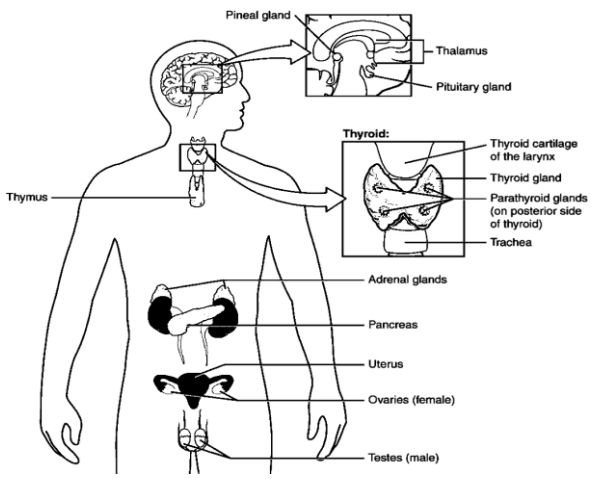
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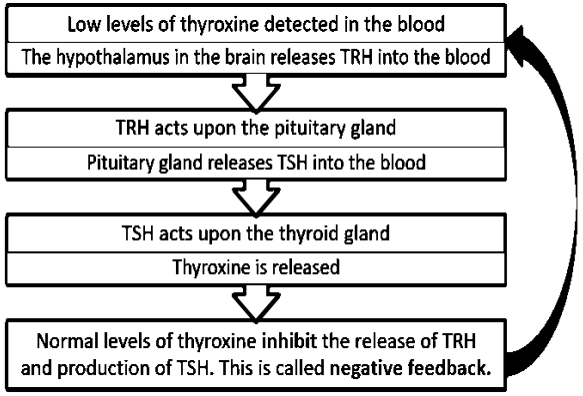
Pages	Topic
2 – 3	Animal Co-ordination and Control
4 – 5	Exchange and Transport
6	Fuels
7	Earth and Atmospheric Science
8 – 9	Alcohols and Carboxylic Acids
10 – 11	Hydrocarbons
12 – 13	Polymers
14	Forces and Matter
15	Forces and Their Effects
16	Charge and Static Electricity
17	Magnetism and the Motor Effect
18 – 19	Electromagnetic Induction
20 – 21	Particle Model

KS4 Biology – Animal Co-ordination and Control

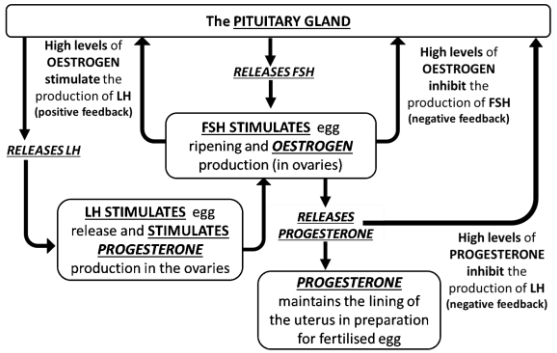
The Human Endocrine System

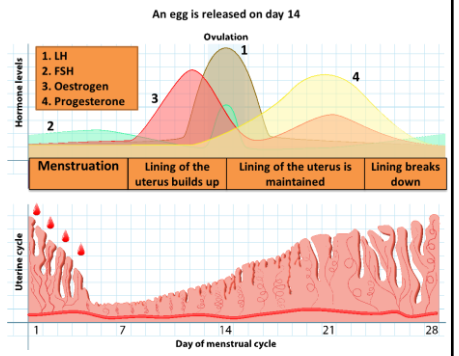


Anti-diuretic hormone (ADH)	Kidney	Controls water levels in the blood
Thyroid-stimulating hormone (TSH)	Thyroid	Stimulates the thyroid gland to secrete thyroxine
Luteinising hormone (LH)	Ovaries	Stimulates egg release and progesterone production in the ovaries
Follicle-stimulating hormone (FSH)	Ovaries	Stimulates egg ripening and oestrogen production (in ovaries)
Prolactin (PRL)	Breasts	Stimulates the breasts to produce milk
Growth hormone (GH)	All cells in the body	Stimulates growth and repair



The Menstrual Cycle





Hormone	Produced in...	Causes...
FSH Follicle stimulating hormone	Pituitary Gland	Stimulates egg ripening and oestrogen production (in ovaries)
Oestrogen	Ovaries	Lining of the womb to develop. Stimulates pituitary gland to make LH
LH Luteinising hormone	Pituitary Gland	Stimulates egg release and progesterone production in the ovaries
Progesterone	Ovaries	Maintains the lining of the womb

Contraception

The pill - oral contraceptives that contain oestrogen to inhibit FSH production so that no eggs develop and mature. After taking for a while egg development and release will stop completely.

The **mini pill** and **injections** contain progesterone. High levels stimulate the cervix to produce a thick mucus which stops sperm entering the uterus.

Implant or **skin patches** of slow release progesterone inhibit the maturation and release of eggs for a number of months or years.

Spermicidal agents which kill or disable sperm.

Barrier methods such as **condoms and diaphragms** prevent the sperm reaching an egg

The **'coil' or other intrauterine devices** which prevent the implantation of an embryo

Sterilisation or vasectomy - surgical methods of male and female sterilisation.

Keyword	Definition
Endocrine system	Collection of organs/glands in the human body that release hormones
Hormones	Chemical messengers released from endocrine glands that cause a change in bodily responses
Target organ	The organ where a particular hormone is released and effects
Metabolic rate	The rate at which the energy stored is transferred by all the reactions that take place in your body
Glycogen	How glucose is stored as a polymer
Fight or flight response	When the body prepares to fight or run away from a perceived danger. This response is caused by the hormone adrenaline
Menstrual cycle	A roughly 28 day cycle of changes that occurs in the female reproductive system
Menstruation	When the lining of the uterus breaks down and passes out through the vagina, Also known as a period
Ovulation	When an egg is releases from its follicle in the ovary, happens roughly on day 14 of the menstrual cycle
Contraception	A method that prevents fertilisation and therefore pregnancy. Contraception can be hormonal or physical/barrier methods
ART	Assisted reproductive technology that uses hormones and other techniques to increase the chance of pregnancy in infertile women. Clomifene therapy is an example of ART

KS4 Biology – Animal Co-ordination and Control

Control of Blood Glucose

Blood glucose concentration TOO HIGH

↓

The PANCREAS releases the hormone insulin

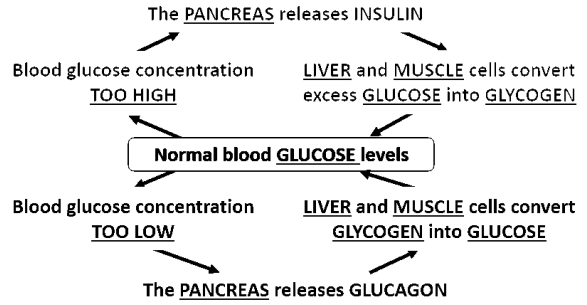
↓

Insulin stimulates the movement of GLUCOSE from the blood into cells

↓

Liver and muscle cells convert excess glucose into glycogen

The control of blood glucose concentration is an example of NEGATIVE FEEDBACK. This ensures that, in any control system, changes are reversed and returned back to the set level.



Diabetes- a condition that causes a person's blood sugar level to become too high.

Type 1 diabetes

A disorder in which the pancreas fails to produce enough insulin.

The lack of insulin causes uncontrolled high blood glucose levels.

Type 1 is normally treated with insulin injections.

Type 2 diabetes

A disorder where the body cells no longer respond to insulin produced by the pancreas.

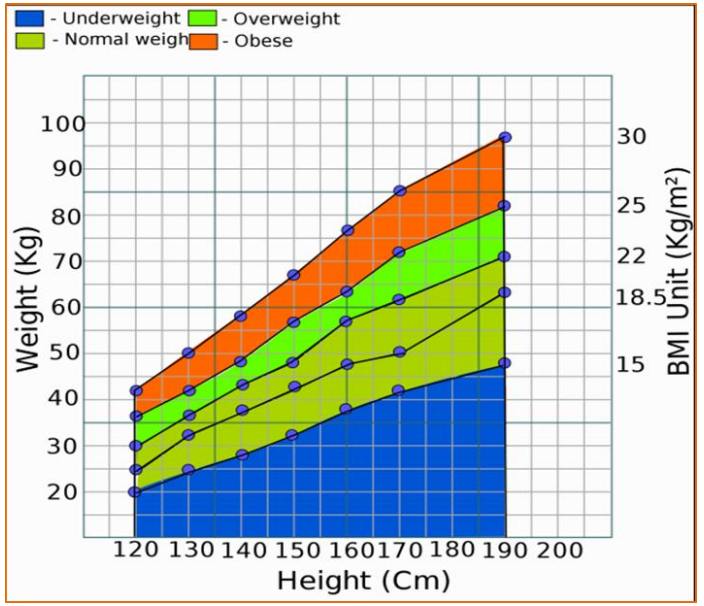
Obesity is a risk factor for Type 2 diabetes.

Type 2 is normally treated by controlling the carbohydrate in the diet and by exercise.

Excess weight (obesity) can make a person have a greater risk of developing type 2 diabetes.

