Knowledge Organiser

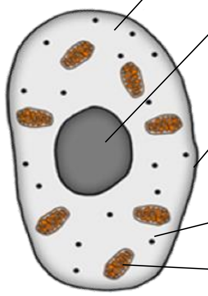
Science: Higher Tier

RAYNES
PARK HIGH SCHOOL

AQA Cell Structure

Eukaryotes complex organisms

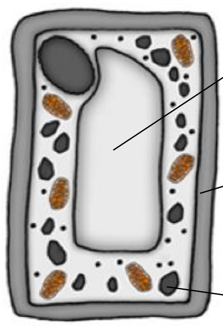
animal cell



cytoplasm	*site of chemical reactions in the cell*	gel like substance containing enzymes to catalyse the reactions
nucleus	*contains **genetic material***	controls the activities of the cell and codes fro proteins
cell membrane	*semi permeable*	controls the movement of substances in and out of the cell
ribosome	*site of protein synthesis*	mRNA is translated to an amino acid chain
mitochondrion	*site of respiration*	where energy is released for the cell to function

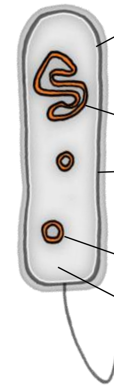
plant cell

contains all the parts of animal cells plus extras



permanent vacuole	*contains cell sap*	keeps cell turgid, contains sugars and salts in solution
cell wall	*made of cellulose*	supports and strengthens the cell
chloroplast	*site of photosynthesis*	contains chlorophyll, absorbs light energy

Prokaryotes simpler organisms

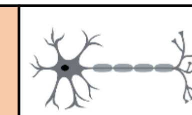


cell membrane	*site of chemical reactions in the cell*	gel like substance containing enzymes to catalyse the reactions
bacterial DNA	*not in nucleus floats in the cytoplasm*	controls the function of the cell
cell wall	***NOT** made of cellulose*	supports and strengthens the cell
plasmid	*small rings of DNA*	contain additional genes
cytoplasm	*semi permeable*	controls the movement of substances in and out of the cell

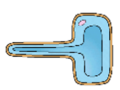
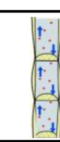
Bacterial cells are much smaller than plant and animal cells

Specialised cells

specialised animal cells

nerve		*carry electrical signals*	long branched connections and insulating sheath
sperm		*fertilise an egg*	streamlined with a long tail acrosome containing enzymes large number of mitochondria
muscle		*contract to allow movement*	contains a large number of mitochondria long

specialised plant cells

root hair		*absorb water and minerals from soil*	hair like projections to increase the surface area
xylem		*carry water and minerals*	TRANSPIRATION - dead cells cell walls toughened by lignin flows in one direction
phloem		*carry glucose*	TRANSLOCATION - living cells cells have end plates with holes flows in both directions

Cell differentiation

how a cell changes and becomes **specialised**
Undifferentiated call are called **STEM** cells

animal cell differentiation

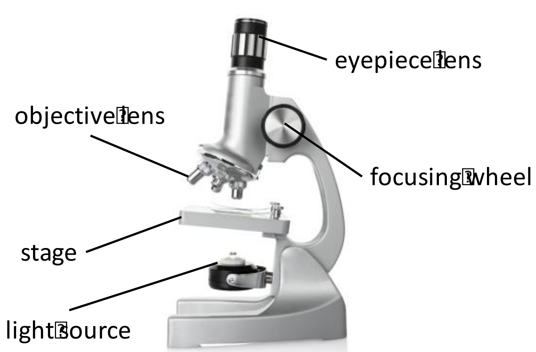
early stages of development
only for repair and replacement

plant cell differentiation

all stages of life cycle the stem cells are grouped together in meristems

Microscopy

magnification (M) = $\frac{\text{size of image (I)}}{\text{real size of the object (A)}}$



Feature	Light (optical) microscope	Electron microscope
Radiation used	Light rays	Electron beams
Max magnification	~ 1500 times	~ 2 000 000 times
Resolution	200nm	0.2nm
Size of microscope	Small and portable	Very large and not portable
Cost	~£100 for a school one	Several £100,000 to £1 million plus

PREFIXES

Prefix	Multiple	Standard form
centi (cm)	1 cm = 0.01 m	x 10^{-2}
milli (mm)	1 mm = 0.001 m	x 10^{-3}
micro (µm)	1 µm = 0.000 001 m	x 10^{-6}
nano (nm)	1nm = 0.000 000 001 m	x 10^{-9}

largest

smallest

cell	The smallest structural and functional unit of an organism.
nucleus	A structure that contains genetic material and controls the activities of the cell.
chromosome	A thread like structure of coiled DNA found in the nucleus of eukaryotic cells.
DNA	A polymer made up of two strands forming a double helix.
gene	A section of DNA that codes for a specific protein or characteristic.

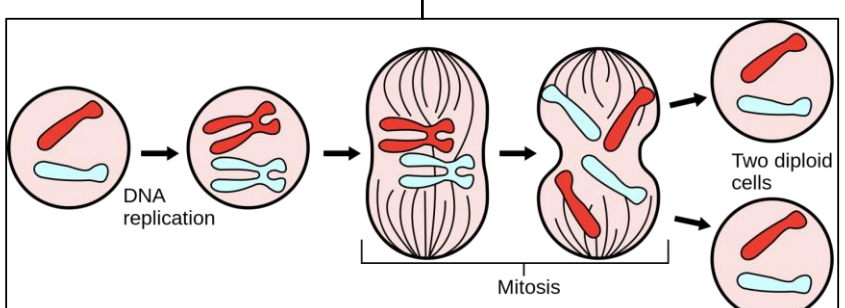
AQA Cell Biology 2

Cell division

MITOSIS AND THE CELL CYCLE

Cells divide in a series of stages. The genetic material is doubled and then divided into two identical cells.

Stage 1	*Growth*	Increase the number of sub-cellular structures e.g. ribosomes and mitochondria.
Stage 2	*DNA Synthesis*	DNA replicates to form two copies of each chromosome.
Stage 3	*Mitosis*	One set of chromosomes is pulled to each end of the cell and the nucleus divides. Then the cytoplasm and cell membranes divide to form two cells that are identical to the parent cell.



Mitosis occurs during growth, repair, replacement of cells. Asexual reproduction occurs by mitosis in both plants & simple animals.

STEM CELLS

Undifferentiated cell of an organism

Divides to form more cells of the same type, and can differentiate to form many other cell types.

Human Embryonic stem cells	*Can be cloned and made to differentiate into most cell types*	Therapeutic cloning uses same genes so the body does not reject the tissue. Can be a risk of infection
Adult bone marrow stem cells	*Can form many types of human cells e.g. blood cells*	Tissue is matched to avoid rejection, risk of infection. Only a few types of cells can be formed.
Meristems (plants)	*Can differentiate into any plant cell type throughout the life of the pant.*	Used to produce clones quickly and economically, e.g. rare species, crop plants with pest /disease resisitance

Treatment with stem cells may be able to help conditions such as diabetes and paralysis. Some people object to the use of stem cells on ethical or religious grounds

Transport in cells

ADAPTATIONS FOR DIFFUSSION

The greater the difference in concentrations the faster the rate of diffusion.

Small intestines	*Villi – increase surface area, Good blood supply – to maintain concentration gradient, Thin membranes – short diffusion distance.*
Lungs	*Alveoli– increase surface area, Good blood supply – to maintain concentration gradient, Thin membranes – short diffusion distance.*
Gills in fish	*Gill filaments and lamella – increase surface area, Good blood supply – to maintain concentration gradient, Thin membranes – short diffusion distance.*
Roots	*Root hair cells - increase surface area.*
Leaves	*Large surface area, thin leaves for short diffusion path, stomata on the lower surface to let O_2 and CO_2 in and out.*

Diffusion **No** energy required	*Movement of particles in a solution or gas from a higher to a lower concentration*	E.g. O_2 and CO_2 in gas exchange, urea in kidneys. Factors that affect the rate are concentration, temperature and surface area.
Osmosis **No** energy required	*Movement of water from a dilute solution to a more concentrated solution*	E.g. Plants absorb water from the soil by osmosis through their root hair cells. Plants use water for several vital processes including photosynthesis and transporting minerals.
Active transport ***ENERGY*** required	*Movement of particles from a dilute solution to a more concentrated solution*	E.g. movement of mineral ions into roots of plants and the movement of glucose into the small intestines.

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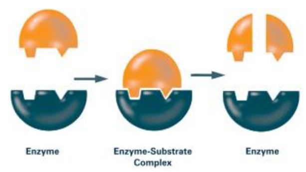
AQA GCSE ORGANISATION Part 1

Enzymes in digestion

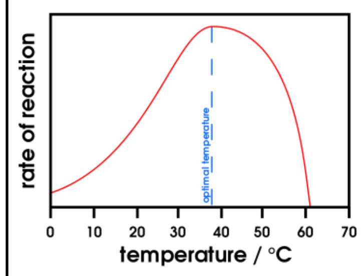
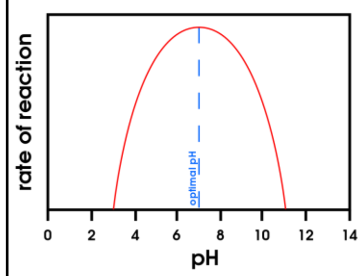
Enzymes catalyse (increase the rate of) specific reactions in living organisms

The 'lock and key theory' is a simplified model to explain enzyme action



Enzymes catalyse specific reactions in living organisms due to the shape of their active site

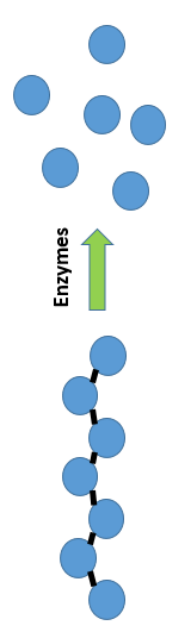
The activity of enzymes is affected by changes in temperature and pH

Enzymes activity has an optimum temperature	*Enzyme activity has an optimum pH*
	

Large changes in temperature or pH can stop the enzyme from working (denature)

Temperature too high	*pH too high or too low*
Enzyme changes shape (denatures) the substrate no longer fits the active site.	

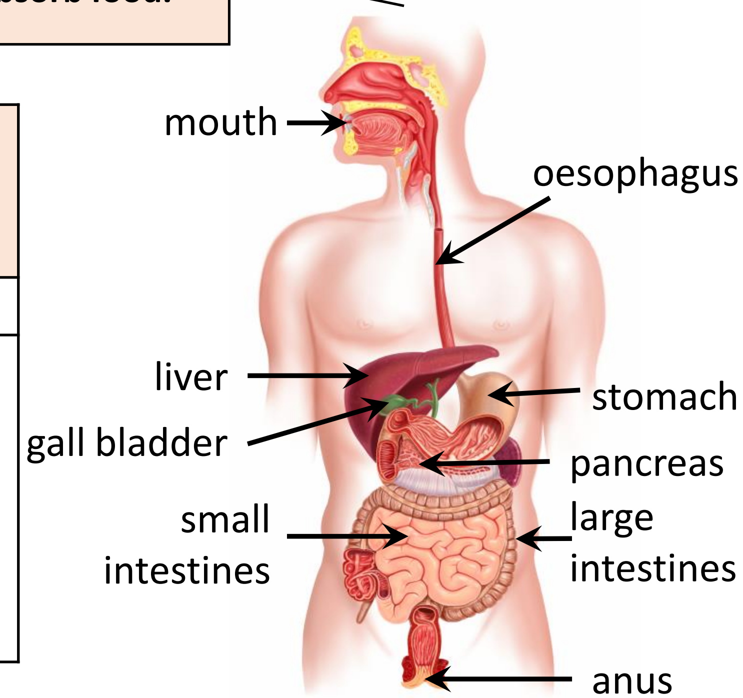
Digestive enzymes speed up the conversion of large insoluble molecules (food) into small soluble molecules that can be absorbed into the bloodstream

Carbohydrases (e.g. amylase)		*Made in salivary glands, pancreas, small intestine*	Break down carbohydrates to simple sugar (e.g. amylase breaks down starch to glucose).
Proteases		*Made in stomach, pancreas*	Break down protein to amino acids.
Lipases		*Made in pancreas (works in small intestine)*	Break down lipids (fats) to glycerol and fatty acids).
Bile (not an enzyme)		*Made in liver, stored in gall bladder.*	Emulsifies lipids to increase surface area to increase the rate of lipid break down by lipase. Changes pH to neutral for lipase to work

The products of digestion are used to build new carbohydrates, lipids and proteins. Some glucose is used for respiration.

