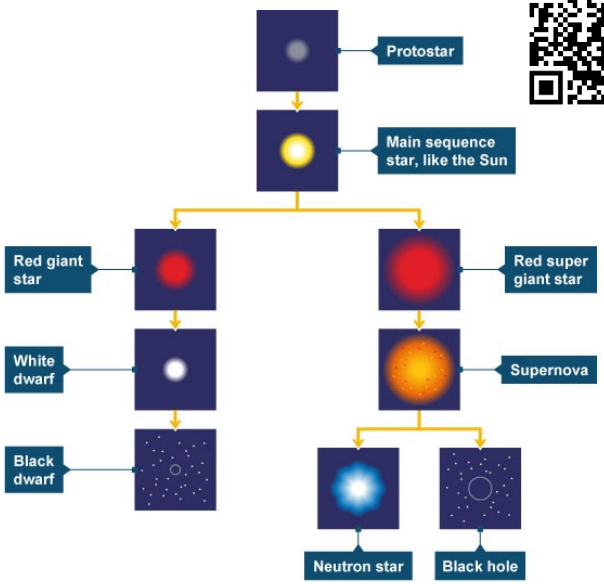
rotate	revolve
To Spin or Turn	Go Around
TAKES: 24 hours or 1 day	TAKES: 365 days or 1 year
CAUSES: Day & Night	CAUSES: The Seasons

Modelling the solar system:



A scale model is a copy of something that is much larger or smaller than the object itself but one which maintains the original's proportions.

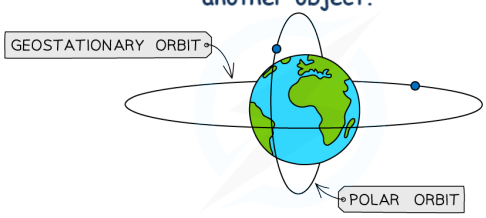
Stars and lifecycle:



The universe:

An orbit: a curved path that an object takes around another object.

A satellite: an object that orbits around another object.



Equations for this topic

Electricity (Part 1)

Threshold Concept

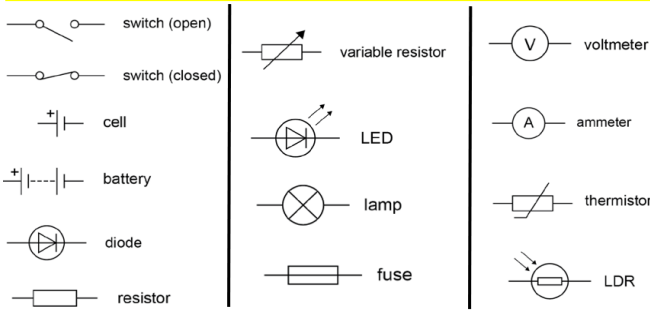
Electricity is the flow of electrons.

Keywords

- **Electron:** a stable subatomic particle with a charge of negative electricity, found in all atoms and acting as the primary carrier of electricity in solids.
- **Electricity:** is the presence or flow of charged particles.
- **Charge:** is a property of a body which experiences a force in an electric field. Charge is measured in coulombs (C).
- **Current:** Current is the rate of flow of electric charge around a circuit.

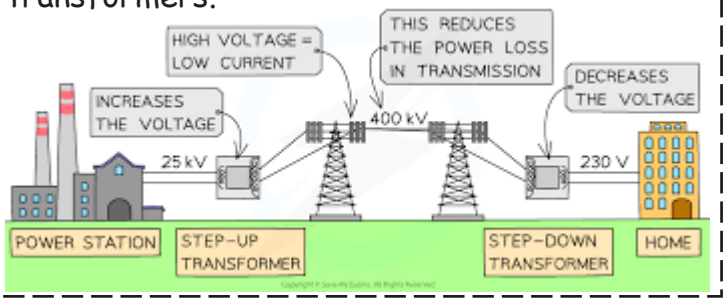
Circuit Symbols

An electronic circuit can include lots of different components. All of which can be represented with a symbol:

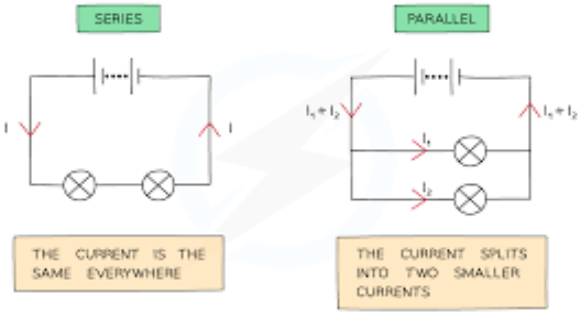


National Grid

The **National Grid** distributes electricity across the country. The National Grid connects power stations to homes, workplaces and public buildings all around the country through a system of cables and transformers.

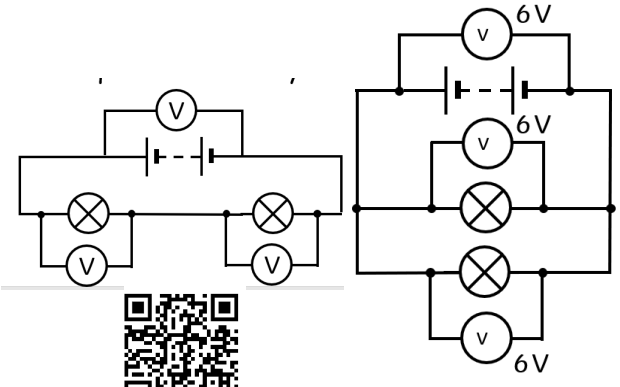


Series and Parallel circuits



In a series circuit, the potential difference/voltage supplied by the battery is **shared** by the components.

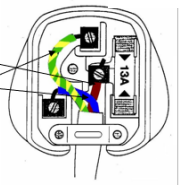
In a parallel circuit, the potential difference across each bulb is the **same** as the potential difference across the battery.