A tool called the **Body Mass Indicator (BMI)** can be used to calculate whether a persons weight lies within a healthy range.

$$BMI = \frac{\text{mass (kg)}}{(\text{height (m)})^2}$$



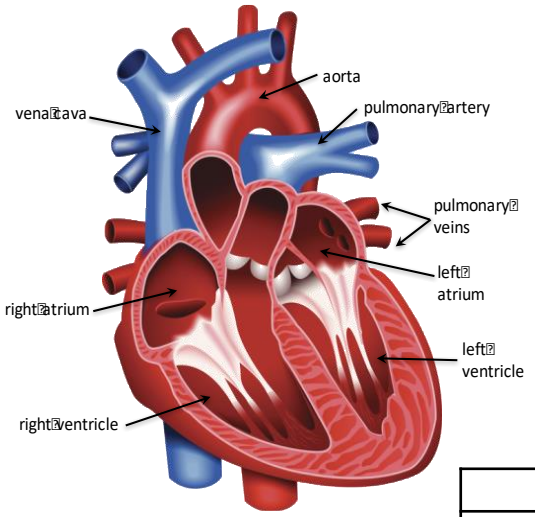
The use of BMI has **limitations** because it simply shows if a person is carrying too much weight. It does not calculate if this is excess fat, muscle or bone.

Very muscular adults and athletes may be classed as overweight or obese even though their body fat is low.

The **waist to hip ratio** should be considered alongside the BMI figure.

Male (waist : hip ratio)	Female (waist : hip ratio)	Health risk based on Waist : hip ratio
0. 95 or below	0.80 or below	Low risk
0.96 to 1.0	0.81 to 0.85	Moderate risk
1.1 or more	0.86 or more	High risk

KS4 Biology – Exchange and Transport

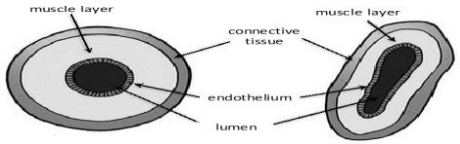


Different structure in the heart have different functions		
	Right ventricle	Pumps blood to the lungs where gas exchange takes place.
	Left ventricle	Pumps blood around the rest of the body. Thicker cardiac muscle in the wall.
	Pacemaker (in the right atrium)	Controls the natural resting heart rate.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

Keyword	Definition
Diffusion	The spreading of the particles of a gas or substances in solution, resulting in a net movement of particles from a region where they are of a higher concentration *to an area of* lower concentration
Surface areas to volume ratio	The surface area to volume ratio can be calculated by dividing an object's surface area (SA) by its volume
Cardiac Output	Cardiac output = stroke volume x heart rate
Stroke Volume	Cardiac output is the volume of blood pumped by a ventricle per minute. The units are $cm^3\ min^{-1}$
Heart Rate	Heart rate is the number of beats per minute (bpm)
Stroke Volume	Stroke volume is the volume of blood pumped by one ventricle per contraction (cm^3)

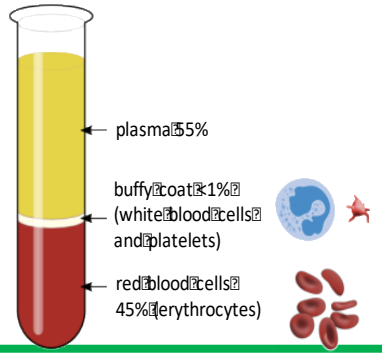
Aerobic respiration
Respiration with oxygen. Occurs inside the mitochondria continuously
Glucose is oxidised by oxygen to transfer the energy the organism needs to perform it's functions.
Glucose + oxygen → carbon dioxide + water

Anaerobic respiration
Respiration when oxygen is in short supply. Occurs during intensive exercise
During hard exercise, muscle cells are respiring so fast that blood cannot transport enough oxygen to meet their needs. Glucose is partially oxidised to produce lactic acid which builds up in muscle tissue causing them to become painful and fatigued.
Glucose → lactic acid



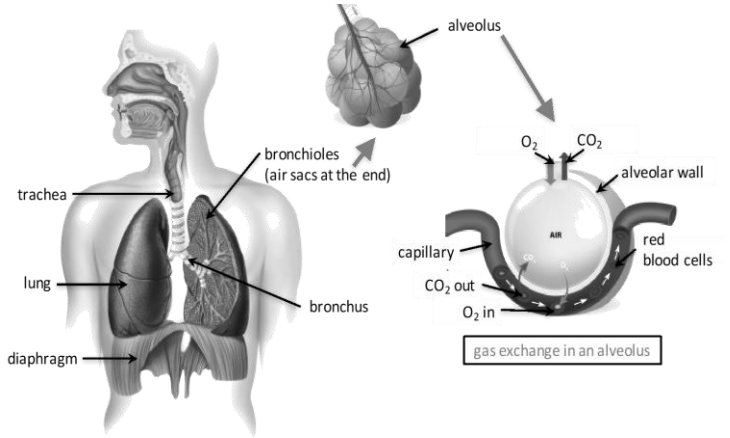


Artery	Vein	Capillary
Carry blood away from the heart	Carry blood to the heart	Connects arteries and veins
Thick muscular walls, small lumen, carry blood under high pressure, carry oxygenated blood (except for the pulmonary artery).	Thin walls, large lumen, carry blood under low pressure, have valves to stop flow in the wrong direction, carry deoxygenated blood (except for the pulmonary vein).	One cell thick to allow diffusion, Carry blood under very low pressure.

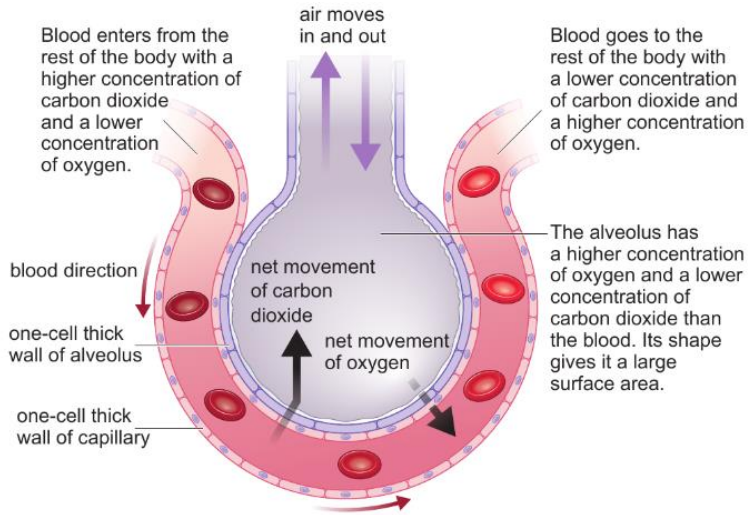


Plasma (55%)	Pale yellow fluid	Transports CO_2, hormones and waste.
Red blood cells (erythrocytes)(45%)	Carries oxygen	Large surface area, no nucleus, full of haemoglobin.
White blood cells (phagocytes and lymphocytes)(<1%)	Part of the immune system	Some produce antibodies, others surround and engulf pathogens.
Platelets (<1%)	Fragments of cells	Clump together to form blood clots.

KS4 Biology – Exchange and Transport



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



D The drawing shows an alveolus, which is adapted for fast gas exchange (swapping of gases). An adult lung contains about 500 million alveoli, which are grouped together in clusters at the ends of tiny tubes.

Factors affecting rate of diffusion (Biology only)		
Surface area	**Concentration gradient**	**Diffusion distance**
Increased surface area on exchange surface increases diffusion.	Diffusion is from area of high concentration to low concentration. A large difference in concentration will increase rate f diffusion.	The smaller the diffusion distance to faster the rate of diffusion,

Fick's Law describes the relationship between the rate of diffusion and the three factors that affect diffusion. It states that 'the rate of diffusion is proportional to both the surface area and concentration difference and is inversely proportional to the thickness of the membrane'.

Fick's law can be written as:

$$\text{Rate of diffusion} \propto \frac{\text{surface area} \times \text{concentration difference}}{\text{thickness of membrane}}$$

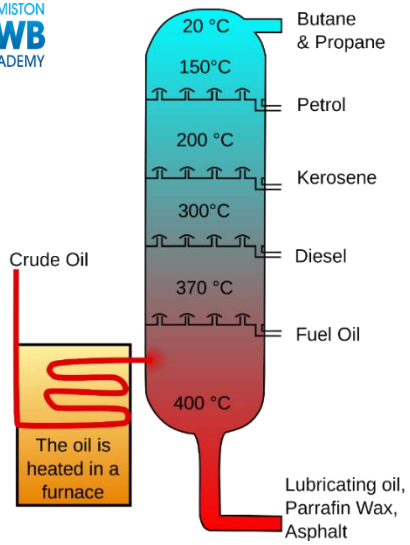
$\propto$ means 'is proportional to'.

The rate of diffusion will double if:

1. surface area or concentration difference is doubled or
2. thickness of the exchange membrane is halved.

All of the exchange surfaces consist of cell membranes which are very thin. This explains why diffusion is very fast across membranes.