The human digestive system

An organ system in which organs work together to digest and absorb food.



Non-communicable diseases

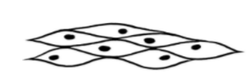
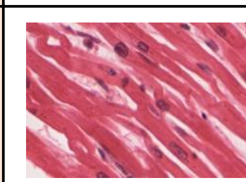
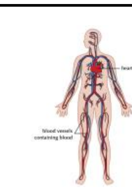
More energy consumed in food and drink than used
obesity
Linked to increased rates of cardiovascular disease and development of diabetes type 2.

Food tests

Sugars (glucose)	*Benedicts' test*	Orange to brick red precipitate.
Starch	*Iodine test*	Turns black.
Biuret	*Biuret reagent*	Mauve or purple solution.

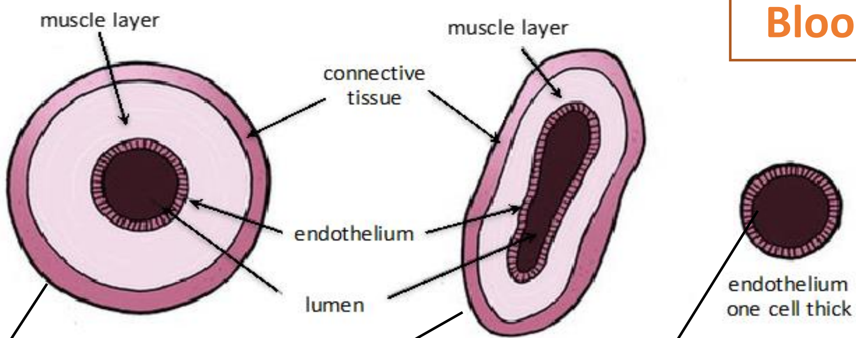
Principles of organisation

Cells, tissues, organs and systems

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

AQA GCSE ORGANISATION part 2

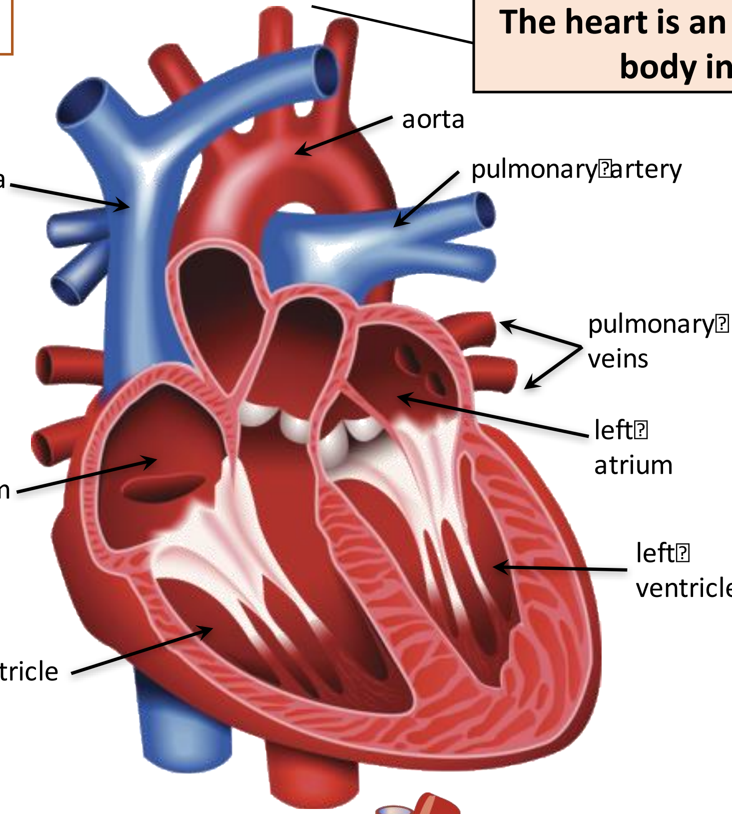
Blood vessels

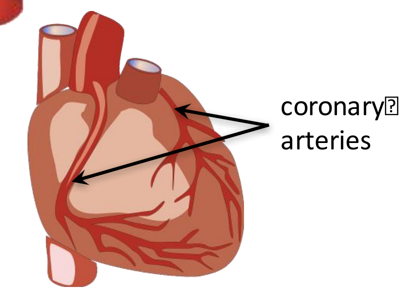


Artery	Vein	Capillary
Carry blood away from the heart	*Carry blood to the heart*	*Connects arteries and veins*
Thick muscular walls, small lumen, carry blood under high pressure, carry oxygenated blood (except for the pulmonary artery).	Thin walls, large lumen, carry blood under low pressure, have valves 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.

Heart

The heart is an organ that pumps blood around the body in a double circulatory system





Different structure in the heart have different functions

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

Blood

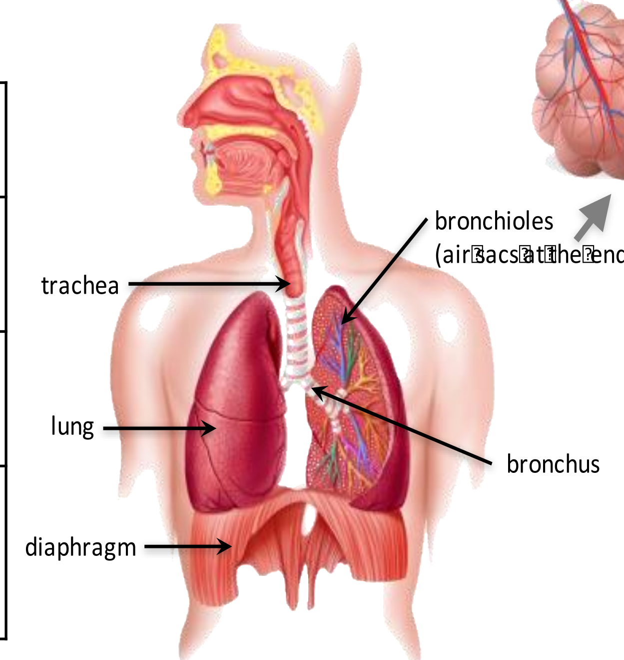
Blood is a tissue consisting of plasma, in which blood cells, white blood cells and platelets are suspended

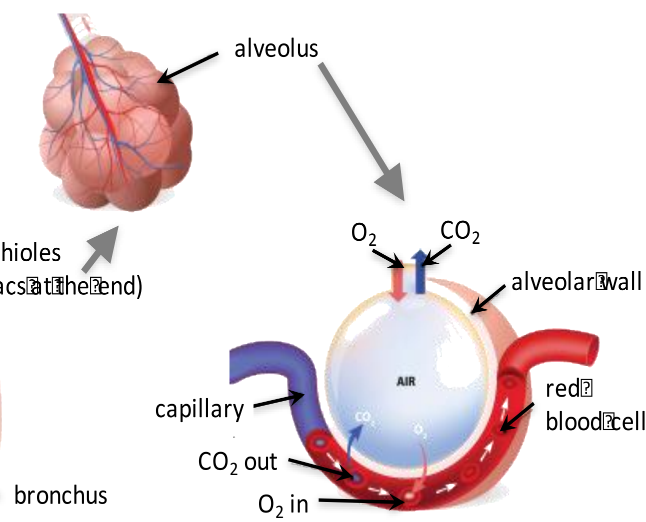
Plasma (55%)	*Pale yellow fluid*	Transports CO_2, hormones and waste.
Red blood cells (45%)	*Carries oxygen*	Large surface area, no nucleus, full of haemoglobin.
White blood cells (<1%)	*Part of the immune system*	Some produce antibodies, others surround and engulf pathogens.
Platelets (<1%)	*Fragments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

Lungs and gas exchange

The heart pumps low oxygen/high carbon dioxide blood to the lungs

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.





gas exchange in an alveolus

AQA GCSE ORGANISATION part 3

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Heart failure can be treated with a transplant or artificial heart

Disease	*Cause*	Effect	Treatment
Coronary heart disease (CHD)	*A build up for fatty substances in the coronary arteries (atherosclerosis)*	Oxygen-ated blood cannot get to the cardiac muscle.	Stents: inserted into the blocked artery to open it up. Statins: lower harmful cholesterol.
Faulty heart valves	*Valves don't open or close properly*	Blood can leak or flow in the wrong direction	Biological valve transplant or a mechanical valve can be inserted

Non-communicable diseases

Cancer

The result of changes in DNA that lead to uncontrolled growth and division

Benign tumour	Contained in one area of the body (usually by a membrane) – not cancer.
Malignant tumour	Invade tissues and spread to different parts of the body to form secondary tumours.

Some cancers have genetic risk factors.

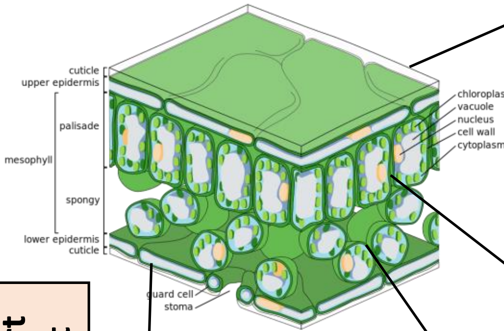
Carcinogens and ionising radiation increase the risk of cancer by changing/ damaging DNA

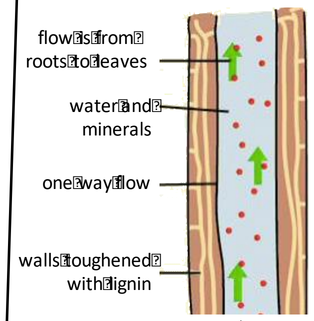
Risk factors for heart/lung disease and certain types of cancer include drinking alcohol, diet, obesity and smoking

These risks factors can also affect the brain, liver and the health of unborn babies

Plant organ systems

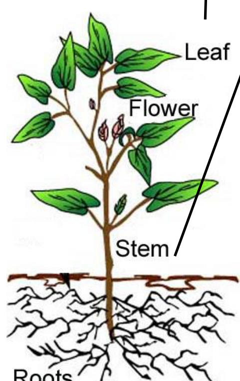
The roots, stem and leaves form a plant organ system for transport of substances around the plant

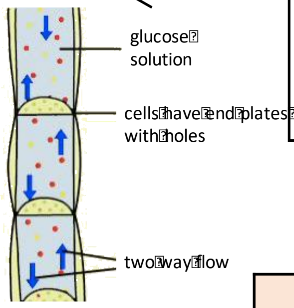


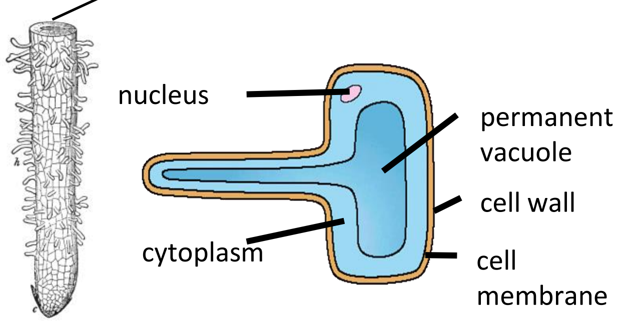


xylem

phloem



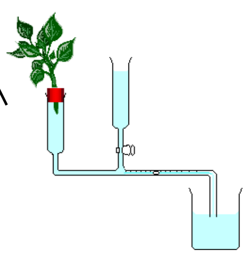




Plant tissues

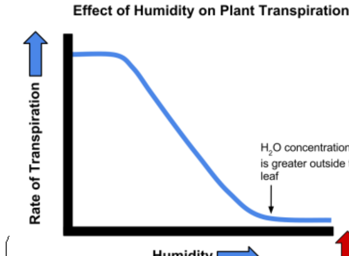
Epidermal tissues	*Waxy cuticle (top layer of the leaf)*	Reduces water loss from the leaf
	Guard cells and stomata	Guard cells open and close the stomata to control water loss and allow for gas exchange (oxygen and carbon dioxide).
Palisade mesophyll	*Palisade cells*	Cells near the top surface of the leaf that are packed with chloroplasts that contain chlorophyll. Both adaptations maximize photosynthesis.
Spongy mesophyll	*Air spaces in the leaf between cells*	Increased surface area for gas exchange so that carbon dioxide can diffuse into photosynthesising cells.
xylem	*Hollow tubes strengthened by lignin adapted for the transportation of water in the transpiration stream*	Allows transport of water and mineral ions from the roots to the stem and the leaves.
phloem	*Cell sap moves from one phloem cell to the next through pores in the end walls*	Transports dissolved sugars from the leaves to the rest of the plant for immediate use or storage (translocation).
Meristem tissue	*New cells (roots and shoot tips) are made here including root hair cells*	Root hair cells have an increased surface area for the uptake of water by osmosis, and mineral ions by active transport.