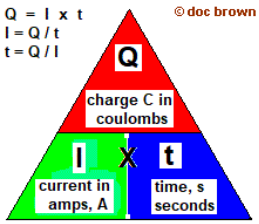
Practical

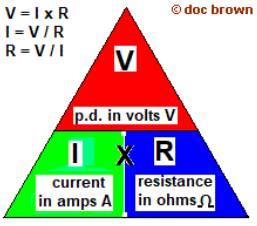
Wiring a plug

- The live wire.
- The neutral wire.
- The earth wire.



Equations for this topic





Waves

Threshold Concept

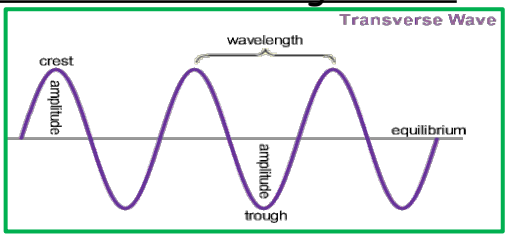
Waves transfer energy, **NOT** matter.

Link to information on the whole topic, consisting of slides, videos, and quizzes **Trilogy pupils ignore tasks 5,6 & 7.**

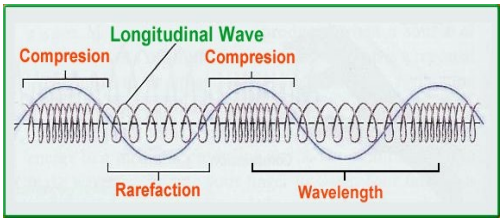
Keywords

Wave - a disturbance/vibration in matter, which transfers the energy through the matter.
Energy – a property of a substance that is stored or transferred in order for things to be done.
Transverse – vibrations are perpendicular (at right angles) to the direction of energy transfer.
Longitudinal – vibrations are parallel (same direction) to the direction of energy transfer.

Transverse vs Longitudinal



Vibrations are **perpendicular** to the direction of energy transfer



Vibrations are **parallel** to the direction of energy transfer

Equations

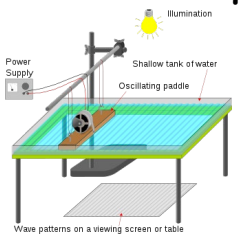
Wave speed = distance / time
$v = s / t$

Wave speed = wavelength x frequency
$v = \lambda \times f$

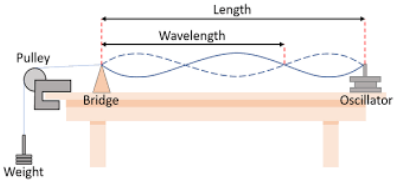
Time Period = 1 / frequency
$T = 1 / f$

Required Practicals

Waves in a liquid



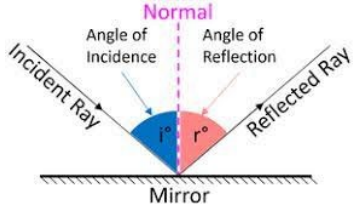
Waves in a solid



Reflection and refraction (HT only)

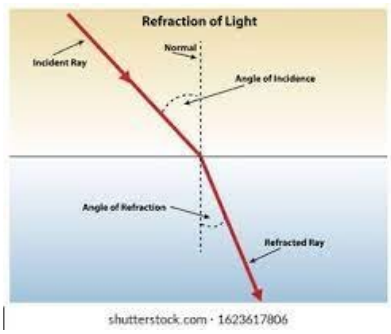
Law of reflection

The angle of incidence = the angle of reflection



Refraction

The change in direction and speed of light, due to passing from one medium into a different medium, of different densities

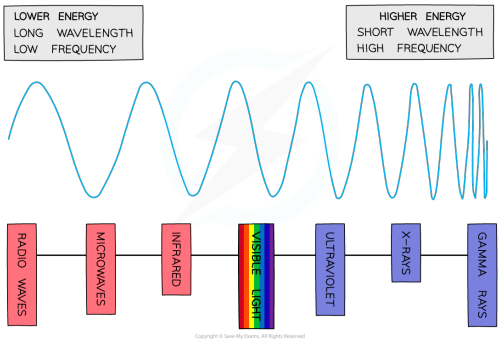


EM Spectrum

Threshold Concept

Electromagnetic waves are waves in different frequencies

Types of electromagnetic waves:



Keywords

Frequency: The number of complete waves passing a certain point per second, or the number of waves produced by a source per second. Measured in Hertz, Hz

Wave: An oscillation that transfers energy without transferring any matter.

Spectrum: Used to classify something in terms of its position on a scale between two extreme points.

Energy: Is a key principle in physics, as it allows work to be done.

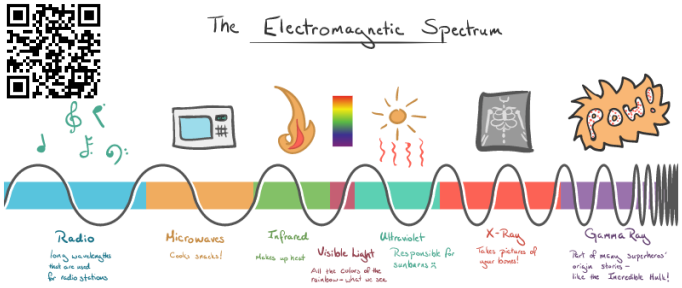
Speed: The maximum rate at which an individual is able to perform a movement or cover a distance in a period of time.