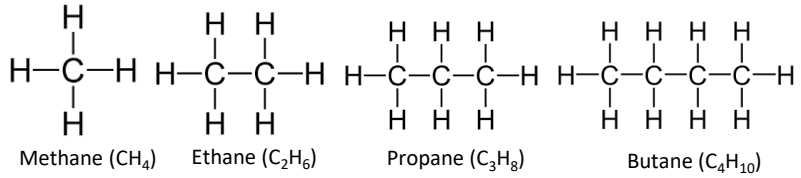
KS4 Chemistry – Fuels



	What happens as the hydrocarbon chain length increases?
Boiling point (temperature at which liquid boils)	↑
Viscosity (how easily it flows)	↑
Flammability (how easily it burns)	↓

1. Hydrogen fuel	Hydrogen reacts with oxygen in the engine to power the vehicle	✓ Water is the product ✓ No greenhouse gases released ✓ Renewable X Expensive to buy X Difficult to re-fuel
2. Fossil fuels	Crude oil, natural gas and coal	Petrol, kerosene and diesel oil are non-renewable. Methane is found in natural gas and is also non-renewable.
3. Sulfur dioxide	Released from burning hydrocarbons with sulfur impurities in	Sulfur dioxide dissolves in rain water to form acid rain. This damages plant life and can make water habitats acidic. Acid rain can also erode limestone and sandstone structures.
4. Oxides of nitrogen	Oxygen and nitrogen react under high temperatures to form these.	As pollutants, oxides of nitrogen can damage the ozone layer and are also classified as greenhouse gases. Can cause respiratory problems.
5. Incomplete combustion issues	1. Carbon monoxide is an odourless, toxic gas that can kill	2. Soot (carbon) is also produced that builds up in the atmosphere and can cause global dimming. This reduces the amount of sunlight that reaches the Earth and can alter rainfall patterns.

Display formula for first four alkanes



Complete combustion of methane:

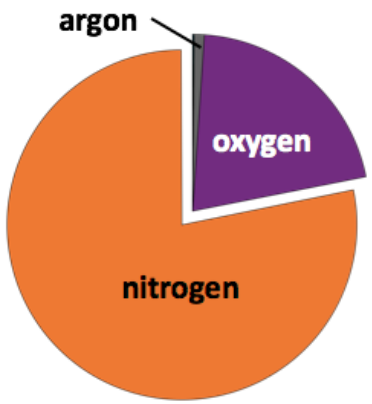
Methane + oxygen → carbon dioxide + water + energy

CH_4 (g) + $2O_2$ (g) → CO_2 (g) + 2 H_2O (l)

Complete Combustion	• The carbon and hydrogen in the fuels are **oxidised**. • **Carbon dioxide, water and energy** are released.
Incomplete combustion	• There is **not enough oxygen** available for complete combustion. • The products of the reaction are **carbon monoxide, carbon and water**.

Keyword	Definition
Crude oil	A finite resource. Consisting mainly of plankton that was buried in the mud, crude oil is the remains of ancient biomass.
Hydrocarbons	• make up the majority of the compounds in crude oil • made up of **hydrogen and carbon only.**
General formula for alkanes	**C_nH_{2n+2}** for example: C_2H_6 or C_6H_{14}
Cracking	• The **breaking down** of long chain hydrocarbons into **smaller, more useful** chains. • Helps **supply** meet **demand.** • Can be done by various methods including **catalytic cracking and steam cracking**.
Fractions	• The hydrocarbons in crude oil can be split into fractions. • Each fraction contains molecules with a similar number of carbon atoms in them. • The process used to do this is called fractional distillation.
Using fractions	• Fractions can be processed to produce **fuels and feedstock** for petrochemical industry. • We depend on many of these fuels; **petrol, diesel and kerosene**. • Many useful materials are made by the petrochemical industry; **solvents, lubricants and polymers**.

KS4 Chemistry – Earth and Atmospheric Science



Gas	Percentage
Nitrogen	78%
Oxygen	21%
Argon	0.9%
Carbon dioxide	0.04%

Volcano activity 1st Billion years	Billions of years ago there was intense volcanic activity	This released gases (mainly CO_2) that formed to early atmosphere and water vapour that condensed to form the oceans.
Other gases	Released from volcanic eruptions	Nitrogen was also released, gradually building up in the atmosphere. Small proportions of ammonia and methane also produced.
Reducing carbon dioxide in the atmosphere	When the water vapour condensed, the oceans formed and the carbon dioxide dissolved into it	This formed carbonate precipitates, forming sediments. This reduced the levels of carbon dioxide in the atmosphere.

Effects of climate change
Rising sea levels
Extreme weather events such as severe storms
Change in amount and distribution of rainfall
Changes to distribution of wildlife species with some becoming extinct

How oxygen increased

Algae and plants	These produced the oxygen that is now in the atmosphere, through photosynthesis.	carbon dioxide + water → glucose + oxygen $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$
Oxygen in the atmosphere	First produced by algae 2.7 billion years ago.	Over the next billion years plants evolved to gradually produce more oxygen. This gradually increased to a level that enabled animals to evolve.

How carbon dioxide decreased

Reducing carbon dioxide in the atmosphere	Algae and plants	These gradually reduced the carbon dioxide levels in the atmosphere by absorbing it for photosynthesis.
Formation of sedimentary rocks and fossil fuels	These are made out of the remains of biological matter, formed over millions of years	Remains of biological matter falls to the bottom of oceans. Over millions of years layers of sediment settled on top of them and the huge pressures turned them into coal, oil, natural gas and sedimentary rocks. The sedimentary rocks contain carbon dioxide from the biological matter.

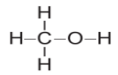
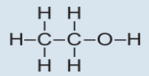
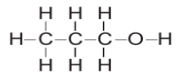
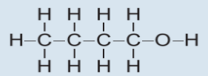
Human activities and greenhouse gases

Carbon dioxide	Human activities that increase carbon dioxide levels include burning fossil fuels and deforestation.
Methane	Human activities that increase methane levels include raising livestock (for food) and using landfills (the decay of organic matter released methane).
Climate change	There is evidence to suggest that human activities will cause the Earth's atmospheric temperature to increase and cause climate change.
Carbon dioxide, water vapour and methane	Examples of greenhouse gases that maintain temperatures on Earth in order to support life
The greenhouse effect	Radiation from the Sun enters the Earth's atmosphere and reflects off of the Earth. Some of this radiation is re-radiated back by the atmosphere (including carbon dioxide, methane and water vapour) to the Earth, warming up the global temperature.

KS4 Chemistry – Alcohols and Carboxylic Acids

Alcohols

General formula: $C_nH_{2n+1}OH$

Name	Molecular formula	Structural formula
methanol	CH_3OH	
ethanol	C_2H_5OH	
propanol	C_3H_7OH	
butanol	C_4H_9OH	

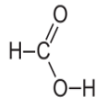
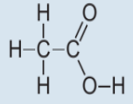
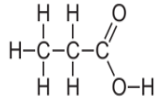
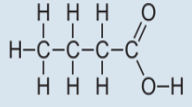
B The naming of compounds uses a set of rules produced by the International Union of Pure and Applied Chemistry (IUPAC).

- -OH functional group
- Combustion of alcohols:
  alcohol + oxygen → carbon dioxide + water
- Oxidised to form carboxylic acids
- React with reactive metals to form hydrogen gas



C Alcohols react with sodium metal but their reactivity depends on carbon chain length.

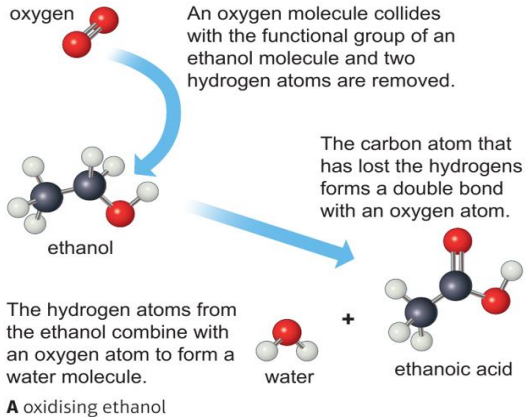
Carboxylic Acids

Name	Molecular formula	Structural formula
methanoic acid	HCOOH	
ethanoic acid	CH_3COOH	
propanoic acid	C_2H_5COOH	
butanoic acid	C_3H_7COOH	

C the first four carboxylic acids

The carboxylic acids have similar chemical properties. They all:

- form solutions with a pH less than 7 (if soluble)
- react with metals to form a salt and hydrogen
- react with bases to form a salt and water
- react with carbonates to form a salt, water and carbon dioxide.



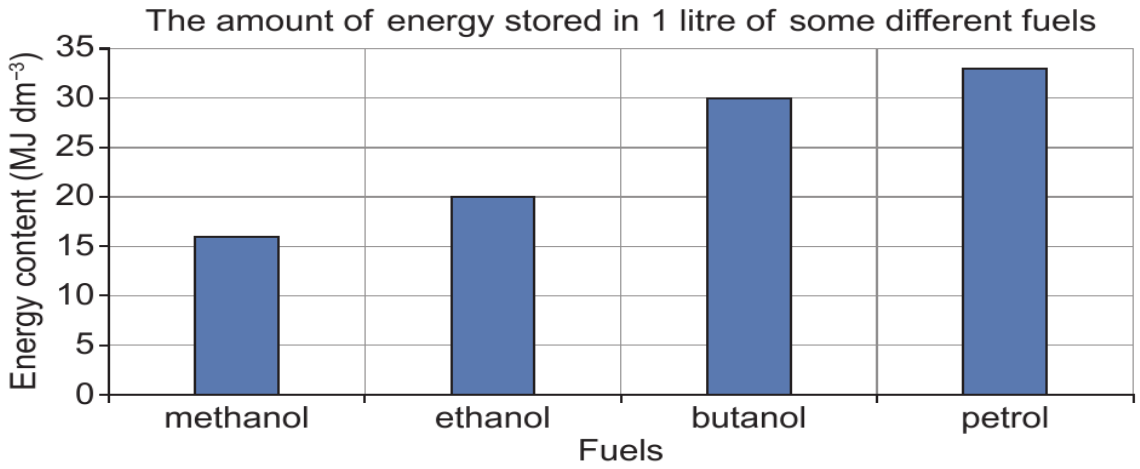
A oxidising ethanol

Keyword	Definition
Alcohol	An homologous series of compounds that contain the –OH functional group.
Fractional distillation	In fractional distillation a mixture of several substances, such as crude oil, is distilled and the evaporated components are collected as they condense at different temperatures.
Fraction	In fractional distillation, such as that of crude oil, the different parts of the original mixture are called fractions. The substances in each fraction have similar boiling points to each other.
Organic compound	Chemical compounds that contain carbon. Atoms such as hydrogen, oxygen, nitrogen or chlorine are also common in organic compounds.
Distillate	A distillate will contain the compound that boils at the lowest temperature
Renewable	Energy sources that are replenished and not exhausted, eg solar power.
Homologous series	A family of compounds that have the same general formula and similar properties, but have different numbers of carbon atoms.
Carboxylic acid	An homologous series of compounds that contain the –COOH functional group.
Oxidation	Oxidation occurs when an atom, molecule, or ion loses one or more electrons in a chemical reaction
Oxidising agent	A substance that can oxidise other substances in chemical reactions.
Fermentation	Anaerobic respiration occurring in microorganisms.
Functional group	An atom or group of atoms in a molecule that is mainly responsible for the molecule's chemical reactions and properties.
Sugar	Basic unit of carbohydrates.
Carbohydrates	Food belonging to the food group consisting of sugars, starch and cellulose.
Respiration	Process in living organisms involving the transfer of energy, typically with the intake of oxygen and the release of carbon dioxide from the oxidation of glucose.
Anaerobic	Without oxygen.
Enzymes	A protein which catalyses or speeds up a chemical reaction.