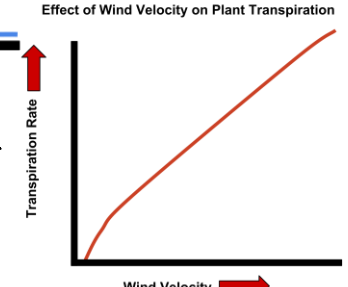
A potometer is used to measure the amount of water lost over time (rate of transpiration)

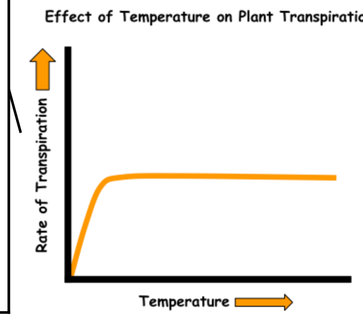


Transpiration

Transpiration	*The rate at which water is lost from the leaves of a plant. The transpiration stream is the column of water moving through the roots, stem and leaves*	Temperature, humidity, air movement and light intensity affect the rate of transpiration.







The shape of the graph for light intensity is the same for temperature (energy)

AQA GCSE INFECTION AND RESPONSE part 1

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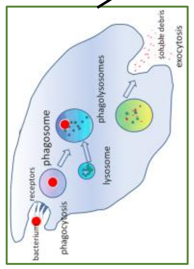
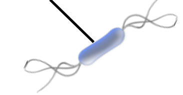


White blood cells are part of the immune system

Phagocytes	*Phagocytosis*	Phagocytes engulf the pathogens and digest them.
Lymphocytes	*Antibody production*	Specific antibodies destroy the pathogen. This takes time so an infection can occur. If a person is infected again by the same pathogen, the lymphocytes make antibodies much faster.
	Antitoxin production	Antitoxin is a type of antibody produced to counteract the toxins produced by bacteria.



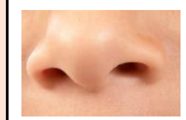
Pathogens are identified by white blood cells by the different proteins on their surfaces **ANTIGENS.**

Human defence systems

Immune system

Non-specific defence systems

The human body has several non specific ways of defending itself from pathogens getting in

	*Nose*	Nasal hairs, sticky mucus and cilia prevent pathogens entering through the nostrils.
	*Trachea and bronchus (respiratory system)*	Lined with mucus to trap dust and pathogens. Cilia move the mucus upwards to be swallowed.
	*Stomach acid*	Stomach acid (pH1) kills most ingested pathogens.
	*Skin*	Hard to penetrate waterproof barrier. Glands secrete oil which kill microbes

Detection and identification of plant diseases (bio only)

Detection	**Identification**
Stunted growth	Reference using gardening manual or website, laboratory test for pathogens, testing kit using monoclonal antibodies.
Spots on leaves	
Area of decay	
growths	
Malformed stem/leaves	
Discolouration	
Presence of pests	

Nitrate ions needed for protein synthesis – lack of nitrate = stunted growth.

Magnesium ions needed to make chlorophyll – not enough leads to chlorosis – leaves turn yellow.

Plants have several ways of defending themselves from pathogens and animals

Physical	*Mechanical*
Thick waxy layers, cell walls stop pathogen entry	Thorns, curling up leaves to prevent being eaten
Chemical	
Antibacterial and toxins made by plant	

Communicable diseases

Pathogens

Pathogens are microorganisms that cause infectious disease

Bacteria may produce toxins that damage tissues and make us fell ill

Viruses	Bacteria (prokaryotes)	Protists (eukaryotes)	Fungi (eukaryotes)
e.g. cold, influenza, measles, HIV, tobacco mosaic virus	*e.g. tuberculosis (TB), Salmonella, Gonorrhoea*	*e.g. dysentery, sleeping sickness, malaria*	*e.g. athlete's foot, thrush, rose black spot*
DNA or RNA surrounded by a protein coat	No membrane bound organelles (no chloroplasts, mitochondria or nucleus). Cell wall. Single celled organisms	Membrane bound organelles. Usually single celled.	Membrane bound organelles, cell wall made of chitin. Single celled or multi-cellular

Viruses live and reproduce inside cells causing damage

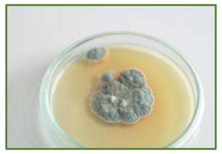
Pathogens may infect plants or animals and can be spread by direct contact, water or air

Pathogen	*Disease*	Symptoms	Method of transmission	Control of spread
Virus	*Measles*	Fever, red skin rash.	Droplet infection from sneezes and coughs.	Vaccination as a child.
Virus	*HIV*	Initially flu like systems, serious damage to immune system.	Sexual contact and exchange of body fluids.	Anti-retroviral drugs and use of condoms.
Virus	*Tobacco mosaic virus*	Mosaic pattern on leaves.	Enters via wounds in epidermis caused by pests.	Remove infected leaves and control pests that damage the leaves.
Bacteria	*Salmonella*	Fever, cramp, vomiting, diarrhoea.	Food prepared in unhygienic conditions or not cooked properly.	Improve food hygiene, wash hands, vaccinate poultry, cook food thoroughly.
Bacteria	*Gonorrhoea*	Green discharge from penis or vagina.	Direct sexual contact or exchange of body fluids.	Use condoms. Treatment using antibiotics.
Protists	*Malaria*	Recurrent fever.	By an animal vector (mosquitoes).	Prevent breeding of mosquitoes. Use of nets to prevent bites.
Fungus	*Rose black spot*	Purple black spots on leaves.	Spores carried via wind or water.	Remove infected leaves. Spray with fungicide.

AQA INFECTION AND RESPONSE

Discovery and drug development

Most new drugs are synthesised by chemists in the pharmaceutical industry.

Traditionally drugs were extracted from plants and microorganisms		
Digitalis	***Aspirin***	***Penicillin***
Extracted from foxglove plants and used as a heart drug	A painkiller and anti-inflammatory that was first found in willow bark	Discovered by Alexander Fleming from the *Penicillium* mould and used as an antibiotic
		

Drugs have to be tested and trialled before to check they are safe and effective

New drugs are extensively tested for:		
	Efficacy	Make sure the drug works
	Toxicity	Check that the drug is not poisonous
	Dose	The most suitable amount to take

Preclinical trials - using cells, tissues and live animals - must be carried out before the drug can be tested on humans.

Clinical trials use healthy volunteers and patients

Stage 1	***Stage 2***	***Stage 3***	***Stage 4***
Healthy volunteers try small dose of the drug to check it is safe record any side effects	A small number of patients try the drug at a low dose to see if it works	A larger number of patients; different doses are trialled to find the optimum dose	A double blind trial will occur. The patients are divided into groups. Some will be given the drug and some a placebo.

Double blind trial: patients and scientists do not know who receives the new drug or placebo until the end of the trial. This avoids bias.

A placebo can look identical to the new drug but contain no active ingredients

Antibiotics and painkillers

Bacteria can mutate

Sometimes this makes them resistant to antibiotic drugs.

Antibiotics have greatly reduced deaths from infectious bacterial disease

antibiotics	***e.g. penicillin***	Kill infective bacteria inside the body. Specific bacterial infections require specific antibiotics.
Painkillers and other medicines	***e.g. aspirin, paracetamol, ibuprofen***	Drugs that are used to treat the symptoms of a disease. They do not kill pathogens

Antibiotics cannot be use to treat viral pathogens

It is difficult to develop drugs to kill viruses without harming body tissues because viruses live and reproduce inside cells

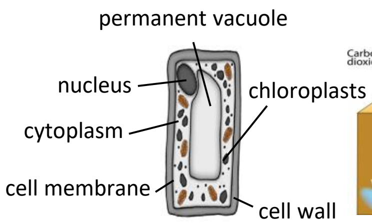
Vaccination

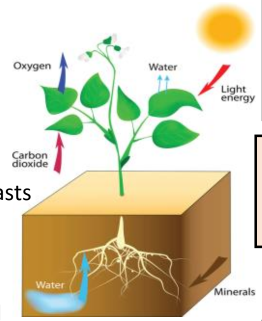
Used to immunise a large proportion of the population to prevent the spread of a pathogen

Vaccination			
	Small amount of dead or inactive form of the pathogen	***1st infection by pathogen***	White blood cells detect pathogens in the vaccine. Antibodies are released into the blood.
		Re-infection by the same pathogen	White blood cells detect pathogens. Antibodies are made much faster and in larger amounts.

A person is unlikely to suffer the symptoms of the harmful disease and it's spread in a population is prevented

AQA GCSE BIOENERGETICS part 1





Respiration, stored as insoluble starch, fats or oils for storage, cellulose for cell walls, combine with nitrates from the soil to form amino acids for protein synthesis

Plants use the glucose produced in photosynthesis in a variety of ways

Photosynthetic reaction

The plant manufactures glucose from carbon dioxide and water using energy transferred from the environment to the chloroplasts by light

Photosynthesis		
Photosynthesis	*Plants make use of light energy from the environment (ENDOTHERMIC) to make food (glucose)*	Carbon dioxide + Water $\xrightarrow{\text{light}}$ Oxygen + Glucose
		$CO_2 + H_2O \xrightarrow{\text{light}} O_2 + C_6H_{12}O_6$

The rate of photosynthesis is affected by temperature, light intensity, carbon dioxide concentration, and the amount of chlorophyll

Factors affecting the rate of photosynthesis

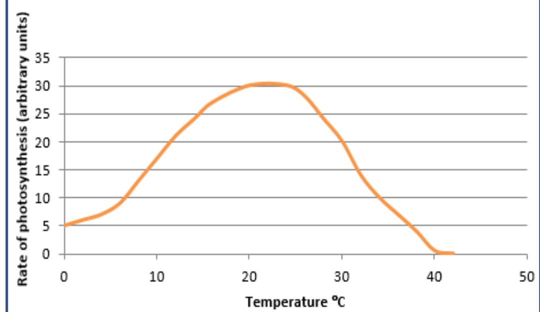
Factor	How the rate is affected	Limiting factors (why the rate stops going up)
Temperature	*As the temperature of the environment the plant is in increases rate of photosynthesis increases (up to a point) as there is more energy for the chemical reaction.*	Photosynthesis is an enzyme controlled reaction. If the temperature increases too much, then the enzymes become denatured and the rate of reaction will decrease and stop
Light intensity	*Light intensity increases as the distance between the plant and the light sources increases. As light intensity increases so does the rate of photosynthesis (up to a point) as more energy is available for the chemical reaction.*	At point X another factor is limiting the rate of photosynthesis. This could be carbon dioxide concentration, temperature or the amount of chlorophyll
Carbon dioxide concentration	*Carbon dioxide is needed for plants to make glucose. The rate of photosynthesis will increase when a plant is given higher concentrations of carbon dioxide (up to a point).*	At point X another factor is limiting the rate of photosynthesis. This could be light intensity, temperature or the amount of chlorophyll
Amount of chlorophyll	*Chlorophyll is a photosynthetic pigment that absorbs light and allows the reaction between water and carbon dioxide to occur (photosynthesis)*	Another factor could limit the rate of photosynthesis. This could be light intensity, temperature or the carbon dioxide concentration

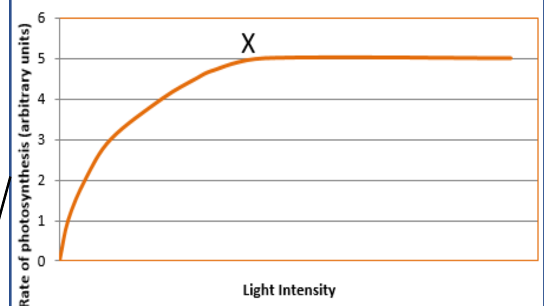
Control conditions in greenhouses to reduce limiting factors can improve crop yields

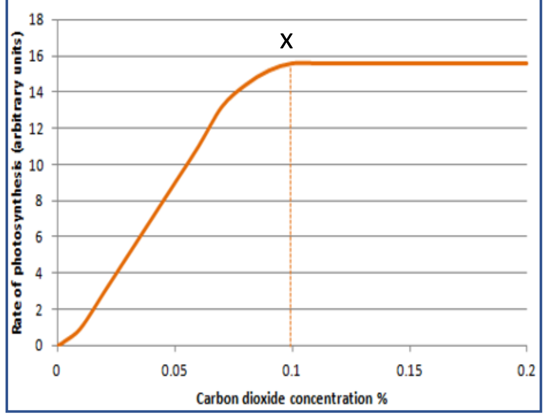
Heating	Used to provide optimum temperatures for maximum plant growth.
Artificial lighting	Enhances the natural sunlight especially overnight and on cloudy days.
Extra carbon dioxide	Gas can be pumped into the air inside the greenhouse.