Properties of electromagnetic waves;

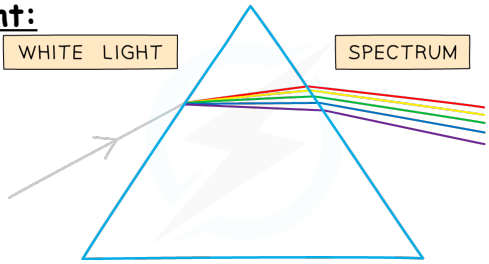
GAMMA RAYS	X RAYS	ULTRA VIOLET	VISIBLE	INFRA RED	MICROWAVES	TELEVISION	RADIO

GAMMA RAYS	Wavelength: around 1 pm Source: Nuclei Detector: Film, Geiger counter Properties/uses: Medical, sterilising food, checking metal castings, checking water flow
X RAYS	Wavelength: around 1 nm Source: Atoms Detector: Film Properties/uses: Medical X rays, defects in metals, checking paintings
ULTRA VIOLET	Wavelength: 0.001 – 0.4 μm Source: Atoms Detector: Skin, film Properties/uses: Sun tan, sun burn, theatre, checking documents, microscopes
VISIBLE	Wavelength: 0.4-0.7 μm Source: Atoms Detector: Eye, film Properties/uses: We use it to see the world around us
INFRA RED	Wavelength: 0.7-10 μm Source: Atoms Detector: Skin, thermometer, film Properties/uses: Physiotherapy, night sight, locating people trapped in smoke or ruins, Remote controls
MICROWAVES	Wavelength: 1 mm – 50 cm Source: Electronics Detector: Aerial Properties/uses: Microwave ovens, radio telescopes, radar
TELEVISION	Wavelength: around 50 cm Source: Electronics Detector: Aerial Properties/uses: Television
RADIO	Wavelength: 1 m – 1500 m Source: Electronics Detector: Aerial Properties/uses: Radio communication

Uses and applications of electromagnetic waves

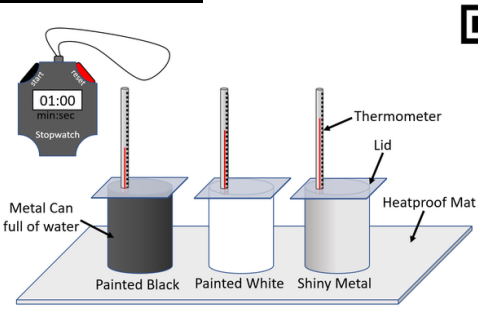


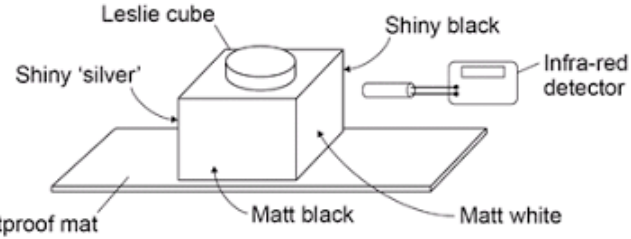
Visible light:



Required practical:

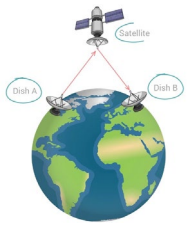
EM infrared RP





Communications:

Electromagnetic radiation is used for communications and transmission of information. The waves that are used in this way are radio waves, microwaves, infrared radiation and light.



Equations for this topic

wave speed = frequency × wavelength	$v = f\lambda$
time period = $\frac{1}{\text{frequency}}$	$T = \frac{1}{f}$

Electricity Part 2

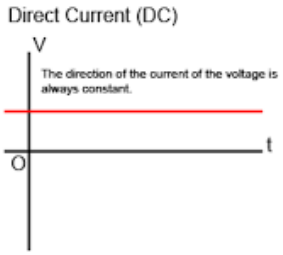
Threshold Concept

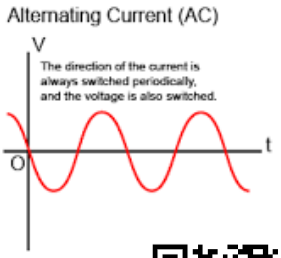
Potential Difference is the push that causes current to flow.

Keywords

- **Energy transfer:** the change of energy from one form to another.
- **Current:** Current is the rate of flow of electric charge around a circuit.
- **Resistance:** is a measure of the opposition to current flow in an electrical circuit.
- **Potential difference (voltage):** is the difference in the amount of energy that charge carriers have between two points in a circuit.

Alternating and Direct current (ACDC)



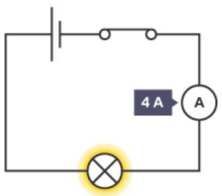


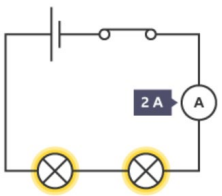
Electricity can flow either as direct or alternating current, and is used in homes to power electrical appliances.

Resistance

Resistance (R) is a measure of how difficult it is for current to flow. Resistance is measured in units called ohms (Ω).

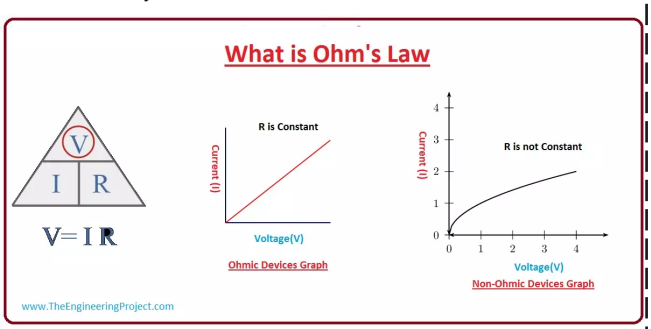
The more resistance there is in a circuit, the less current will flow.





Ohm's Law

Ohm's law states that current is directly proportional to potential difference (providing the temperature remains constant).