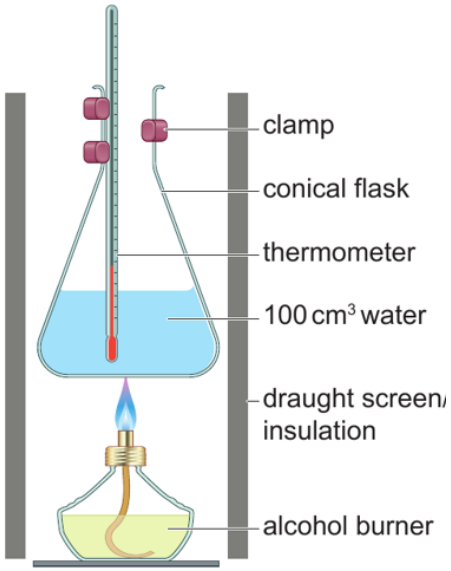
- In solution:
  $CH_3COOH \leftrightarrow CH_3COO^- + H^+$
- Carboxylic acid + metal → salt + hydrogen
- Carboxylic acid + base → salt + water

KS4 Chemistry – Alcohols and Carboxylic Acids

Combustion of alcohols



D Butanol has some advantages over some other alcohols used as fuels.



B investigating energy in fuels

Method

Wear eye protection. Do not refill the alcohol burner if there are any naked flames nearby.

A Measure the mass of an alcohol burner and cap. Record the mass and the name of the alcohol.

B Place the alcohol burner in the centre of a heat-resistant mat.

C Use a measuring cylinder to add 100 cm^3 of cold water to a conical flask.

D Measure and record the initial temperature of the water and clamp the flask above the alcohol burner.

E Light the wick of the burner and allow the water to heat up by about 40 °C.

F Replace the cap on the burner and measure and record the final temperature of the water.

G Measure the mass of the alcohol burner and cap again and record the mass.

H Calculate the mass of the alcohol burned to produce a 1 °C rise in temperature.

I Repeat steps A to H using fresh, cold water and a different alcohol.

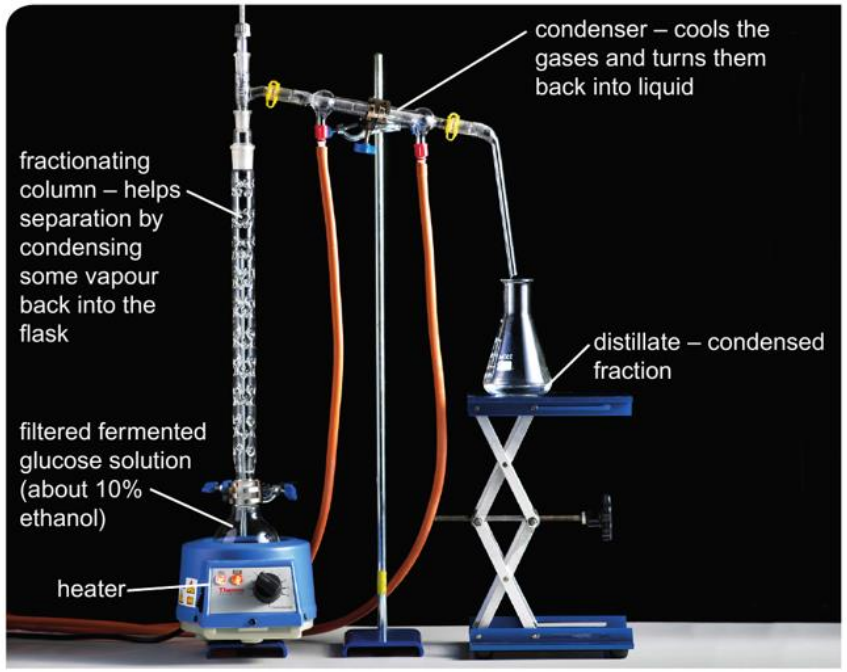
Ethanol Production (C_2H_5OH)

- Sugars mixed with water and yeast
- Fermentation - enzymes in the yeast turn the sugars into ethanol and carbon dioxide
- Temperature and pH must be carefully controlled
- Yeast undergo anaerobic respiration (occurs in absence of oxygen)

Example:

glucose → ethanol + carbon dioxide

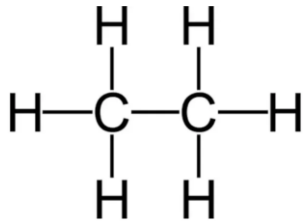
- Fermentation produces alcohol concentrations <15%
- Fractional distillation used to form more concentrated alcohol solutions
- Yeast undergo anaerobic respiration (occurs in absence of oxygen)



D fractional distillation of an ethanol solution

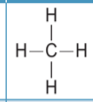
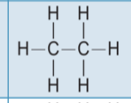
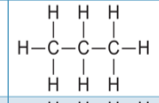
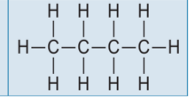
KS4 Chemistry – Hydrocarbons

Alkane



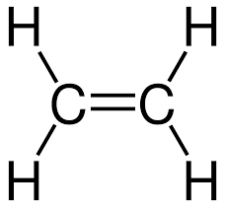
e.g. ethane

- General formula: C_nH_{2n+2}
- Saturated molecule

Number of carbons in the chain	Prefix	Alkane	Molecular formula	Structural formula
1	meth-	methane	CH_4	
2	eth-	ethane	C_2H_6	
3	prop-	propane	C_3H_8	
4	but-	butane	C_4H_{10}	

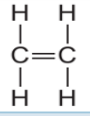
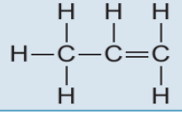
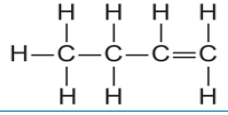
B the first four members of the alkane homologous series

Alkene



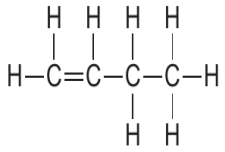
e.g. ethene

- General formula: C_nH_{2n}
- Unsaturated molecule
- C=C functional group

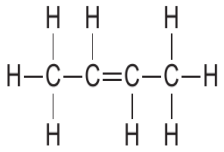
Name	Molecular formula	Structural formula
ethene	C_2H_4	
propene	C_3H_6	
butene	C_4H_8	

C the first three members of the alkene homologous series

Isomers



but-1-ene



but-2-ene

D The numbers in the butene isomer names show the position of the double bond. The 1 shows that the C=C bond starts at the end of the molecule on the first carbon, the 2 shows that it is in the middle. Carbon atoms are numbered starting from the end closest to the double bond.

Keyword	Definition
Alkane	A hydrocarbon in which all the bonds between the carbon atoms are double bonds.
Alkene	A hydrocarbon in which there are one or more double bonds between carbon atoms.
Homologous series	A family of compounds that have the same general formula and similar properties, but have different numbers of carbon atoms.
Carbon monoxide	A poisonous gas produced from carbon burning without enough oxygen.
Carbon dioxide	A colourless, odourless gas with the molecular formula CO_2.
Saturated	A molecule that contains only single bonds between the carbon atoms in a chain.
Unsaturated	A molecule that contains one or more double bonds between carbon atoms in a chain.
Complete Combustion	Combustion of hydrocarbons with enough oxygen present to convert all the fuel into carbon dioxide and water.
Incomplete Combustion	When a substance reacts only partially with oxygen, such as when carbon burins in air producing carbon monoxide and soot (unburnt carbon).
Isomer	Molecules with the same molecular formula but different arrangements of atoms.
Addition reaction	A reaction in which reactants combine to form one larger product and no other products.
Functional group	An atom or group of atoms in a molecule that is mainly responsible for the molecule's chemical reactions and properties.

KS4 Chemistry – Hydrocarbons

Combustion

Complete

- Plentiful supply of oxygen
- Products:
  - Carbon dioxide
  - Water
- Blue flame on Bunsen burner
- Example:

$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$

Incomplete

- Poor supply of oxygen
- Products:
  - Carbon monoxide
  - Carbon (soot)
- Yellow flame on Bunsen burner

Bromine Water Test



Bromine water is a dilute solution of bromine in water, Br_2 (aq).
It has an orange-brown colour.