Growers must balance the economics of additional costs of controlling the conditions to maximise photosynthesis with making a profit.

Rate of photosynthesis







Light intensity obeys the inverse square law. This means that if you double the distance between the plant and the light source you quarter the light intensity

Rate of photosynthesis

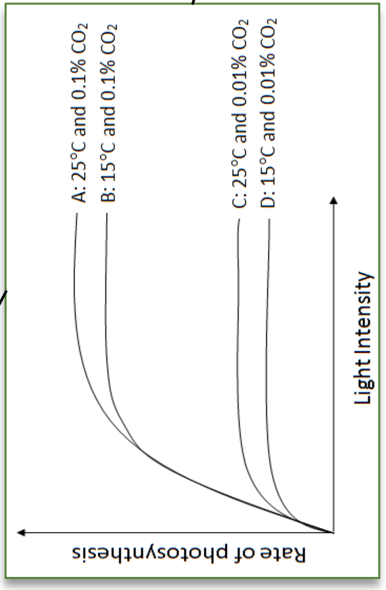
Explain graphs of two or three factors and decide which is the limiting factor

Graph lines C and D: If temperature is increased by 10°C then a slight increase in rate of photosynthesis occurs.

Graph lines A and B: If carbon dioxide concentration is increased from 0.01% to 0.1% then a large increase in rate occurs up to a point.

Graph lines A and D: If carbon dioxide concentration and temperature are increased the rate of photosynthesis increases significantly up to a point.

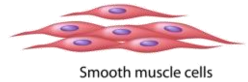
Graph line A: Rate could be limited by temperature and/or amount of chlorophyll. Plant tissue can be damaged when carbon dioxide concentrations exceed 0.1%



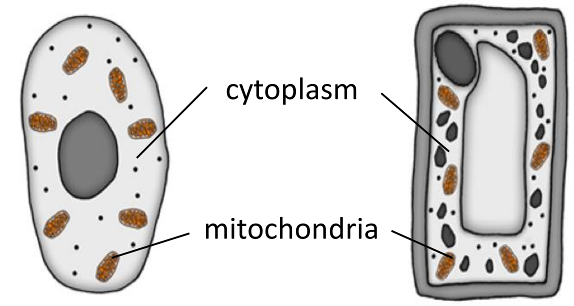
AQA GCSE BIOENERGETICS part 2

Respiration

An organism will receive all the energy it needs for living processes as a result of the energy transferred from respiration

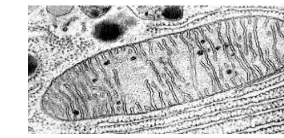
For movement		To enable muscles to contract in animals.
For keeping warm		To keep a steady body temperature in a cold environment.
For chemical reactions		To build larger molecules from smaller one.

Cellular respiration is an exothermic reaction which is continuously occurring in all living cells



animal cell

plant cell



Electron micrograph of a mitochondrion

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

Anaerobic respiration releases a much smaller amount of energy than aerobic respiration.

The incomplete oxidation of glucose causes a build up of lactic acid and creates an oxygen debt

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.

$C_6H_{12}O_6 + O_2 \longrightarrow CO_2 + H_2O$

glucose + oxygen → carbon dioxide + water

Aerobic respiration releases a large amount of energy from each glucose molecule

Anaerobic respiration in plant and yeast cells

The end products are ethanol and carbon dioxide. Anaerobic respiration in yeast cells is called fermentation

glucose → ethanol + carbon dioxide

This process is economically important in the manufacture of alcoholic drinks and bread.

Response to exercise

During long periods of vigorous activity muscles become fatigued and stop contracting efficiently

During exercise the human body reacts to increased demand for energy	*Heart rate increases*	Top pump oxygenated blood faster to the muscle tissues and cells.
	Breathing rate and breath volume increase	This increases the amount of oxygen entering the blood stream.

Metabolism

Metabolism is the sum of all the reactions in a cell or the body

Metabolism	*The energy transferred by respiration in cells is used by the organism for the continual enzyme controlled processes of metabolism.*	Conversion of glucose to starch, glycogen and cellulose.
		The formation of lipid molecules from a molecule of glycerol and three molecules of fatty acid.
		The use of glucose and nitrate ions to form amino acids which in turn are used to synthesise proteins.
		Respiration
		Breakdown of excess proteins to form urea for excretion.

Response to exercise

The extra amount of oxygen required to remove all lactic acids from cells is called the oxygen debt

Lactic acid builds up in the muscles cells during exercise → Blood flows through the muscle cells and transports the lactic acid to the liver → The liver oxidises the lactic acid and converts it back to glucose

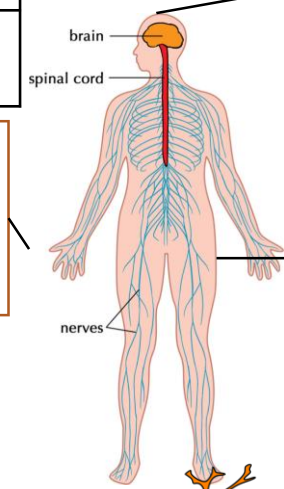
AQA GCSE HOMEOSTASIS AND RESPONSE part 1

The human nervous system

Human control systems include

Cells called receptors	Detect stimuli (changes in environment).
Coordination centres	e.g. brain, spinal cord and pancreas that receive information from receptors.
Effectors	Muscles or glands, which bring about responses to restore optimum levels.

Enables humans to react to their surroundings and to co-ordinate their behaviour

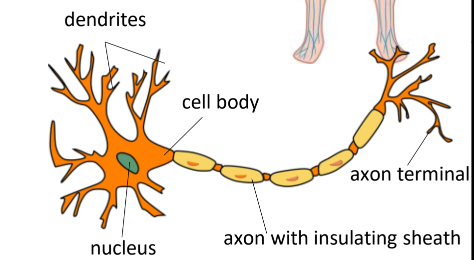


Information from receptors passes along cells (neurones) as electrical impulses to the central nervous system (CNS)

The CNS is the brain and the spinal cord.

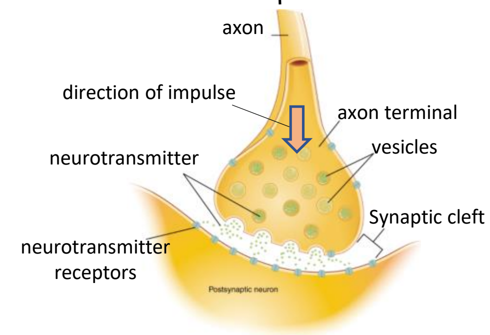
Coordinates the response of effectors; muscles contracting or glands secreting hormones

Stimulus	Lights switch on
⇩	⇩
Receptor	Cells in retina
⇩	⇩
Coordinator	CNS
⇩	⇩
Effector	Muscles connected to iris
⇩	⇩
Response	Pupils get smaller



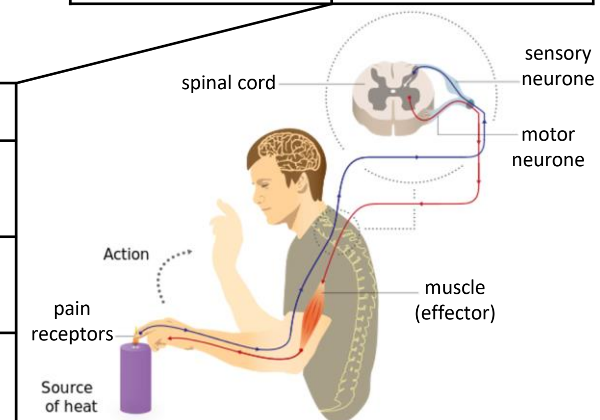
Typical motor neurone

Synapse (gap where two neurones meet).



Reflex arc

Receptor	Detect stimuli.
Sensory neurone	Long axon carries impulse from receptor to spinal cord.
Synapse	Gap where neurones meet. Chemical message using neurotransmitter.
Relay neurone	Allows impulses to travel between sensory and motor neurones in the spinal cord.
Motor neurone	Long axon carries impulse from receptor to effector.
Effector	Muscle or gland that carries out response.



Reflex actions are automatic and rapid; they do not involve the conscious part of the brain and can protect humans from harm.

AQA GCSE HOMEOSTASIS AND RESPONSE PART 2

Homeostasis

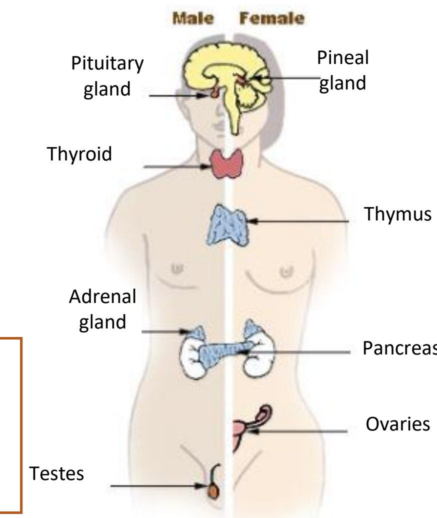
Controls in the human body		
Controls in the human body	*Blood glucose concentration*	These automatic control systems may involve nervous responses or chemical responses.
	Body temperature	
	Water levels	

The regulation of internal conditions of a cell or organism to maintain optimum conditions for function.

Response to internal and external change

Homeostasis maintains optimal conditions for enzyme action and all cell functions.

Human endocrine system



Endocrine system		
Endocrine system	*Composed of glands which secrete chemicals called hormones directly into the bloodstream.*	The blood carries the hormone to a target organ where is produces an effect. Compared to the nervous system effects are slower but act for longer.

Pituitary gland		
Pituitary gland	*'Master gland'; secretes several hormones into the blood*	Stimulates other glands to produce hormones to bring about effects.

Control of blood glucose concentration

Blood glucose concentration	
Monitored and controlled by the pancreas	
Too high	**(HT only)** Too low
Pancreas produces the hormone insulin, glucose moves from the blood into the cells. In liver and muscle cells excess glucose is converted to glycogen for storage.	Pancreas produces the hormone glucagon that causes glycogen to be converted into glucose and released into the blood.

(HT) Rising glucose levels inhibit the release of glucagon in a negative feedback system. Insulin is released to reduce glucose levels and which cause the pancreas to release glucagon

Diabetes	
Type 1	*Type 2*
Pancreas fails to produce sufficient insulin leading to uncontrolled blood glucose levels. Normally treated by insulin injection.	Obesity is a risk factor. Body cells no longer respond to insulin. Common treatments include changing by diet and increasing exercise.

Negative feedback (HT only)		
Negative feedback (HT only)	*Adrenaline*	Produced in adrenal glands, increases breathing/heart rate, blood flow to muscles, conversion glycogen to glucose. Prepares body for 'fight or flight'.
	Thyroxine	Produced in the thyroid gland, stimulates the basal metabolic rate. Important in growth and development.

Increasing thyroxine levels prevent the release of thyroid stimulating hormone which stops the release of thyroxine.