Required Practical's

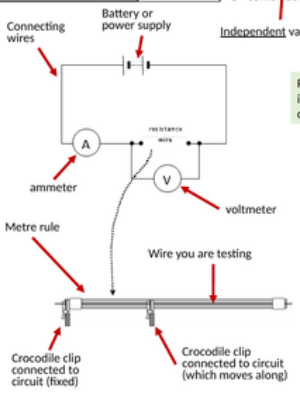
Resistance

Required practical	Physics 3
Resistance in circuits	Combined Science 15

Use circuit diagrams to set up and check appropriate circuits to investigate the factors affecting the resistance of electrical circuits. This should include:
A - the length of a wire at constant temperature
B - combinations of resistors in series and parallel

Independent variable

Dependent variable



Possible sources of significant **error** (which you can attempt to control): inaccurate attachment of crocodile clips; heating effect of electric current; misreading metre rule; misreading ammeter or voltmeter.

Method A steps:

- Connect the circuit as shown
- Record in a table:
  - length of the wire between the crocodile clips
  - the readings on the ammeter
  - the readings on the voltmeter
- Move the crocodile clip and record the new ammeter and voltmeter readings. Note that the voltmeter reading may not change.
- Repeat this to obtain several pairs of meter readings for different lengths of wire
- Calculate and record the resistance for each length of wire using the equation $R = V/I$

I-V characteristics

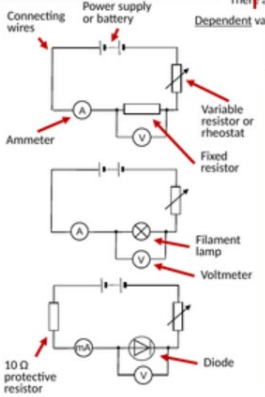
Required practical	Physics 4
I-V characteristics	Combined Science 16

Use circuit diagrams to construct appropriate circuits to investigate the current–potential difference characteristics of a variety of circuit elements including a filament lamp, a diode and a resistor at constant temperature.

There are three investigations in this required practical.

Dependent variable

Independent variable

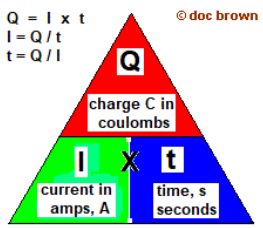


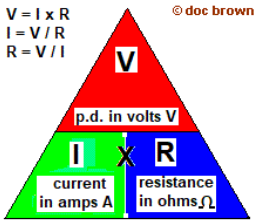
Possible sources of significant **error** (which you can attempt to control): misreading ammeter or voltmeter; inaccurate graphing

Method steps:

- Connect the circuit
- Record the readings on the ammeter and voltmeter in a suitable table.
- Adjust the variable resistor and record the new ammeter and voltmeter readings. Repeat this to obtain several pairs of readings
- Swap the connections on the battery. (the readings on the ammeter and voltmeter should now be negative)
- Continue to record pairs of readings of current and potential difference with the battery reversed
- Swap the leads on the battery back to their original positions
- Replace the resistor with the lamp.
- Repeat the steps above with the lamp in place of the resistor
- Swap the leads on the battery back to their original positions.
- If you can, reduce the battery potential difference to less than 5 V
- Replace the ammeter with a milliammeter (**or** change the setting on the multimeter)
- Replace the lamp with the diode. Connect the positive side of the diode to the milliameter.
- Repeat steps above to obtain pairs of readings of potential difference and current for the diode.

Equations for this topic





Motion

Threshold Concept

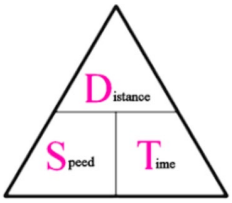
Speed equals distance travelled in a given time

Keywords

- **Speed:** Distance travelled in a certain time
- **Distance**: how far an object has travelled. It is a scalar quantity
- **Time**: how long something takes
- **Metres**: a unit measurement of distance (m)
- **Seconds**: a unit measurement of time (s)

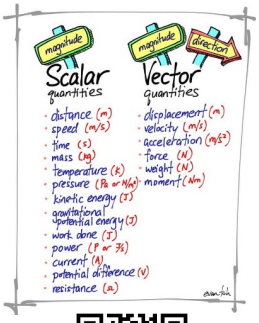
Speed, distance, time

-Speed is measured in metres per second (m/s)
-Distance is measured in metres (m)
-Time is measured in second (s)

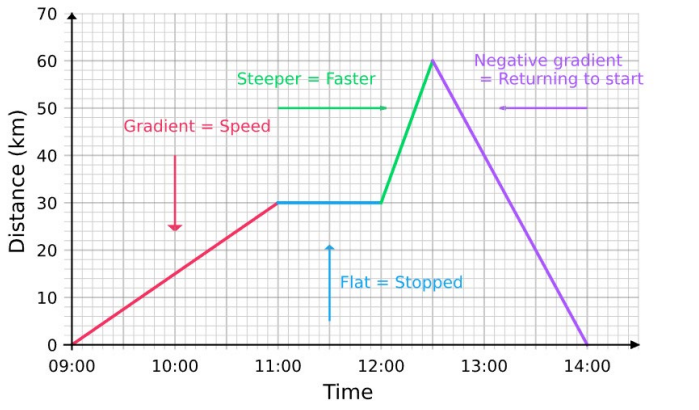


Scalar and vector quantities

Scalar – a measurement of something. They only have MAGNITUDE (size)
Vector – a measurement of something. They have DIRECTION & MAGNITUDE (size)