- Alkenes – react with Br_2
- Alkanes – do not react with Br_2

The C=C double bond reacts with the bromine to form a colourless product. The bromine is therefore removed from the solution, which loses its colour.

Addition Reactions

Two reactant molecules add to one another to form just one product molecule.

A reaction in which reactants combine to form one larger product molecule and no other products.

Example:

ethene + bromine ⟶ 1,2-dibromoethane



D Ethene reacts with bromine to form 1,2-dibromoethane.

SC24 – Separate Chemistry – Polymers

Polymers are made from polymers.

Polymers have a high RMM.

Addition polymer – poly(ethene) from ethene monomers

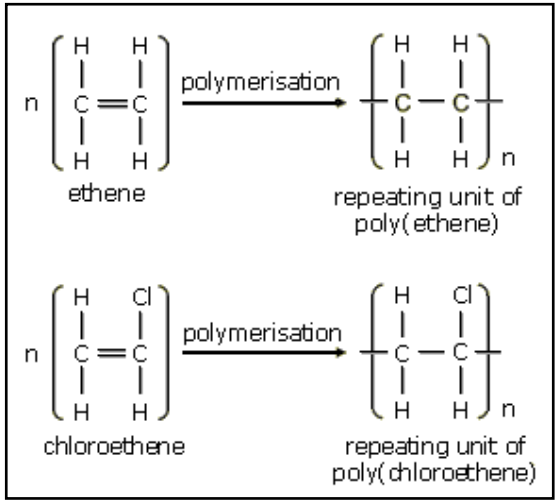


n = a big number of monomers

Polymers: Alkenes can be used to make polymers. Polymers are very large molecules made when many smaller molecules join together, end-to-end. The smaller molecules are called **monomers**.

Displayed formulas of polymers
Polymer molecules are very large compared with most other molecules, so the idea of a repeating unit is used when drawing a displayed formula. When drawing one, starting with the monomer:
change the double bond in the monomer to a single bond in the repeating unit add a bond to each end of the repeating unit.

Addition polymeristion – when a double bond in a monomer opens and another monomer molecule is added on.



Synthetic polymers – man made. Manufactured in the laboratory. E.g. poly(ethene)

Natural polymers – DNA, starch, proteins. DNA – made from 4 different monomers called nucleotides. Starch is made from a sugar called glucose. Proteins are polymers made from amino acids.

Key word	Definition
Addition polymerisation	When a double bond in a monomer opens and another monomer molecule is added on.
Biodegradable	Microbes can feed on these types of materials, and break them down.
Condensation polymerisation	Monomers join together, and eliminate a small molecule of water.
Ester links	Functional group in polymers formed when an acid has reacted with an alcohol.
Functional group	Atom or group of atoms that is responsible for the properties and reactions of the compound.
Monomers	Small molecules with a double bond, that can open to form polymers
Non-biodegradable	Microbes cannot feed on these types of materials, and cannot break them down.
Polyester	Polymer made by condensation from a carboxylic acid and an alcohol. Synthetic polymers.
Polymerisation	Monomers (small molecules) join together to form polymers (large molecules)
Polymers	Large molecules made from lots of small molecules, called monomers.
Repeating unit	Shows how the monomer has changed and how it repeats in a polymer.
Synthetic polymers	Man made polymers (plastics)

SC24 – Separate Chemistry – Polymers

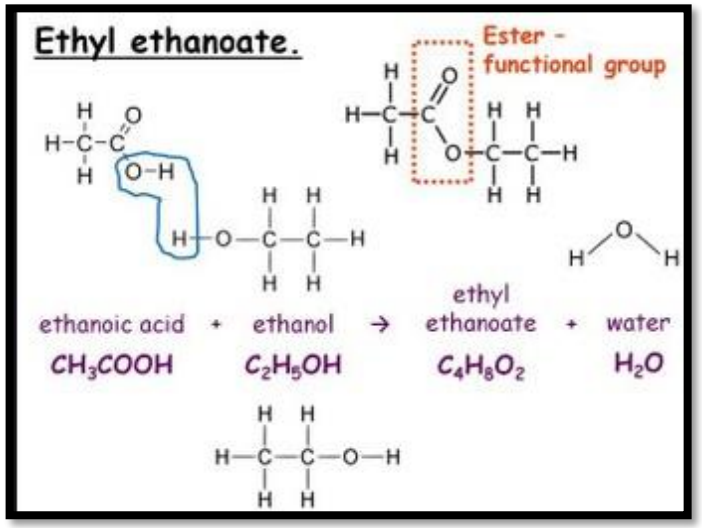
H Condensation Polymers:
Condensation polymerisation is a process whereby many small monomer molecules join together to form one large polymer, with water, or some other small molecule formed at the same time. The monomers have more than one functional group.

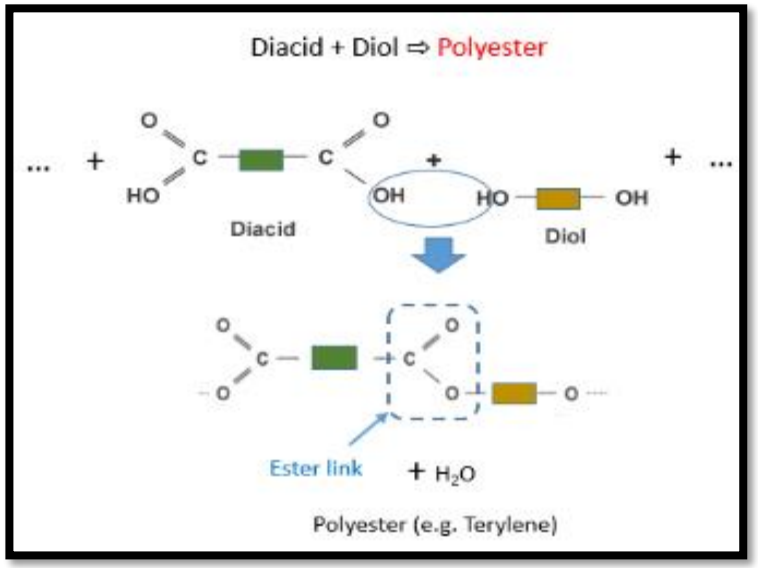
H Polyesters: You can use reaction of alcohols and carboxylic acids to make long chain esters which contain thousands of individual ester molecules joined together,

This is a polyester. The long-chain molecules can be made into fibres, which can be woven into fabrics.

Problems with polymers:
- They are non-biodegradable, causing problems in landfill sites.
- When incinerated, the energy released can be used to generate electricity. However toxic gases are formed.
- Difficult to recycle polymers, as they need to be sorted into different types before they can be made into new objects.3

Polymer (and common name)	Properties	Uses
poly(ethene) polythene or polyethylene	flexible, cheap, good insulator	plastic bags, plastic bottles, cling film, insulation for electrical wires
poly(propene) polypropene or polypropylene	flexible, shatterproof, high softening point	buckets and bowls
poly(chloroethene) **PVC**	tough, cheap, long-lasting, good insulator	window frames, gutters, pipes, insulation for electrical wires
poly(tetrafluoroethene) **PTFE** or **Teflon®**	tough, slippery, resistant to corrosion, good insulator	non-stick coatings for saucepans, bearings and skis, containers for corrosive substances, stain-proofing carpets, insulation for electrical wires





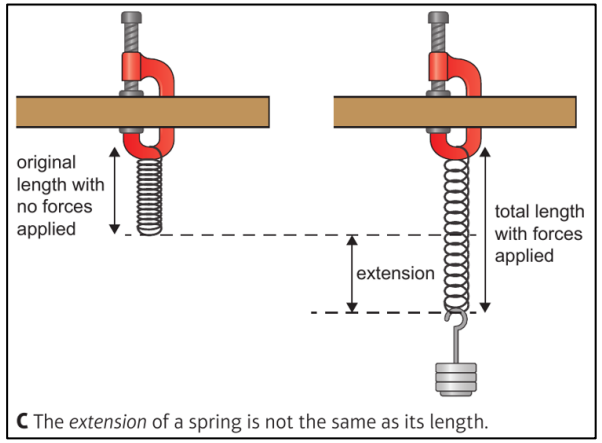
Esters are made when carboxylic acids (like ethanoic acid) react with alcohols (like ethanol):

ethanoic acid (acid) + ethanol (alcohol) → ethyl ethanoate (ester) + water

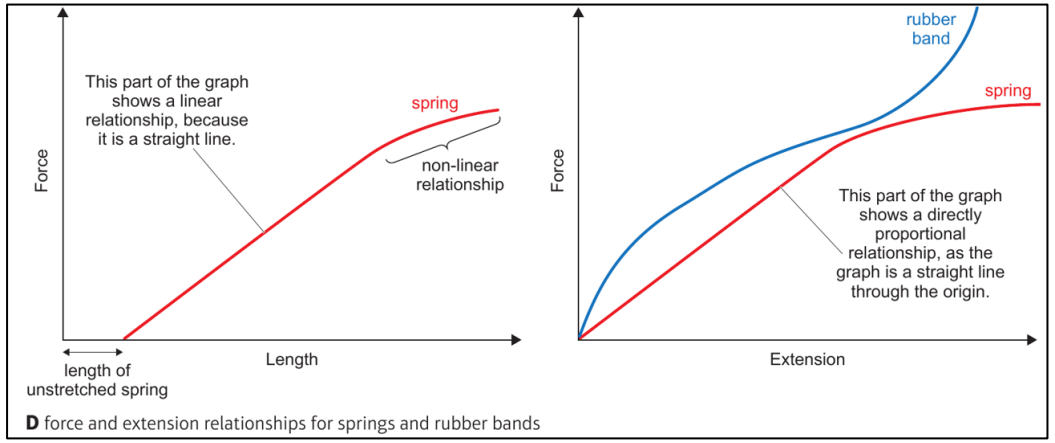
Recycling symbols on polymers:



KS4 Physics – Forces and matter



C The *extension* of a spring is not the same as its length.