AQA GCSE HOMEOSTASIS AND RESPONSE PART 3

The use of hormone to treat infertility

Hormones are used in modern reproductive technologies to treat infertility

FSH and LH are used as 'fertility drugs' to help someone become pregnant in the normal way

In Vitro Fertilisation (IVF) treatment.
Involves giving a mother FSH and LH to stimulate the maturation of several eggs
The eggs are collected from the mother and fertilised by sperm from the father in a laboratory. ↓ The fertilised eggs develop into embryos. ↓ At the stage when they are tiny balls of cells, one or two embryos are inserted into the mother's uterus (womb).

Potential disadvantages of IVF	Emotional and physical stress.
	Success rates are not high.
	Multiple births risk to mother and babies.

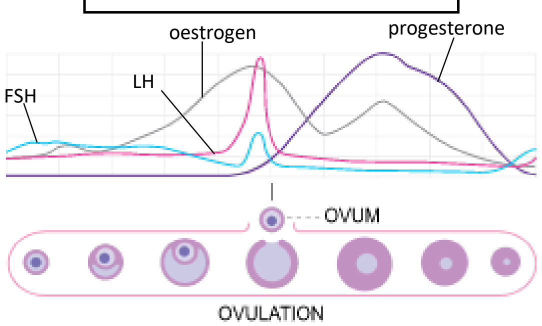
Contraception

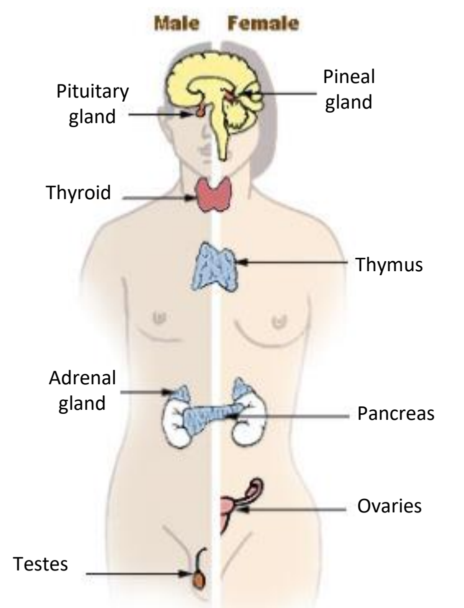
Fertility can be controlled by hormonal and non hormonal methods	***Oral contraceptives***	Contain hormones to inhibit FSH production so that no eggs mature.
	Injection, implant, skin patch	For slow release of progesterone to inhibit the maturation and release of eggs for months or years.
	Barrier methods	Condoms or diaphragms which prevent sperm reaching the egg.
	Intrauterine devices	Prevent implantation of an embryo or release a hormone.
	Spermicidal agents	Kill or disable sperm.
	Abstaining	Avoiding intercourse when an egg may be in the oviduct.
	Surgery	Male or female sterilisation.

Hormones in human reproduction

During puberty reproductive hormones cause secondary sexual characteristics to develop	
Oestrogen (main female reproductive hormone)	***Testosterone (main male reproductive hormone)***
Produced in the ovaries. At puberty eggs being to mature releasing one every 28 days – **ovulation**.	Produced in the testes stimulation sperm production.

(HT only) a graph of hormone levels over time





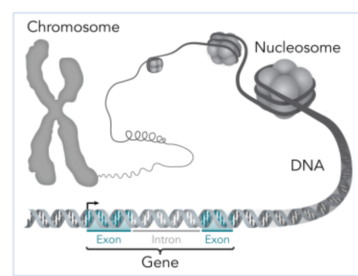
Menstrual cycle	***Follicle stimulating hormone (FSH)***	Causes maturation of an egg in the ovary.	**(HT)** FSH stimulates ovaries to produce oestrogen.
	Luteinising hormone (LH)	Stimulates release of an egg.	**(HT)** Oestrogen stops FSH production and stimulates LH production in pituitary gland.
	Oestrogen and progesterone	Maintain uterus lining.	

AQA GCSE INHERITANCE, VARIATION AND EVOLUTION Part 1

DNA and the genome

Genetic material in the nucleus is composed of a chemical called DNA.

DNA structure
Polymer made up of two strands forming a double helix.
Contained in structures called chromosomes. A gene is a small section of DNA on a chromosome. Each gene codes for a sequence of amino acids to make a specific protein.



The genome is the entire genetic material of an organism.

The whole human genome has now been studied.	*It is of great importance for future medical developments*	Searching for genes linked to different types of disease.
		Understanding and treatment of inherited disorders.
		Tracing migration patterns from the past.

Sexual and asexual reproduction

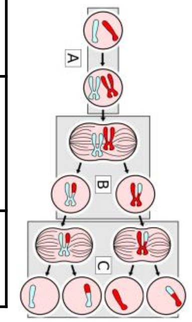
Meiosis leads to non-identical cells being formed while mitosis leads to identical cells being formed

Sexual reproduction involves the fusion of male and female gametes.	*Sperm and egg in animals.*	Produced by meiosis. There is mixing of genetic information which leads to a variety in the offspring.
	Pollen and egg cells in flowering plants.	
Asexual reproduction involves only one parent and no fusion of gametes.	*e.g. cloning of females only in an aphid population.*	Only mitosis is involved. There is no mixing of genetic information. This leads to genetically identical clones.

Meiosis

Meiosis halves the number of chromosomes

Gametes are made in reproductive organs (in animals ovaries and testes)	*Cells divide by meiosis to form gametes*	Copies of the genetic information are made.
		The cell divides twice to form four gametes each with single set of chromosomes.
		All gametes are genetically different from each other.



Gametes join at fertilisation to restore the number of chromosomes

The new cell divides by mitosis. The number of cells increase. As the embryo develops cells differentiate.

AQA GCSE INHERITANCE, VARIATION AND EVOLUTION PART 2

PiXL Partners in excellence

Variation

Very rarely a mutation will lead to a new phenotype which if is suited to environmental change can lead to rapid change in the species.

Mutations occur continuously

Variation: difference in the characteristics of individuals in a population may be due to

Genetic causes (inheritance)	There is usually extensive genetic variation within the population of a species e.g. hair colour, skin colour, height that can also be affected by environment e.g. nutrition, sunlight.
Environmental causes (condition they have developed in)	
A combination of genes and environment	

All genetic variation arises in mutation, most have no effect on phenotype, some influence but very few determine phenotype.

The genome and its interaction with the environment influence the development of phenotypes

Embryo screening and gene therapy may alleviate suffering

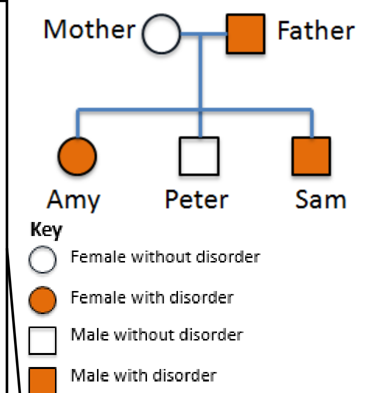
Embryo screening: small piece of developing placenta removed to check for presence of faulty genes

Gene therapy: replacing the faulty allele in somatic cells with a normal allele

Embryo screening /gene therapy issues		
	Economic	Costly and not 100% reliable.
	Social	Not available to everyone (due to cost).
	Ethical	Should only 'healthy' embryos be implanted following screening.

Inherited disorders

Using a family tree: If the father was homozygous dominant then all of the offspring would have the disorder. He must be heterozygous



Some disorders are inherited. They are caused by the inheritance of certain alleles

Polydactyly	***Cystic fibrosis***
Caused by inheriting a dominant allele.	Caused by inheriting a recessive allele (both parents have to at least carry it).
Causes a person/animal to have extra toes or fingers.	A disorder of the cell membrane. Patients cannot control the viscosity of their mucus.

Sex determination

Ordinary human body cells contain 23 pairs of chromosomes

One pair of chromosomes carry the genes that determine sex

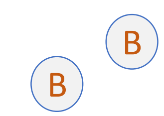
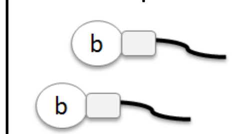
Female	***Male***
XX	XY

Gametes	X	Y
X	XX	XY
X	XX	XY

The probability of a male of female child is 50%. The ratio is 1:1

Genetic inheritance

Using a punnet square (using mouse fur colour as an example)

Parent phenotype	Black fur 	White fur 
Parent genotype	BB	bb
What gametes are present	In each egg 	In each sperm 

Gametes	b	b
B	Bb	Bb
B	Bb	Bb

The probability of black fur offspring phenotype is 100%. All offspring genotypes are heterozygous (Bb).

Crossing two heterozygous mice (Bb)

Gametes	B	b
B	BB	Bb
b	Bb	bb

The probability of black fur is 75% and white fur 25%. The ratio of black to white mice is 3:1

The concept of probability in predicting results of a single gene cross.

Dominant and recessive allele combinations

Dominant	***Recessive***
Represented by a capital letter e.g. B.	Represented by a lower case letter e.g. b.

3 possible combinations:
Homozygous dominant BB
Heterozygous dominant Bb
Homozygous recessive bb

Some characteristics are controlled by a single gene e.g. fur colour, colour blindness.

The alleles present, or genotype operate at a molecular level to develop characteristics that can be expressed as a phenotype.

Most characteristics are as a result of multiple genes interacting.

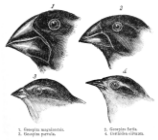
Define terms linked to genetics

Gamete	Sex cells produced in meiosis.
Chromosome	A long chain of DNA found in the nucleus.
Gene	Small section of DNA that codes for a particular protein.
Allele	Alternate forms of the same gene.
Dominant	A type of allele – always expressed if only one copy present and when paired with a recessive allele.
Recessive	A type of allele – only expressed when paired with another recessive allele.
Homozygous	Pair of the same alleles, dominant or recessive.
Heterozygous	Two different alleles are present 1 dominant and 1 recessive.
Genotype	Alleles that are present for a particular feature e.g. Bb or bb
Phenotype	Physical expression of an allele combination e.g. black fur, blonde hair, blue eyes.

AQA GCSE INHERITANCE VARIATION AND EVOLUTION PART 3

Evolution

A change in the inherited characteristics of a population over time through the process of natural selection.

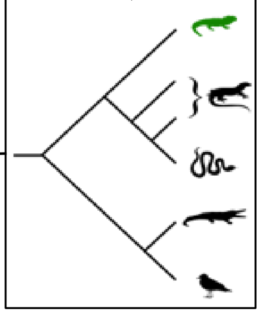
The theory of evolution by natural selection.	***Species of all living things have evolved from simple life forms that first developed 3 billion years ago.***	Through natural selection of variants (genotypes) that give rise to phenotypes best suited to their environment or environmental change e.g. stronger, faster. This allows for variants to pass on their genotype to the next generation.	
		If two populations of one species become so different in phenotype that they can no longer interbreed to produce fertile offspring they have formed two new species.	 Darwin's finches

Over time this results in the formation of new species.

Classification of living organisms

Evolutionary trees are a method used by scientists to show how organisms are related

Use current classification data for living organisms and fossil data for extinct organisms



Selective breeding

The process by which humans breed plants/animals for particular genetic characteristics

Humans have been doing this for thousands of years since they first bred food from crops and domesticated animals.

Selective breeding

Choosing parents with the desired characteristics from a mixed population

Chosen parents are bred together.

↓

From the offspring those with desired characteristics are bred together.

↓

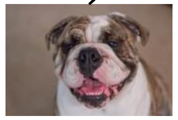
Repeat over several generations until all the offspring show the desired characteristics.

Choosing characteristics

Desired characteristics are chosen for usefulness or appearance

Disease resistance in food crops.	
Animals which produce more meat or milk.	
Domestic dogs with a gentle nature.	
Large or unusual flowers.	

Selective breeding can lead to 'inbreeding' where some breeds are particularly prone to disease or inherited defects e.g. British Bulldogs have breathing difficulties.