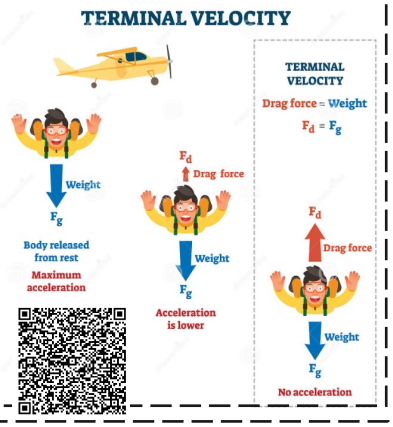


Distance – Time Graphs

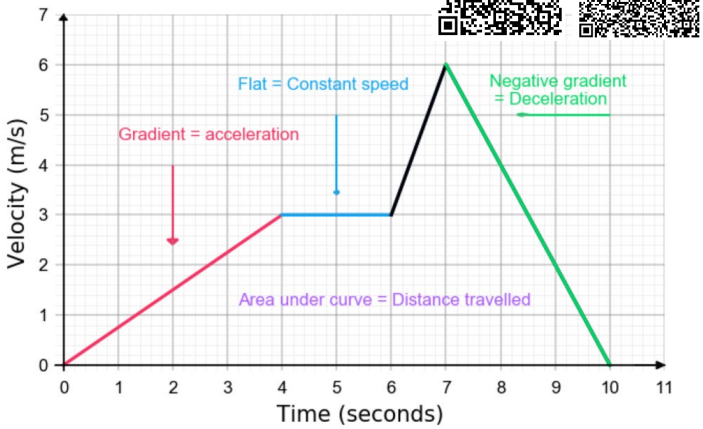


Terminal velocity

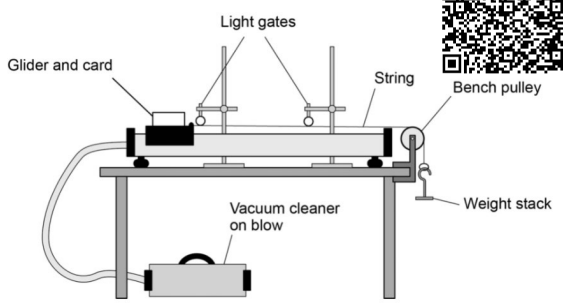
At terminal velocity, the object moves at a steady speed in a constant direction because the **resultant force** acting on it is zero



Velocity – Time graphs



Required practical – Acceleration



Equations for this topic

Speed = Distance ÷ Time
Change in Velocity = Acceleration x Time
Force = Mass X Acceleration

Atomic Structure

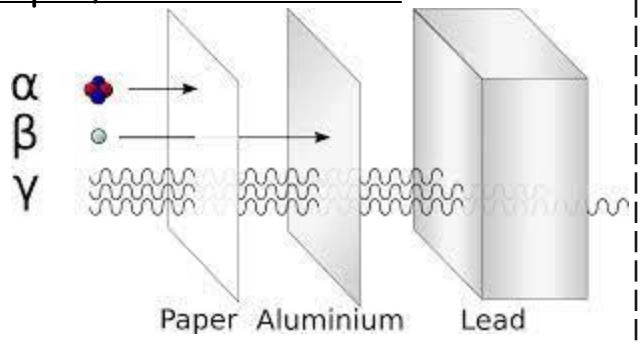
Threshold Concept

Identify that there are three types of radiation

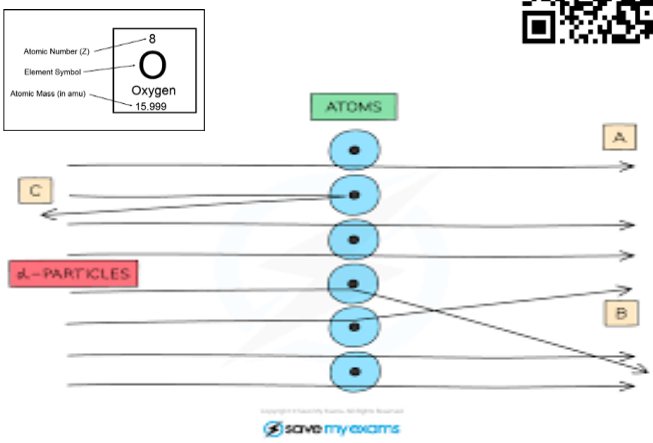
Keywords

Atom – the smallest particle of a chemical element that can exist
Proton – positively charged particle
Neutron – Particle with no charge
Electron – Negatively charged particle
Wave – Energy transfer method

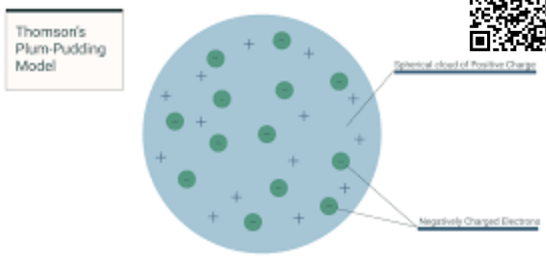
Alpha, Beta and Gamma



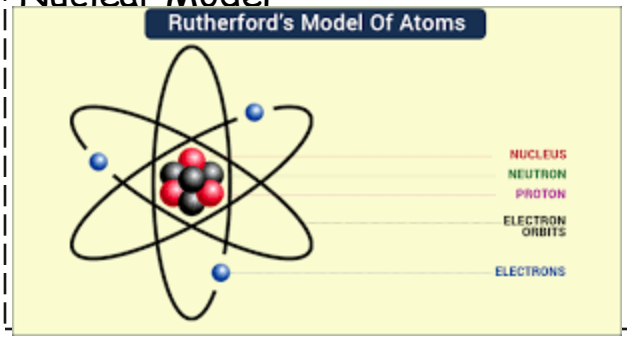
Rutherfords Scattering Experiment



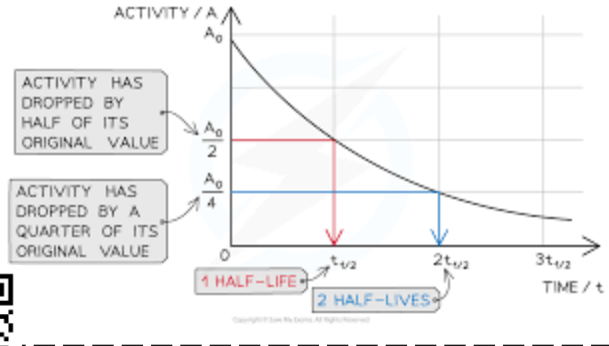
Plum Pudding Model



Nuclear Model



Half Life



Uses and Dangers of Radiation

	Irradiation	Contamination
Description	Object is exposed to radiation but does not become radioactive	Object becomes radioactive and emits radiation
Source	Danger is from radiation emitted outside the object	Danger from radiation emitted within the object
Prevention	Prevented by using shielding, such as lead clothing	Prevented by safe handling of sources and airtight safety clothing
Causes	Caused by the presence of radioactive sources outside the body	Caused by inhalation or ingestion of radioactive sources