D force and extension relationships for springs and rubber bands

Key word	Definiton
Elastic	An object that can return to its original shape, after forces are removed
Inelastic	An object that cannot return to its original shape, so keeps its new shape, even after forces are removed
Extension	The change in length of an object after forces have been applied
Linear relationship	The graph shows a straight line
Non-linear relationship	The graph does not show a straight line (curve)
Directly proportional	If the value of one variable increase, the other variable also increase by the same percentage
Spring constant	The force needed to produce an extension of 1 metre in a spring
Work done	The energy transferred when a force moves through a distance

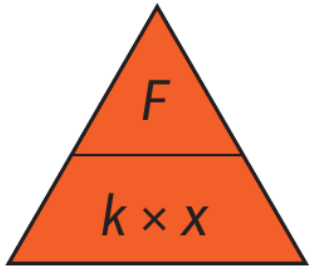
The force needed to extend a spring by 1 metre is called the spring constant. The stiffer the spring, the larger the spring constant.

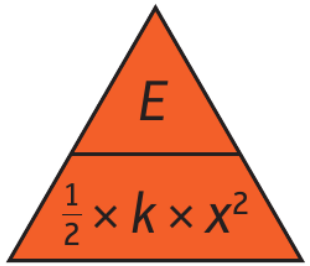
The spring constant is calculated using the following equation:

spring constant = force / extension
(N/m) (N) (m)

The work done to stretch a spring is calculated using the following equation:

energy transferred in stretching = ½ × spring constant × (extension)²
(J) (N/m) (m)²





Separate physics ONLY

Calculating pressure in fluids

Liquids and gases are fluids. An object in a fluid experiences a pressure caused by both the fluid itself and the atmospheric pressure.

The pressure in fluids causes a force normal to a surface. A force that is normal to a surface acts at right angles (90°) to it. To calculate the pressure at the surface of a fluid use the equation:

$$pressure = \frac{force\ normal\ to\ a\ surface}{area\ of\ that\ surface}$$

$$P = \frac{F}{A}$$

This is when:

- pressure (P) is measured in pascals (Pa)
- force (F) is measured in newtons (N)
- area (A) is measured in metres squared (m^2)

Separate physics ONLY

Pressure in a liquid increases as the depth increases. The pressure in a liquid is due to the weight of the column of water above. Since the particles in a liquid are tightly packed, this pressure acts in all directions

Separate physics HIGHER ONLY

Calculating pressure in a liquid

The pressure caused by a column of liquid can be calculated using the equation:

pressure = height of column × density of the liquid × gravitational field strength

$$P = h\,\rho\,g$$

This is when:

- pressure (P) is measured in pascals (Pa)
- height of column (h) is measured in metres (m)
- density (ρ) is measured in kilograms per metre cubed (kg/m^3)
- gravitational field strength (g) is measured in newtons per kilogram (N/kg)

Separate physics ONLY

Atmospheric pressure decreases as the height of a surface above ground level increases. This is because, as the altitude increases:

- the number of air molecules decreases
- the weight of the air decreases
- there is less air above a surface



This is why aircrafts that fly at high altitudes must be pressurised. If the air pressure is too low, humans cannot take in oxygen quickly enough to meet their bodies' needs.

KS4 Physics – Forces and their Effects

Forces can be placed into two groups. There are forces that act on contact and there are forces that act at a distance.

Contact Forces	Non-Contact Forces
Air Resistance	Gravity
Friction	Magnetism
Tension	Electrical Force
Normal Force	Nuclear Force

Force	A vector quantity	. A push or a pull on an object.
Contact forces	Two objects have to touch for the force to act. Interact at zero distance.	Caused by objects interacting. E.G. Friction, man pushing a wall, a book on a table, Upthrust of water on a boat.
Non-contact forces	Two objects do not have to touch for the force to act. Can interact at a distance.	Caused by interacting fields. E.G. Magnetic forces, electrostatic forces, gravitational forces.

When two children are on a see-saw the see-saw may be balanced and the children will not move. In this case the clockwise moment is balanced by the anti-clockwise moment – so the two moments are equal.

As both the clockwise moment and anti-clockwise moment are balanced:

$$F_c \times {}_c = F_a \times {}_a$$

Where the subscript denotes the direction (clockwise or anti-clockwise).

Free body force diagrams	A diagram showing all the forces acting on an isolated object or a system	The size and direction of the pairs of forces acting upon an object or system.
Resultant force	Forces acting along the same line	Add together the forces acting in the same direction. Subtract the forces acting in opposite directions.
Vector diagrams	A diagram where forces do not act in the same line. Use scale diagrams to find the resultant force	Draw all the forces acting upon an object. Make sure they are to scale and in the right directions. Draw a joining line rom the start of the first force and the end of the last force.

Moments: A force or a system of forces may cause an object to rotate.

Everyday examples of force causing a rotation motion include door handles, steering wheels and see-saws.

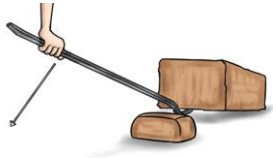
The turning effect of a force is called the moment of the force. The size of the moment is determined by the equation:

moment of a force (Nm) = force (N) × distance (m)

$$M = F \times x$$

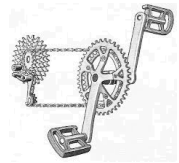
The distance, x, is normal to the direction of the force

Levers are used to increase the force applied to an object, usually to lift it up from a surface. Levers must have a pivot to rotate around and will work on the principle of moments.



A gear is a wheel that has teeth on it (also known as a cog), as shown in the diagram opposite. For gears to do work you need at least two gears. Gears are used to transmit rotational forces from one place to another .





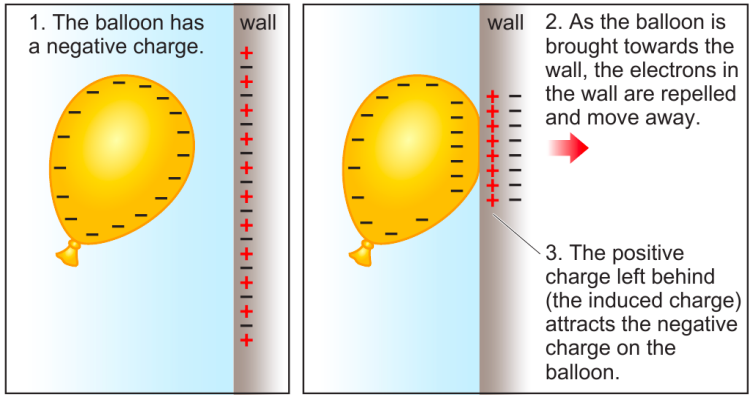
When two cogs are in contact with their teeth interlocking, the driven cog will rotate in the opposite direction to the drive cog. If the drive cog in a gear spins clockwise then the driven cog will spin anti-clockwise.

When a large cog is driving a small cog, then the small cog will rotate faster than the large cog. Halving the number of teeth on the small cog will double the speed of the small cog. Going from a large cog to a smaller cog will increase the speed of rotation.



KS4 Physics – Charge and Static Electricity

Example of Static Electricity

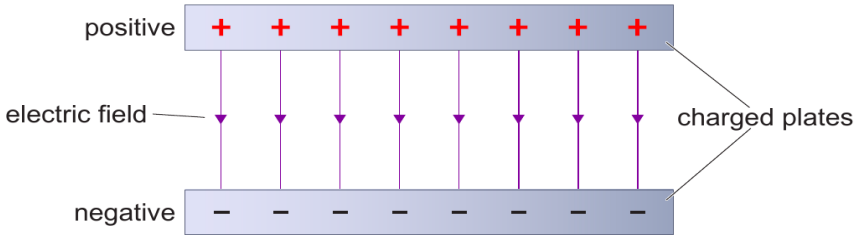


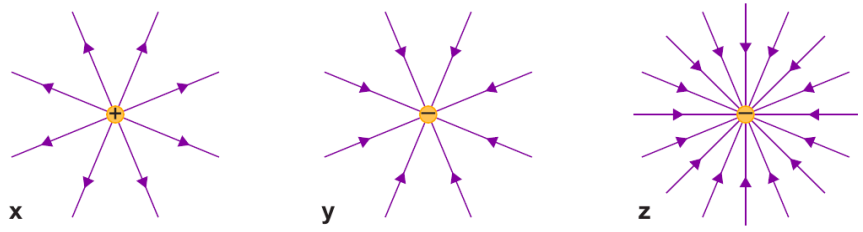
<u>Dangers of static electricity</u>
Risk of discharge/sparks. Could lead to fire. Solution and to prevent sparks – earth wire is used to disperse electricity into the ground.

Sparks are a problem when refueling an aircraft, which often becomes charged when flying through the air.



<u>Electric fields –</u> a charged object has a force field around it called an electric field (or electrostatic field)
Field lines 1. Never cross, 2. show where the field is strongest (lines are closest), 3. Show the direction of the force on a charge in the field. 4. Go from positive to negative – if only 1 object they keep going and become more widely dispersed.