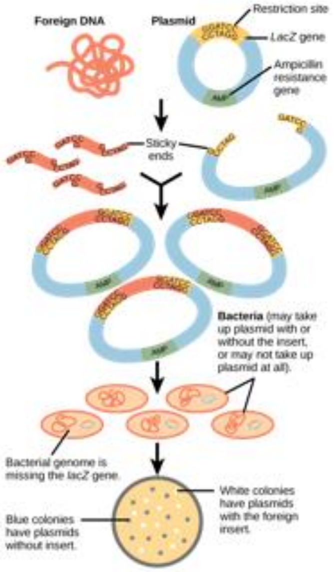
Genetic engineering

Genes from the chromosomes of humans or other organisms can be 'cut out' and transferred to the cells of other organisms.

Concern: effect of GMO on wild populations of flowers and insects.

Concern: effect of GMO on human health not fully explored

Modern medical is exploring the possibility of GM to over come inherited disorders e.g. cystic fibrosis



Genetic engineering process (HT only)

1. Enzymes are used to isolate the required gene.
2. Gene is inserted into a vector – bacterial plasmid or virus.
3. Vector inserts genes into the required cells.
4. Genes are transferred to plants/animals/microbes at an early stage of development so they develop the required characteristics.

Genetically modified crops (GMO)	***Crops that have genes from other organisms***	To become more resistant to insect attack or herbicides.
		To increase the yield of the crop.

AQA GCSE INHERITANCE VARIATION AND EVOLUTION PART 4

Classification of living organisms

The full human classification

Carl Linnaeus classified living things

Kingdom	Animalia
Phylum	Chordata
Class	Mammalia
Order	Primates
Family	Hominidae
Genus	*Homo*
Species	*sapiens*

Organisms are named by the binomial system of genus and species. Humans are *Homo sapiens*

Due to improvements in microscopes, and the understanding of biochemical processes, new models of classification were proposed.

Carl Woese

3 domain based on chemical analysis.

Archaea (primitive bacteria), true bacteria, eukaryota.

Evidence for evolution

Fossils and antibiotic resistance in bacteria provide evidence for evolution.

Antibiotic resistant bacteria

Mutations produce antibiotic resistant strains which can spread

- Resistant strains are not killed.
- Strain survived and reproduces.
- People have no immunity to strain and treatment is ineffective.

Evolution is widely accepted. Evidence is now available as it has been shown that characteristics are passed on to offspring in genes.

Extinction

When no members of a species survive

Due to extreme geological events, disease, climate change, habitat destruction, hunting by humans.

Fossils tell scientists how much or how little different organisms have changed over time.

Fossils

'remains' of ancient organisms which are found in rocks

- Parts of organism that have not decayed as necessary conditions are absent.
- Parts of the organism replaced by minerals as they decay.
- Preserved traces of organisms such as footprints, burrows and rootlet traces.

Early forms of life were soft bodied and few traces are left behind and have been destroyed by geological activity, cannot be certain about how life began.

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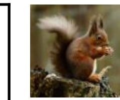
AQA GCSE ECOLOGY PART 1



Ecosystem

Environment	The conditions surrounding an organism; abiotic and biotic.
Habitat	Place where organisms live e.g. woodland, lake.
Population	Individuals of a species living in a habitat.
Community	Populations of different species living in a habitat.

Surviving and reproducing

Competition	Plants in a community or habitat compete with each other for light, space, water and mineral ions.
	Animals compete with each other for food, mates and territory.
Interdependence	Species depend on each other for food, shelter, pollination, seed dispersal etc. Removing a species can affect the whole community

EXAMPLE: Introduction of grey squirrels to UK increased competition for food for red squirrels. The greys also carry a pathogen that kills reds.

EXAMPLE: climate change is leading to more dissolved CO_2 in oceans lowering the pH of the water affecting organisms living there.

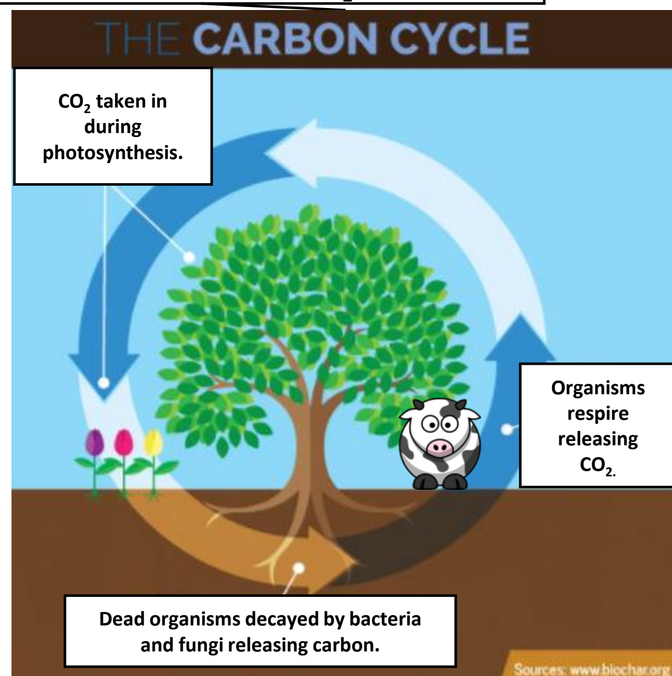
Decomposition and material cycling

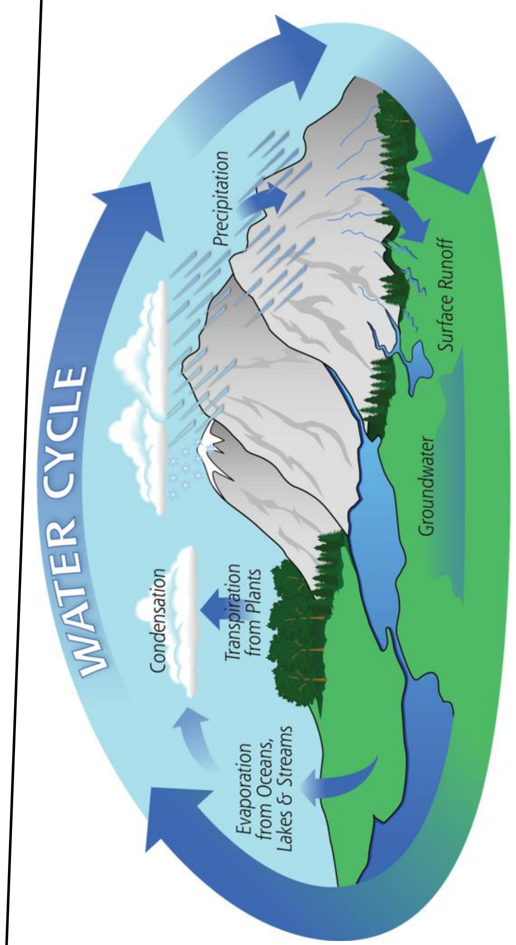
Organisms require a supply of materials from their surroundings and from the other living organisms.

Bacteria respire when breaking down dead organisms releasing CO_2.

Farmers optimise conditions for making compost for use as a natural fertiliser.

Anaerobic decay in biogas generators produces methane gas, used as a fuel.





Materials are recycled to provide the building blocks for future organisms

Factors affecting rate of decay
Temperature, water, oxygen
Increase the rate of decay. In enzyme controlled reactions raising the temperature too high will denature the enzymes.

Breakdown of dead organisms releases mineral ions into the soil.

Interdependence and competition

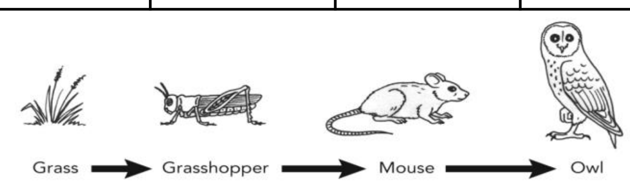
Abiotic and biotic factors

Abiotic	Biotic
Non-living factors that affect a community	*Living factors that affect a community*
Living intensity.	Availability of food.
Temperature.	
Moisture levels.	New predators arriving.
Soil pH, mineral content.	
Wind intensity and direction.	New pathogens.
Carbon dioxide levels for a plant.	
Oxygen levels for aquatic organisms.	One species outcompeting so numbers are no longer sufficient to breed

Levels of organisation

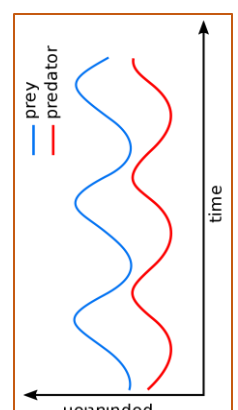
Photosynthetic organisms are the producers of biomass for life on Earth

Food chains			
Feeding relationships in a community			
Producer	Primary consumer	Secondary consumer	Tertiary consumer



All food chains begin with a producer e.g. grass that is usually a green plant or photosynthetic algae.

Consumers that kill and eat other animals are predators and those eaten are prey.



In a stable community the numbers of predators and prey rise and fall in cycles.

Adaptations

Organisms adaptations enable them to survive in conditions where they normally live.

Adaptations may be structural, behavioural or functional.

Adaptations		
Plants	*Animals*	*Extremophiles*
Cactus in dry, hot desert	Polar bear in extreme cold artic	Deep sea vent bacteria
		
No leaves to reduce water loss, wide deep roots for absorbing water.	Hollow hairs to trap layer of heat. Thick layer of fat for insulation.	Populations form in thick layers to protect outer layers from extreme heat of vent.

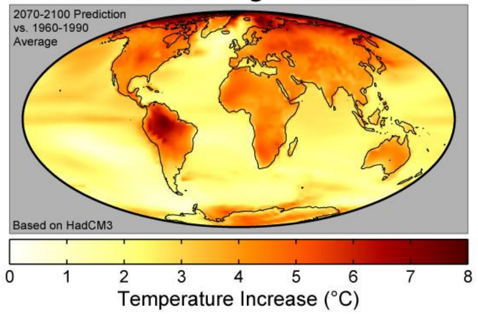
AQA GCSE ECOLOGY PART 2

Global warming

Global warming	*Levels of CO_2 and methane in the atmosphere are increasing.*	Decreased land availability from sea level rise, temperature rise damages delicate habitats, extreme weather events harm populations of plants and animals.

There is a global consensus about global warming and climate change based on systematic reviews of thousands of peer reviewed publications.

Global Warming Predictions



Maintaining biodiversity

Human activity can have a positive impact on biodiversity

Scientists and concerned citizens
Put in place programmes to reduce the negative impacts of humans on ecosystems and biodiversity
Breeding programmes for endangered species.
Protection and regeneration of rare habitats.
Reintroduction of field margins and hedgerows in agricultural areas where farmers grow only one type of crop.
Reduction of deforestation and CO_2 emissions by some governments.
Recycling resources rather than dumping waste in landfill.

Some of the programmes potentially conflict with human needs for land use, food production and high living standards.

AQA GCSE ECOLOGY PART 3

Biodiversity

Biodiversity is the variety of all different species of organisms on Earth, or within an ecosystem

Maintain a great biodiversity		
	Ensures the stability of ecosystems	By reducing the dependence on one species on another for food, shelter, maintenance of the physical environment.
	Future of human species	Many human activities are reduction biodiversity and only recently measures have been taken to stop it.

Experimental methods are used to determine the distribution and abundance of a species.

Sampling techniques		
	Quadrats	Organisms are counted within a randomly placed square
	Transects	Organisms are counted along a belt (transect) of the ecosystem.

Processing data	
Median	Middle value in a sample.
Mode	Most occurring value in a sample.
Mean	The sum of all the value in a sample divided by the sample number.

Biodiversity and the effect of human interaction on the ecosystem

Human activity can have a negative impact on biodiversity

Pollution kills plants and animals which can reduce biodiversity.

Waste management		
	Rapid growth in human population and higher standard of living	More resources used and more waste produced.
		Pollution in water; sewage, fertiliser or toxic chemicals.
		Pollution in air; smoke or acidic gases.
		Pollution on land; landfill and toxic chemicals.

Waste, land use and deforestation

Land use
Humans reduce the amount of land and habitats available for other plants, animals and microorganisms.
Building and quarrying.
Farming for animals and food crops.
Dumping waste.
Destruction of peat bogs to produce cheap compost for gardeners/farmers to increase food production.

The decay or burning of peat release CO_2 into the atmosphere.

This conflicts with conserving peat bogs and peatlands as habitats for biodiversity and reduce CO_2 emissions.

Large scale deforestation
In tropical areas (e.g. rain forest) has occurred to:
Provide land for cattle and rice fields, grow crops for biofuels.