uations for this topic

$$^{235}_{92}U \xrightarrow{\text{decay by releasing an alpha particle}} {}^{4}_{2}\alpha + {}^{231}_{90}Th$$

$$^{14}_{6}C \xrightarrow{\text{decay by releasing an beta particle}} {}^{0}_{-1}\beta + {}^{14}_{7}N$$

$$^{235}_{92}U \xrightarrow{\text{decay by releasing a gamma wave}} {}^{0}_{0}\gamma + {}^{235}_{92}U$$

Particle Models of Matter

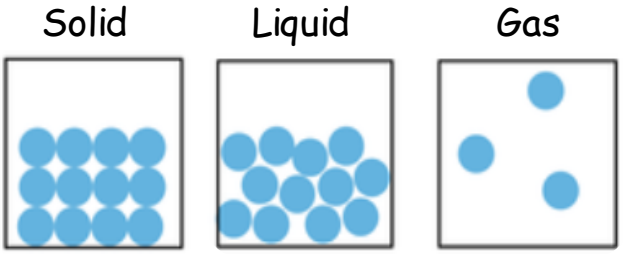
Threshold Concept

Changes of state are caused by energy changes

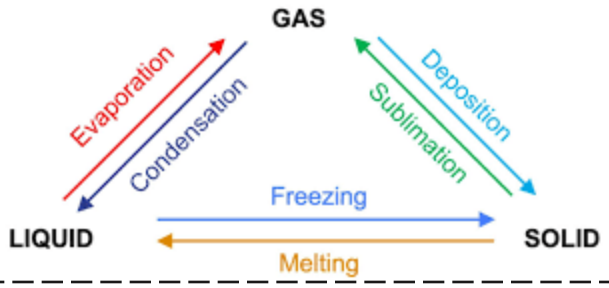
Keywords

States of matter – solid, liquid or gas.
Particles – the smallest part that a substance can be broken down into.
Energy – a property of a substance that is stored or transferred in order for things to be done.
Density – how compact a substance is.
Pressure – continuous force acted on or against an object.

States of matter



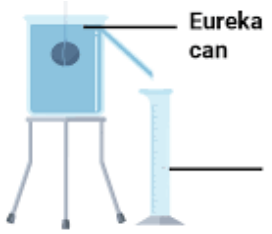
Changes of state



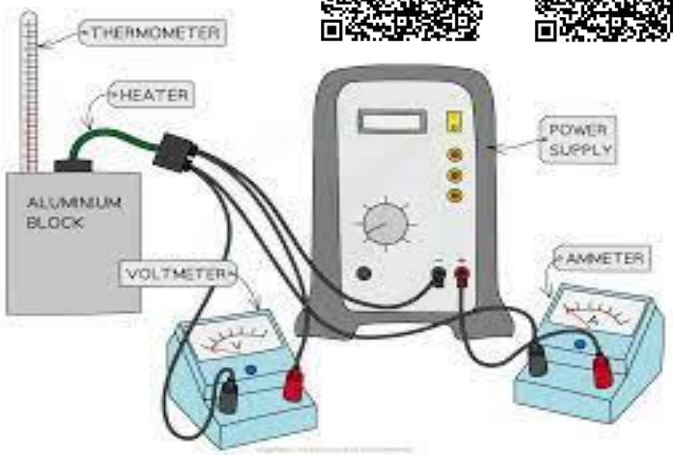
Links to information on the whole topic, consisting of slides, videos, and quizzes

Required Practical

Density



Specific Heat Capacity



Equations for this topic

P=F/A Pressure = Force / Area

P = m/V Density = mass / volume

ΔE = m x c x Δθ Change in Energy = mass x specific heat capacity x change in temperature

ΔE = m x L Change in Energy = mass x Specific Latent Heat

P = ρ x g x h Pressure in a liquid column = density x gravity x height (TRIPLE ONLY)

For gases: p x v = constant For Gases: pressure x volume = constant (TRIPLE ONLY)

Electromagnetism

Threshold Concept

Magnets have two poles that attract or repel.

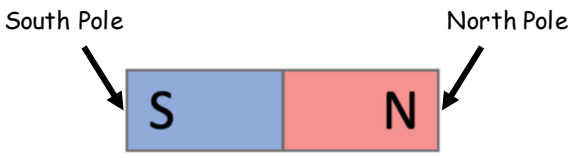
Keywords

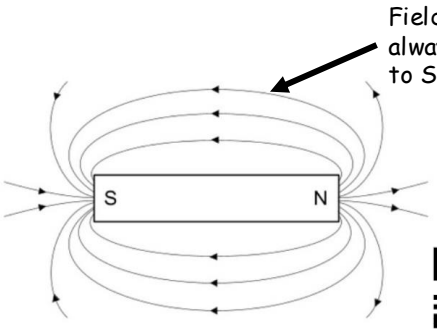
Permanent Magnet - A material that has its own magnetic field without needing to be helped by another magnetic material.
Induced Magnet – a material that only becomes a magnet when placed in another magnetic field.
Magnetic Field – a region around a magnet where the force of magnetism acts.
Solenoid – a coil of wire that carries an electrical current.
Electromagnet – a soft, iron core placed inside a solenoid.