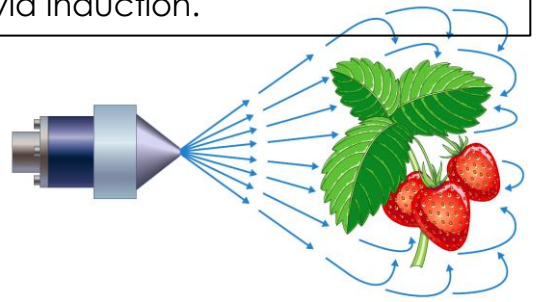




A an electric field around positive and negative point charges

Separate only

<u>Uses of Static Electricity</u>
Electrostatic spraying makes use of static electricity. Use of charged particles for painting, applying pesticides. Particles spread out due to repulsion, and are then attracted to a surface via induction.

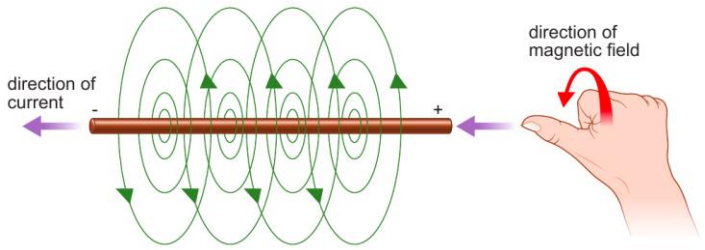


Keyword	Definition
Static Electricity	Electric charge on insulating materials
Conductor	Material that does conduct electricity.
Insulator	Material that does not conduct electricity.
Electric Charge	Electric charge is a fundamental property of a material that causes a force to be experience when in a magnetic field
Acetate	An insulator that can be used to build up a static charge by friction.
Induction	To create, for example build up of a current in a wire in a magnetic field.
Discharge	Is the release of electricity, commonly via a spark.
Electrostatic	A force of attraction between oppositely charged particles and repulsion between like charges.
Force field	The space around something where a non-contact force affects things, e.g magnetic and gravitational fields.
Field line	The field lines are perpendicular to the surface of the charge. The magnitude of charge and the number of field lines, both are proportional to each other.

KS4 Physics – Magnetism and the Motor Effect

Maxwell's Right Hand Grip rule

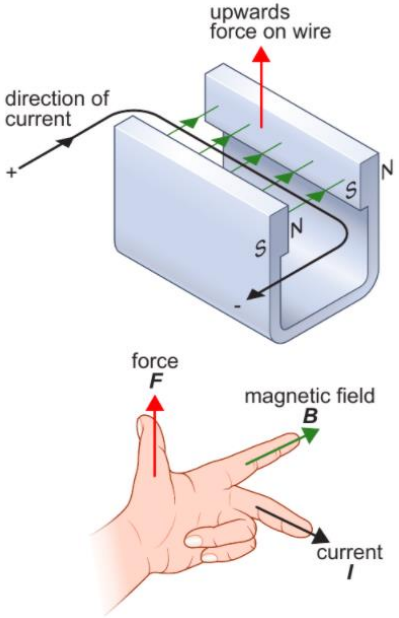
A circular magnetic field forms around a current carrying wire. If you point your right thumb in the direction of the current (+ to -), the magnetic field goes in the direction your fingers are pointing.



A current flowing through a wire causes a magnetic field. Electric motors and other devices depend on the magnetic effect of electric currents.

Fleming's Left Hand Rule (HT)

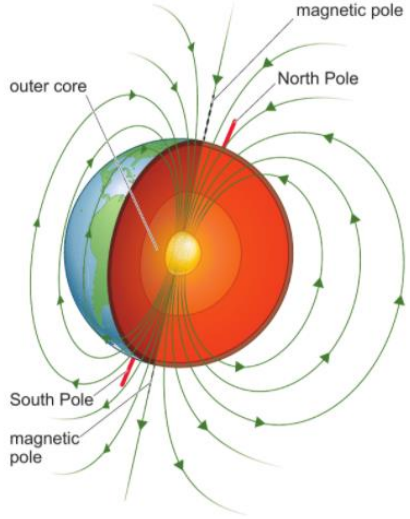
The motor effect describes the force that acts on a current carrying wire in a magnetic field.



Earth's magnetic field

A plotting compass can also show the Earth's magnetic field.

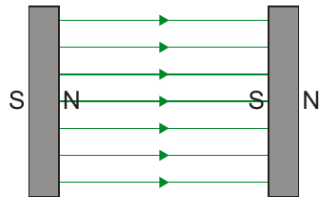
The behaviour of compasses is evidence that the Earth has a magnetic field, which is similar in shape to the magnetic field of a bar magnet.



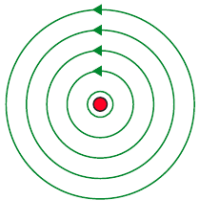
Keyword	Definition
Magnet	An object that has its own magnetic field around it.
Magnetic field	The area around a magnet where it can affect magnetic materials or induce a current.
Permanent magnet	A magnet that is always a magnet such as a bar magnet.
Solenoid	A coil of wire with electricity flowing in it. Also called an electromagnet.
Motor Effect	The force experienced by a wire carrying a current that is placed in a magnetic field.
Magnetic flux density	A way of describing the strength of a magnetic field. Measured in Teslas (T).
Split ring commutator (HT)	This reverses the direction of the current in the coil each half turn. This allows the motor coil to rotate continuously in one direction.

Magnetic field diagrams (HT)

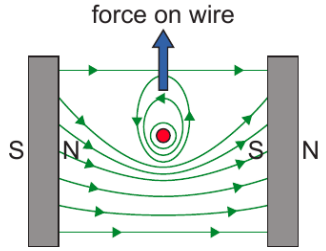
Magnetic field flows from north to south. Also around a current carrying wire.



Two flat magnets produce a uniform magnetic field between them.



A magnetic field goes around a wire carrying a current.



When the wire carrying a current is put between the magnets, the two fields interact to produce a force.

KS4 Physics – Electromagnetic Induction

Inducing a potential difference

A potential difference can be induced (created) in a **conductor** when there is movement between the conductor and a magnetic field. This can occur in two different ways:

a coil of wire is moved in a magnetic field
a magnet is moved into a coil of wire

This is called **electromagnetic induction** and is often referred to as the **generator effect**.

The direction of the induced potential difference or induced current depends on the direction of movement. The current is reversed when:

The magnet is moved out of the coil
The other pole of the magnet is moved into the coil

An induced potential difference or induced current will increase if:

The speed of movement is increased
The magnetic field strength is increased
The number of turns on the coil is increased

Transformer Calculations

The primary coil of a transformer has a current of 0.5 A with a potential difference of 100 V. The current in the secondary coil is 25 A. What is the potential difference across the secondary coil? Use $V_p \times I_p = V_s \times I_s$

$$100\,V \times 0.5\,A = V_s \times 25\,A$$

$$50 = V_s \times 25$$

$$V_s = \frac{50}{25} = 2\,V$$

A radio runs off the 230 V mains supply but only needs 23 V. Its transformer has 100 turns of wire in the primary coil. How many turns are needed in the secondary coil?

$$\frac{V_p}{V_s} = \frac{N_p}{N_s}$$

$$\frac{230\,V}{23\,V} = \frac{100}{N_p}$$

$$10 = \frac{100}{N_p}$$

$$10 \times N_p = 100$$

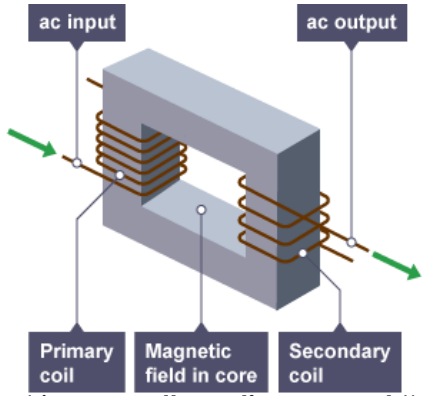
$$N_p = \frac{100}{10} = 10$$

So the secondary coil must have 10 turns.

Keyword	Definition
A.C	Alternating current, current that flow in both directions
Alternator	An electrical generator which produces alternating current
Conductor	Electrical conductors are materials that have low resistance and allow current to pass through them easily
Dynamo	An electrical generator which produces direct current
Electromagnetic Induction	The production of potential difference (voltage) when a conductor e.g. wire moves through a magnetic field. If the conductor is part an electric current, an induced current will flow
Generator	Device that converts kinetic energy into electrical energy
Generator Effect	When motion between a conductor and a magnetic field creates electricity, i.e. a magnet is moved into a coil of wire.
Magnetic Field	Area surrounding a magnet that can exert a force on magnetic materials
National Grid	The network that connects all of the power stations in the country to make sure that everywhere has access to electricity.
Potential Difference	The potential difference (or voltage) of a supply is a measure of the energy given to the charge carriers in a circuit. Units = volts (V). This is the voltage between two points that makes an electric current flow between them.
Power	The energy transferred each second, measured in watts (W). Power = work done ÷ time taken.
Transformer	An electrical device that increases, or decreases, the potential difference (voltage) of an alternating current.