Deforestation reduces biodiversity and removes a sink for increasing the amount CO_2 in the atmosphere.

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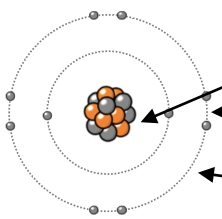
AQA GCSE Atomic structure and periodic table part 1

Atoms, elements and compounds

Atom	*The smallest part of an element that can exist*	Have a radius of around 0.1 nanometres and have no charge (0).
Element	*Contains only one type of atom*	Around 100 different elements each one is represented by a symbol e.g. O, Na, Br.
Compound	*Two or more elements chemically combined*	Compounds can only be separated into elements by chemical reactions.



Central nucleus	Contains protons and neutrons
Electron shells	Contains electrons

Electronic structures

Electronic shell	Max number of electrons
1	2
2	8
3	8
4	2

Relative electrical charges of subatomic particles

Name of Particle	Relative Charge	Relative Mass
Proton	+1	1
Neutron	0	1
Electron	-1	Very small

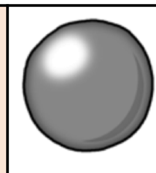
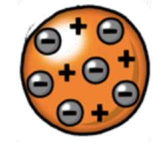
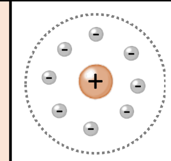
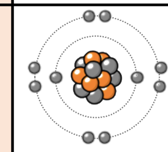
7
Li
3

Mass number	*The sum of the protons and neutrons in the nucleus*	
Atomic number	*The number of protons in the atom*	Number of electrons = number of protons

Mixtures	*Two or more elements or compounds not chemically combined together*	Can be separated by physical processes.

Method	Description	Example
Filtration	*Separating an insoluble solid from a liquid*	To get sand from a mixture of sand, salt and water.
Crystallisation	*To separate a solid from a solution*	To obtain pure crystals of sodium chloride from salt water.
Simple distillation	*To separate a solvent from a solution*	To get pure water from salt water.
Fractional distillation	*Separating a mixture of liquids each with different boiling points*	To separate the different compounds in crude oil.
Chromatography	*Separating substances that move at different rates through a medium*	To separate out the dyes in food colouring.

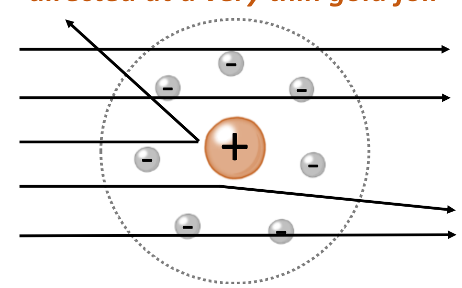
The development of the model of the atom

Pre 1900		*Tiny solid spheres that could not be divided*	Before the discovery of the electron, John Dalton said the solid sphere made up the different elements.
1897 'plum pudding'		*A ball of positive charge with negative electrons embedded in it*	JJ Thompson 's experiments showed that showed that an atom must contain small negative charges (discovery of electrons).
1909 nuclear model		*Positively charge nucleus at the centre surrounded negative electrons*	Ernest Rutherford's alpha particle scattering experiment showed that the mass was concentrated at the centre of the atom.
1913 Bohr model		*Electrons orbit the nucleus at specific distances*	Niels Bohr proposed that electrons orbited in fixed shells; this was supported by experimental observations.

James Chadwick	*Provided the evidence to show the existence of neutrons within the nucleus*

Rutherford's scattering experiment

A beam of alpha particles are directed at a very thin gold foil



Most of the alpha particles passed right through.
A few (+) alpha particles were deflected by the positive nucleus.
A tiny number of particles reflected back from the nucleus.

Chemical equations	*Show chemical reactions - need reactant(s) and product(s) energy always involves and energy change*	Law of conservation of mass states the total mass of products = the total mass of reactants.
Word equations	*Uses words to show reaction* **reactants → products** magnesium + oxygen → magnesium oxide	Does not show what is happening to the atoms or the number of atoms.
Symbol equations	*Uses symbols to show reaction* **reactants → products** $2Mg + O_2 \rightarrow 2MgO$	Shows the number of atoms and molecules in the reaction, these need to be balanced.

Relative atomic mass

Isotopes	*Atoms of the same element with the same number of protons and different numbers of neutrons*	**^{35}Cl (75%) and ^{37}Cl (25%)** Relative abundance = (% isotope 1 x mass isotope 1) + (% isotope 2 x mass isotope 2) ÷ 100 **e.g. (25 x 37) + (75x 35) ÷ 100 = 35.5**

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AQA GCSE Atomic structure and periodic table part 2

Alkali metals — Halogens — Noble gases — Transition metals

1	2											3	4	5	6	7	0
H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	?	?	?						

Metals to the left of this line, non metals to the right

The Periodic table

Elements arranged in order of atomic number	*Elements with similar properties are in columns called groups*	Elements in the same group have the same number of outer shell electrons and elements in the same period (row) have the same number of electron shells.

Development of the Periodic table

Before discovery of protons, neutrons and electrons	*Elements arranged in order of atomic weight*	Early periodic tables were incomplete, some elements were placed in inappropriate groups if the strict order atomic weights was followed.
Mendeleev	*Left gaps for elements that hadn't been discovered yet*	Elements with properties predicted by Mendeleev were discovered and filled in the gaps. Knowledge of isotopes explained why order based on atomic weights was not always correct.

Metals and non metals

Metals	*To the left of the Periodic table*	Form positive ions. Conductors, high melting and boiling points, ductile, malleable.
Non metals	*To the right of the Periodic table*	Form negative ions. Insulators, low melting and boiling points.

Group 1

Alkali metals	*Very reactive with oxygen, water and chlorine*	Only have one electron in their outer shell. Form +1 ions.
	Reactivity increases down the group	Negative outer electron is further away from the positive nucleus so is more easily lost.

With oxygen	Forms a metal oxide	Metal + oxygen → metal oxide	e.g. $4Na + O_2 \rightarrow 2Na_2O$
With water	Forms a metal hydroxide and hydrogen	Metal + water → metal hydroxide + hydrogen	e.g. $2Na + 2H_2O \rightarrow 2NaOH + H_2$
With chlorine	Forms a metal chloride	Metal + chlorine → metal chloride	e.g. $2Na + Cl_2 \rightarrow 2NaCl$

Group 7

Halogens	*Consist of molecules made of a pair of atoms*	Have seven electrons in their outer shell. Form -1 ions.
	Melting and boiling points increase down the group (gas → liquid → solid)	Increasing atomic mass number.
	Reactivity decreases down the group	Increasing proton number means an electron is more easily gained

With metals	Forms a metal halide	Metal + halogen → metal halide e.g. Sodium + chlorine → sodium chloride	e.g. NaCl metal atom loses outer shell electrons and halogen gains an outer shell electron
With hydrogen	Forms a hydrogen halide	Hydrogen + halogen → hydrogen halide e.g. Hydrogen + bromine → hydrogen bromide	e.g. $Cl_2 + H_2 \rightarrow 2HCl$
With aqueous solution of a halide salt	A more reactive halogen will displace the less reactive halogen from the salt	Chlorine + potassium bromide → potassium chloride + bromine	e.g. $Cl_2 + 2KBr \rightarrow 2KCl + Br_2$

Group 0

Noble gases	*Unreactive, do not form molecules*	This is due to having full outer shells of electrons.
	Boiling points increase down the group	Increasing atomic number.

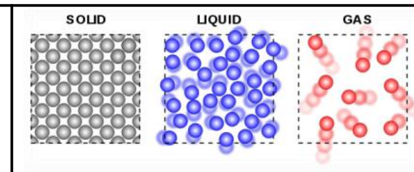
AQA BONDING, STRUCTURE AND THE PROPERTIES OF MATTER 1

Chemical bonds

Ionic	*Particles are oppositely charged ions*	Occurs in compounds formed from metals combined with non metals.
Covalent	*Particles are atoms that share pairs of electrons*	Occurs in most non metallic elements and in compounds of non metals.
Metallic	*Particles are atoms which share delocalised electrons*	Occurs in metallic elements and alloys.

The three states of matter

Solid, liquid, gas	*Melting and freezing happen at melting point, boiling and condensing happen at boiling point.*	The amount of energy needed for a state change depends on the strength of forces between particles in the substance.	(HT only) Limitations of simple model: • There are no forces in the model • All particles are shown as spheres • Spheres are solid



s	solid
l	liquid
g	gas

Properties of ionic compounds

High melting and boiling points	Large amounts of energy needed to break the bonds.
Do not conduct electricity when solid	Ions are held in a fixed position in the lattice and cannot move.
Do conduct electricity when molten or dissolved	Lattice breaks apart and the ions are free to move.

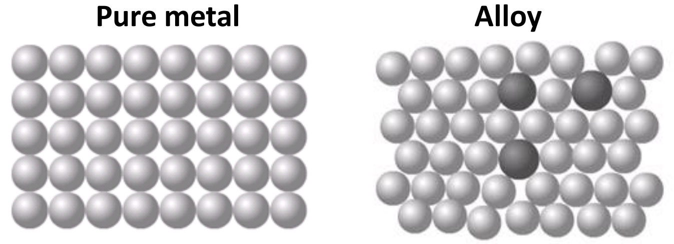
Metals as conductors

Good conductors of electricity	Delocalised electrons carry electrical charge through the metal.
Good conductors of thermal energy	Energy is transferred by the delocalised electrons.

Properties of metals and alloys

High melting and boiling points	This is due to the strong metallic bonds.
Pure metals can be bent and shaped	Atoms are arranged in layers that can slide over each other.

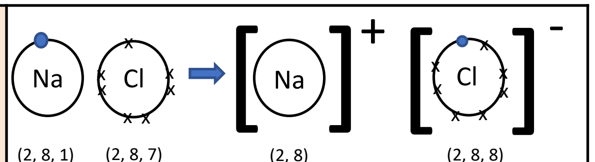
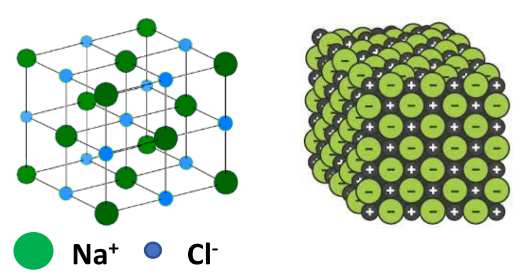
Alloys	*Mixture of two or more elements at least one of which is a metal*	Harder than pure metals because atoms of different sizes disrupt the layers so they cannot slide over each other.



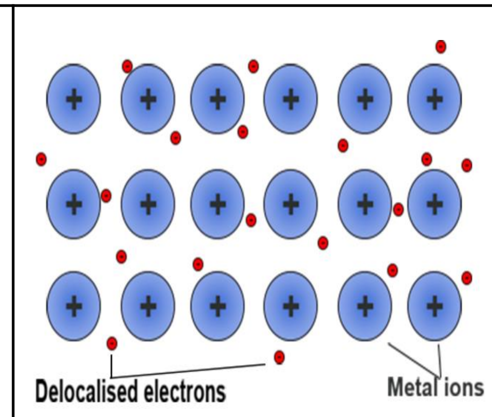
Ionic bonding

Electrons are transferred so that all atoms have a noble gas configuration (full outer shells).	*Metal atoms lose electrons and become positively charged ions*	Group 1 metals form +1 ions Group 2 metals form +2 ions
	Non metals atoms gain electrons to become negatively charged ions	Group 6 non metals form -2 ions Group 7 non metals form -1 ions

Ionic compounds

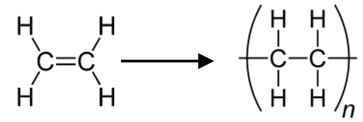
Dot and cross diagram	
Giant structure	
Structure	• *Held together by strong electrostatic forces of attraction between oppositely charged ions* • *Forces act in all directions in the lattice*

Metallic bonding

Giant structure of atoms arranged in a regular pattern		Electrons in the outer shell of metal atoms are delocalised and free to move through the whole structure. This sharing of electrons leads to strong metallic bonds.