Common magnetic materials

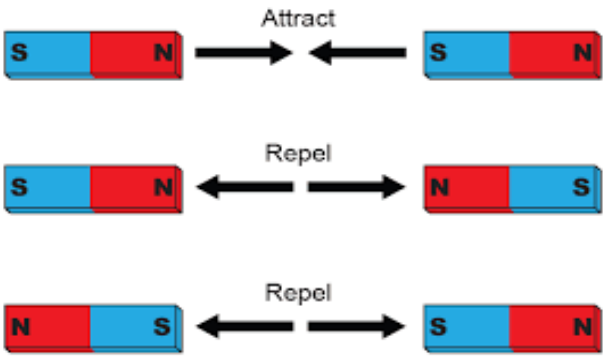
- Iron
- Nickel
- Cobalt
- Steel

A bar magnet and its magnetic field





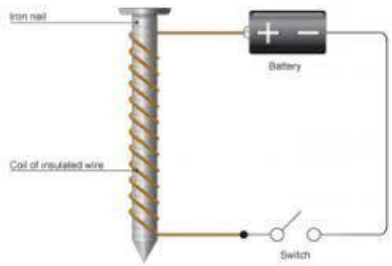
Attraction and repulsion



Electromagnets

Building an electromagnet

Electromagnets



Required Practical

Equations for this topic

Force = Magnetic Flux Density x Current x length of wire

$F = B \times I \times l$

Vehicle Safety

Threshold Concept

Cars have safety features to reduce impact forces

Keywords

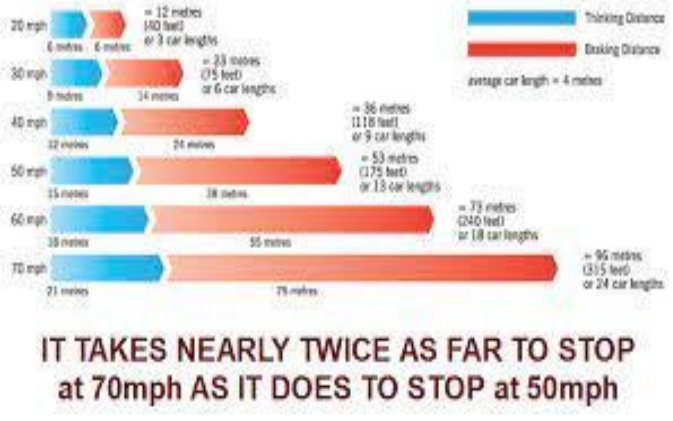
Newtons Laws – Three guiding principles stating the movement and reactions of all things due to physics

Impact forces – The forces occurring when two objects collide

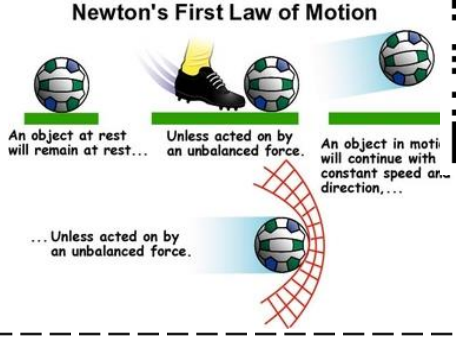
Momentum – A measure of how difficult it is to stop a moving objects

Safety Features in Cars

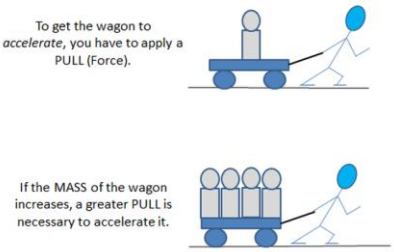
Stopping Distances



Newtons First Law



Newtons Second Law



Momentum

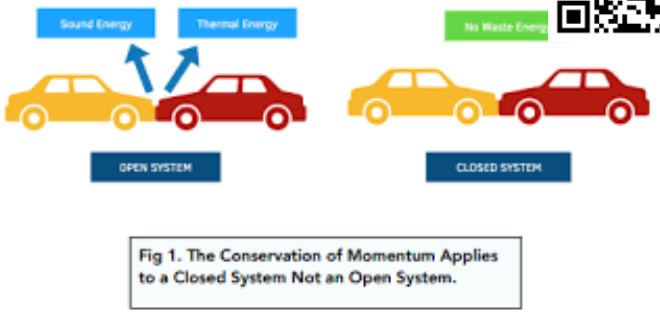
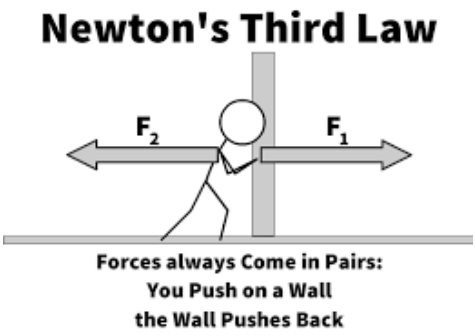


Fig 1. The Conservation of Momentum Applies to a Closed System Not an Open System.

Newtons Third Law



Equations for this topic

Force = Mass x Acceleration

Momentum = Mass x Velocity

Energy Recap (E_k, E_p, E_e)

Threshold Concept

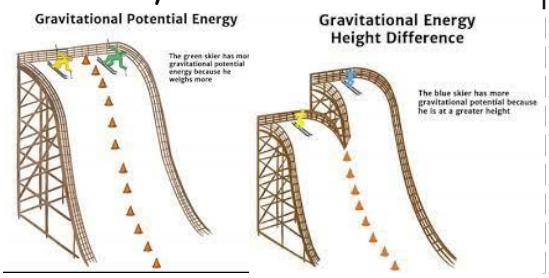
Energy can be transferred between stores depending on an objects motion

Keywords

Energy – a property of a substance that is stored or transferred in order for things to be done.
Work done = **energy transferred**
Elastic Potential Energy – energy stored in a stretchy or springy object.
Kinetic Energy – energy stored in a moving object
Gravitational Potential Energy – energy stored in an object raised above ground.

Gravitational Potential

Don't forget to click on the worksheet tab and exam question tab to try some tasks.