KS4 Physics – Electromagnetic Induction

Transformers and how they work



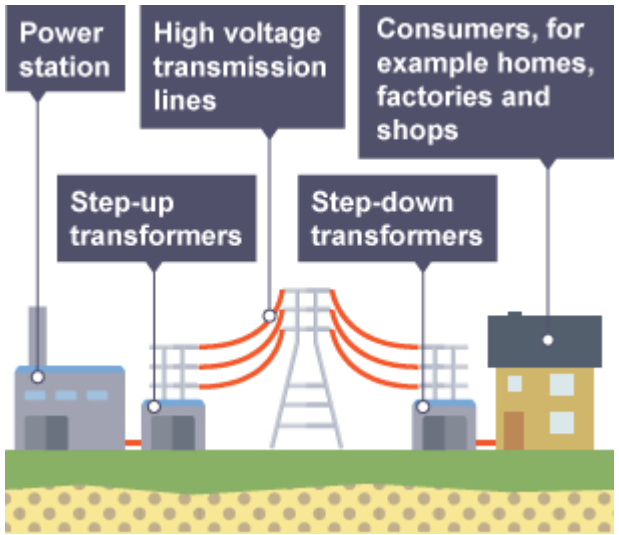
1.A primary voltage drives an **alternating current** through the primary coil.
2.The primary coil current produces a magnetic field, which changes as the current changes.
3.The iron core increases the strength of the magnetic field.
4.The magnetic field passes through (or cuts) the secondary coil.
5.The changing magnetic field induces a changing potential difference in the secondary coil.
6.The induced potential difference produces an alternating current in the external circuit.

Transmission Lines

To ensure that the minimum amount of power is lost from the cables:
- the cables are thick so that their resistance is low
- high voltages are used to reduce the current through the transmission lines

A low resistance and a low current mean that the transmission wires will not heat up as much. As a result, most of the power is delivered to the consumer, and not lost through the wires.

Transformers and how they work



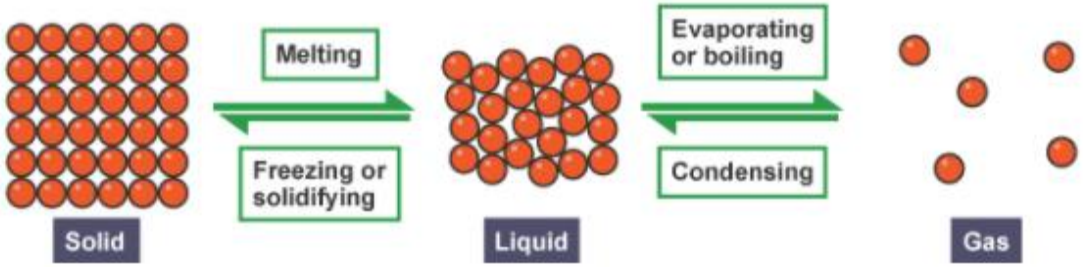
Transformers are used to change voltages and currents in transmission lines. A transformer is formed from two coils of wire around a magnetic core. The number of coils determines whether the transformers will step-up or step-down the voltage.

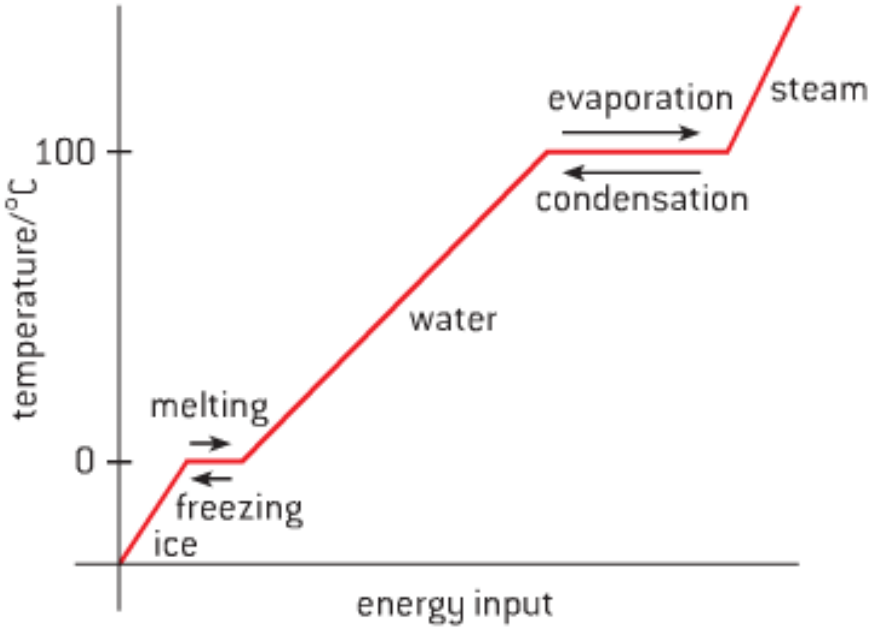
As the power transferred must stay the same:
- increasing voltage decreases current
- decreasing voltage increases current

In the National Grid, a step-up transformer is used to increase the voltage and reduce the current. The voltage is increased from about 25,000 Volts (V) to 400,000 V causing the current to decrease. Less current means less energy is lost through heating the wire.

To keep people safe from these high voltage wires, pylons are used to support transmission lines above the ground.
Before reaching the end user, a step-down transformer, reduces the voltage from the transmission voltage to the safer voltage of 230 V for home use.

KS4 Physics – Particle Model





Particles and pressure:

The pressure of a gas is due to the forces on the walls of the container, caused by the moving particles hitting the walls. The faster the particles are moving, the more frequent the collisions will be and the more force they will exert when they collide.

The faster the average speed of the particles in a gas, the higher the temperature of the gas.

The higher the temperature, the higher the pressure.

Worked example

What is the boiling point of water in kelvin?

boiling point = 100 °C + 273 = 373 K

To convert from kelvin to degrees Celsius, subtract 273.

To convert from degrees Celsius to kelvin, add 273.

When a substance undergoes a **change of state** the particles end up in a different arrangement. There are the same number of particles so the mass stays the same (mass is **conserved**). This is a **physical change**, because no new substances are formed and the substance recovers its original properties if the change is reversed. Mass is also conserved in **chemical changes**, but the change in the substances often cannot be reversed.

Key word	Definiton
Sublimation	When a solid turns straight into a gas without becoming a liquid first
State of matter	One of three different forms a substance can have: solid, liquid, gas
Change of state	Adding or removing energy to change the arrangment of particles in a material
Physical change	A reversible change in a substance
Chemical change	An irreversible change in a substance
Density	The mass of a certain volume of a substance
Specific heat capacity	The amount of energy it takes to make 1kg of a substance by 1°C
Specific latent heat	The amount of energy it takes to make 1kg of substanc change state
kinetic theory	The model that explains the properties of different states of matter in terms of movement of particles
Conserved	A quantity that is kept the same throughout
Joule (J)	A unit for measuring energy
Kelvin (K)	The unit in the Kelvin temperature scale. One kelvin is the same temperature interval as 1° C
Pascals (Pa)	The units for pressure

KS4 Physics – Particle Model

$\rho = m / v$

Density (g/cm^3) = $\frac{mass\ (g)}{volume\ (cm^3)}$

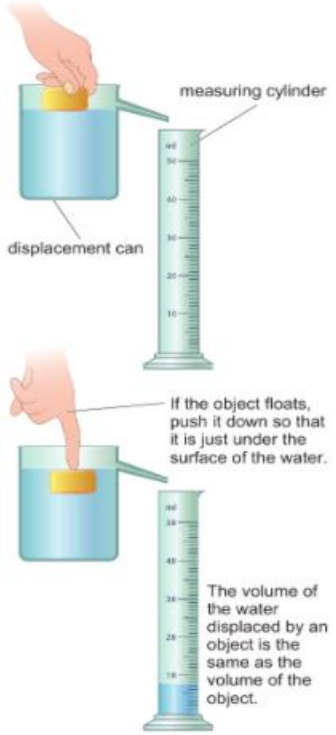
$Q = m \times L$

thermal energy for a change of state (J) = mass (kg) × specific latent heat (J/kg)

$\Delta Q = m \times c \times \Delta\theta$

change in thermal energy (J) = mass (kg) × specific heat capacity (J/kg °C) × change in temperature (°C)

Core Practical: Investigate the densities of solids and liquids



Method

Liquids

A Put an empty beaker on a balance, and set the balance to zero.

B Use a measuring cylinder to measure 50 cm^3 of a liquid and then pour it into the beaker. Write down the reading on the balance. This is the mass of 50 cm^3 of the liquid.

Solids

C Find the mass of the solid and write it down.

Diagram B shows how to find the volume of an irregular shape:

D Stand a displacement can on the bench with its spout over a bowl. Fill it with water until the water just starts to come out of the spout.

E Hold a measuring cylinder under the spout and carefully drop your object into the can. If your object floats, carefully push it down until all of it is under the water. Your finger should not be in the water.

F Stand the measuring cylinder on the bench and read the volume of water you have collected. This is the same as the volume of your object. Write it down.

Core Practical: Investigate the properties of water by determining the specific heat capacity of water



Method

Melting ice

Wear eye protection.

A Put a boiling tube full of crushed ice into a Pyrex [or heatproof] beaker. Put a thermometer in the ice and note the temperature.

B Put the beaker onto a tripod and gauze. Pour hot water from a kettle into the beaker, and keep it warm using a Bunsen burner.

C Measure the temperature of the ice every minute and record your results in a table. Stop taking readings three minutes after all the ice has melted.

D Note the times at which the ice starts to melt and when it appears to be completely melted.

Specific heat capacity

E Put a polystyrene cup in a beaker onto a battery-powered balance and zero the balance. Then fill the cup almost to the top with water and write down the mass of the water. Carefully remove the cup from the balance.

F Put a thermometer in the water and support it as shown in photo B. Put a 12 V electric immersion heater into the water, making sure the heating element is completely below the water level. Connect the immersion heater to a joulemeter.

G Record the temperature of the water, and then switch the immersion heater on. Stir the water in the cup gently using the thermometer.

H After five minutes record the temperature of the water again and also write down the reading on the joulemeter.