Equations

Gravitational potential energy = mass x gravitational field strength x height
$E_p = m \times g \times h$

Elastic potential energy = $\frac{1}{2}$ x spring constant x extension^2
$E_e = \frac{1}{2} \times k \times e^2$

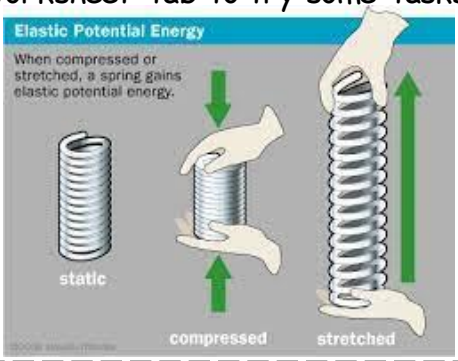
Kinetic energy = $\frac{1}{2}$ x mass x velocity^2
$E_k = \frac{1}{2} \times m \times v^2$

Kinetic Energy

Don't forget to click on the worksheet tab to try some tasks.

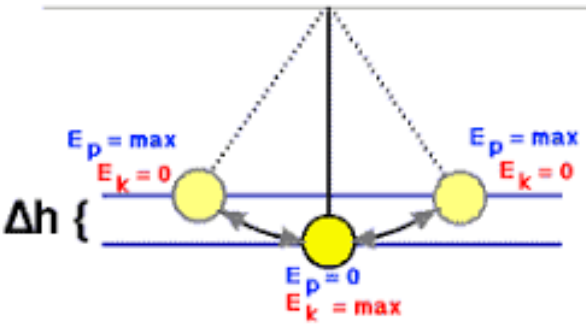
Elastic Potential Energy

Don't forget to click on the worksheet tab to try some tasks.



Conservation of energy

Don't forget to click on the exam questions tab to try some tasks.



E_k = Kinetic Energy
E_p = Potential Energy

Space (TRIPLE)

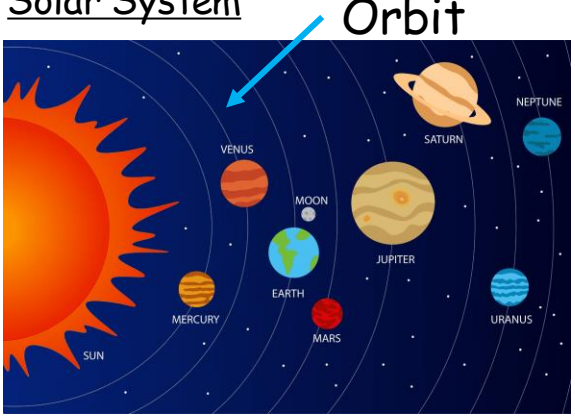
Threshold Concept

The Solar System is made up of many types of objects.

Keywords

Solar System - the collection of eight planets and their moons in orbit round the Sun, together with smaller bodies in the form of asteroids, meteoroids, and comets.
Orbit – the curved path of a celestial object or spacecraft round a star, planet, or moon
Sun – the star around which the 8 planets of the Solar System orbits.
Planet – a celestial body moving in an elliptical orbit round a star.
Moon – a celestial body moving in orbit around a planet. They are natural satellites.
Satellite – an object, either natural (e.g. The Moon), or artificial, that orbits a moon, planet or star. Artificial satellites are for information gathering.

Solar System



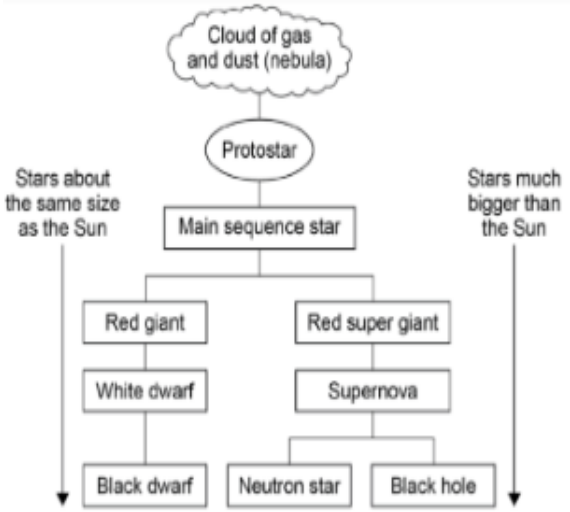
Link to information on the whole topic, consisting of slides, videos, and quizzes

Orbital Motion & Satellites

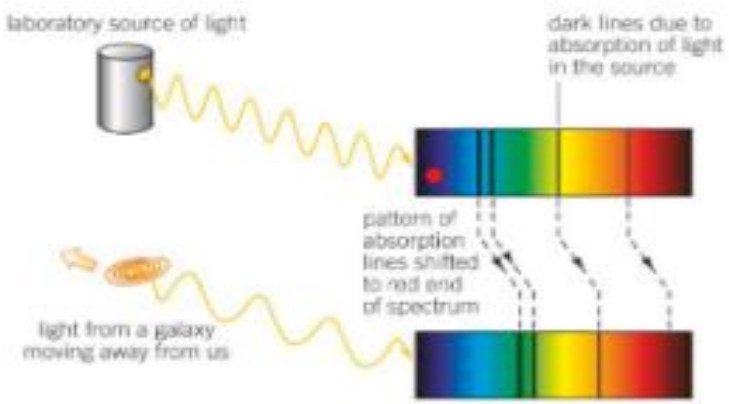
Planets orbit in near-circular orbits: they maintain a constant speed but are always changing direction. This means they have a constant speed but NOT a constant velocity

The Moon is a Natural Satellite. All other satellites of Earth are artificial, such as weather, military, ISS, GPS etc.
Geostationary satellites follow the same point above Earth, so have an orbital period of 24 hours.

Life Cycle of Stars



Red-shift and Big Bang



Equations for this topic

Required Practical