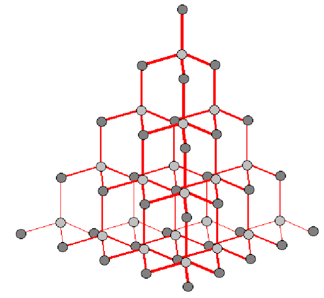
AQA BONDING, STRUCTURE AND THE PROPERTIES OF MATTER 2

Polymers

Very large molecules	*Solids at room temperature*	Atoms are linked by strong covalent bonds.	

Diamond

Each carbon atom is bonded to four others



Very hard.	Rigid structure.
Very high melting point.	Strong covalent bonds.
Does not conduct electricity.	No delocalised electrons.

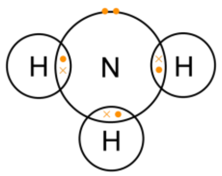
Giant covalent structures

Diamond, graphite, silicon dioxide	*Very high melting points*	Lots of energy needed to break strong, covalent bonds.

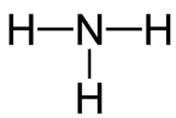
Covalent bonding

Atoms share pairs of electrons

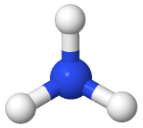
Can be small molecules e.g. ammonia



Dot and cross :
+ Show which atom the electrons in the bonds come from
- All electrons are identical

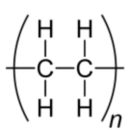


2D with bonds:
+ Show which atoms are bonded together
- It shows the H-C-H bond incorrectly at 90°



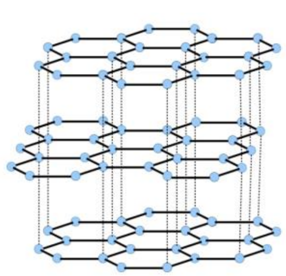
3D ball and stick model:
+ Attempts to show the H-C-H bond angle is 109.5°

Can be giant covalent structures e.g. polymers



Graphite

Each carbon atom is bonded to three others forming layers of hexagonal rings with no covalent bonds between the layers



Slippery.	Layers can slide over each other.
Very high melting point.	Strong covalent bonds.
Does conduct electricity.	Delocalised electrons between layers.

Properties of small molecules

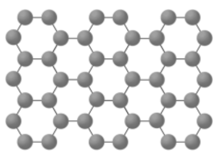
Usually gases or liquids

Covalent bonds in the molecule are strong but forces between molecules (intermolecular) are weak

Low melting and boiling points.	Due to having weak intermolecular forces that easily broken.
Do not conduct electricity.	Due to them molecules not having an overall electrical charge.
Larger molecules have higher melting and boiling points.	Intermolecular forces increase with the size of the molecules.

Graphene and fullerenes

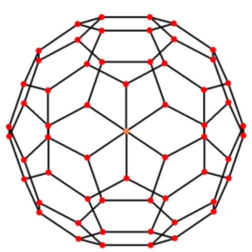
Graphene



Single layer of graphite one atom thick

Excellent conductor.	Contains delocalised electrons.
Very strong.	Contains strong covalent bonds.

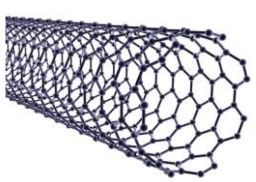
Fullerenes



Buckminsterfullerene, C_{60}
First fullerene to be discovered.

Hexagonal rings of carbon atoms with hollow shapes. Can also have rings of five (pentagonal) or seven (heptagonal) carbon atoms.

Carbon nanotubes



Very thin and long cylindrical fullerenes

Very conductive.	Used in electronics industry.
High tensile strength.	Reinforcing composite materials.
Large surface area to volume ratio.	Catalysts and lubricants.

AQA GCSE QUANTITATIVE CHEMISTRY

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Relative formula mass (M_r)

M_r	*The sum of the relative atomic masses of the atoms in the numbers shown in the formula*	The sum of the M_r of the reactants in the quantities shown equals the sum of the M_r of the products in the quantities shown.	$2Mg + O_2 \rightarrow 2MgO$ 48g + 32g = 80g 80g = 80g

Limiting reactants (HT only)

The reactant that is completely used up	*Limits the amount of product that is made*	Less moles of product are made.

Mass changes when a reactant or product is a gas

Mass appears to increase during a reaction	*One of the reactants is a gas*	Magnesium + oxygen → magnesium oxide
Mass appears to decrease during a reaction	*One of the products is a gas and has escaped*	Calcium carbonate → carbon dioxide + calcium oxide

Chemical measurements

Whenever a measurement is taken, there is always some uncertainty about the result obtained	*Can determine whether the mean value falls within the range of uncertainty of the result*	1. Calculate the mean 2. Calculate the range of the results 3. Estimate of uncertainty in mean would be half the range

Example:
1. Mean value is 46.5s
2. Range of results is 44s to 49s = 5s
3. Time taken was 46.5s $\pm$2.5s

Conservation of mass and balanced symbol equations

Conservation of mass	*No atoms are lost or made during a chemical reaction*	Mass of the products equals the mass of the reactants.
Balanced symbol equations	*Represent chemical reactions and have the same number of atoms of each element on both sides of the equation*	$H_2 + Cl_2 \rightarrow 2HCl$ Subscript → ; Normal script → Subscript numbers show the number of atoms of the element to its left. Normal script numbers show the number of molecules.

Concentration of solutions

Measured in mass per given volume of solution (g/dm³)	*Conc. = mass (g) / volume (dm³)*	HT only Greater mass = higher concentration. Greater volume = lower concentration.

Using moles to balance equations (HT only)

The balancing numbers in a symbol equation can be calculated from the masses of reactants and products	*Convert the masses in grams to amounts in moles and convert the number of moles to simple whole number ratios.*

Moles (HT only)

Chemical amounts are measured in moles (mol)	*Mass of one mole of a substance in grams = relative formula mass*	One mole of H_2O = 18g (1 + 1 + 16) One mole of Mg = 24g
Avogadro constant	*One mole of any substance will contain the same number of particles, atoms, molecules or ions.*	6.02×10^{23} per mole One mole of H_2O will contain 6.02×10^{23} molecules One mole of NaCl will contain 6.02×10^{23} Na^+ ions
Number of moles = $\frac{\text{mass (g)}}{A_r}$ or $\frac{\text{mass (g)}}{M_r}$		How many moles of sulfuric acid molecules are there in 4.7g of sulfuric acid (H_2SO_4)? Give your answer to 1 significant figure. $\frac{4.7}{98}$ = 0.05 mol 98 ← (M_r of H_2SO_4)

Amounts of substances in equations (HT only)

Chemical equations show the number of moles reacting and the number of moles made	*$Mg + 2HCl \rightarrow MgCl_2 + H_2$* *One mole of magnesium reacts with two moles of hydrochloric acid to make one mole of magnesium chloride and one mole of hydrogen*	If you have a 60g of Mg, what mass of HCl do you need to convert it to $MgCl_2$? A_r : Mg =24 so mass of 1 mole of Mg = 24g M_r : HCl (1 + 35.5) so mass of 1 mole of HCl = 36.5g So 60g of Mg is 60/24 = 2.5 moles Balanced symbol equation tells us that for every one mole of Mg, you need two moles of HCl to react with it. So you need 2.5x2 = 5 moles of HCl You will need 5 x 36.5g of HCl= 182.5g

AQA Chemical Changes 1

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

Oxidation and reduction in terms of electrons (HT ONLY)

Ionic half equations (HT only)

For displacement reactions	*Ionic half equations show what happens to each of the reactants during reactions*	For example: The ionic equation for the reaction between iron and copper (II) ions is: **$Fe + Cu^{2+} \rightarrow Fe^{2+} + Cu$** The half-equation for iron (II) is: **$Fe \rightarrow Fe^{2+} + 2e^-$** The half-equation for copper (II) ions is: **$Cu^{2+} + 2e^- \rightarrow Cu$**

Reactions of acids

Reactions of acids and metals

HT ONLY: Reactions between metals and acids are redox reactions as the metal donates electrons to the hydrogen ions. This displaces hydrogen as a gas while the metal ions are left in the solution.

Reactions with acids	*metal + acid → metal salt + hydrogen*	**magnesium + hydrochloric acid → magnesium chloride + hydrogen** **zinc + sulfuric acid → zinc sulfate + hydrogen**

Acids react with some metals to produce salts and hydrogen.

Neutralisation of acids and salt production

Acid name	Salt name
Hydrochloric acid	Chloride
Sulfuric acid	Sulfate
Nitric acid	Nitrate

sodium hydroxide + hydrochloric acid → sodium chloride + water

calcium carbonate + sulfuric acid → calcium sulfate, + carbon dioxide + water

Neutralisation	*Acids can be neutralised by alkalis and bases*	An **alkali** is a soluble base e.g. metal hydroxide. A **base** is a substance that neutralises an acid e.g. a soluble metal hydroxide or a metal oxide.

Reactivity of metals

Metal oxides

Metals and oxygen	*Metals react with oxygen to form metal oxides*	**magnesium + oxygen → magnesium oxide** *$2Mg + O_2 \rightarrow 2MgO$*
Reduction	*This is when oxygen is removed from a compound during a reaction*	e.g. metal oxides reacting with hydrogen, extracting low reactivity metals
Oxidation	*This is when oxygen is gained by a compound during a reaction*	e.g. metals reacting with oxygen, rusting of iron

Extraction of metals and reduction

Extraction using carbon

Metals less reactive than carbon can be extracted from their oxides by reduction.	For example: **zinc oxide + carbon → zinc + carbon dioxide**

Unreactive metals, such as gold, are found in the Earth as the metal itself. They can be mined from the ground.

The reactivity series

	Reactions with water	Reactions with acid
Group 1 metals	*Reactions get more vigorous as you go down the group*	*Reactions get more vigorous as you go down the group*
Group 2 metals	*Do not react with water*	*Observable reactions include fizzing and temperature increases*
Zinc, iron and copper	*Do not react with water*	*Zinc and iron react slowly with acid. Copper does not react with acid.*

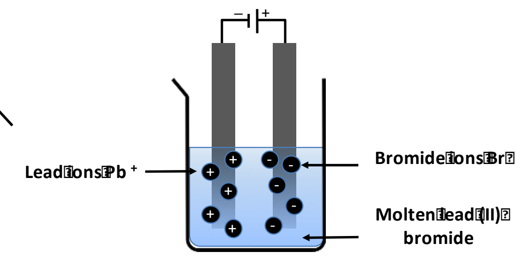
Metals form positive ions when they react	*The reactivity of a metal is related to its tendency to form positive ions*	The reactivity series arranges metals in order of their reactivity (their tendency to form positive ions).
Carbon and hydrogen	*Carbon and hydrogen are non-metals but are included in the reactivity series*	These two non-metals are included in the reactivity series as they can be used to extract some metals from their ores, depending on their reactivity.
Displacement	*A more reactive metal can displace a less reactive metal from a compound.*	Silver nitrate + Sodium chloride → Sodium nitrate + Silver chloride

potassium (most reactive)	K
sodium	Na
calcium	Ca
magnesium	Mg
aluminium	Al
carbon	C
zinc	Zn
iron	Fe
tin	Sn
lead	Pb
hydrogen	H
copper	Cu
silver	Ag
gold	Au
platinum (least reactive)	Pt

AQA Chemical Changes 2

Electrolysis

Process of electrolysis	*Splitting up using electricity*	When an ionic compound is melted or dissolved in water, the ions are free to move. These are then able to conduct electricity and are called electrolytes. Passing an electric current though electrolytes causes the ions to move to the electrodes.
Electrode	*Anode Cathode*	The positive electrode is called the anode. The negative electrode is called the cathode.
Where do the ions go?	*Cations Anions*	Cations are positive ions and they move to the negative cathode. Anions are negative ions and they move to the positive anode.



Higher tier: You can display what is happening at each electrode using half-equations:

At the cathode: $Pb^{2+} + 2e^- \rightarrow Pb$

At the anode: $2Br^- \rightarrow Br_2 + 2e^-$

Extracting metals using electrolysis

- *Metals can be extracted from molten compounds using electrolysis.*
- *This process is used when the metal is too reactive to be extracted by reduction with carbon.*
- *The process is expensive due to large amounts of energy needed to produce the electrical current. Example: aluminium is extracted in this way.*

Electrolysis of aqueous solutions

The ions discharged when an aqueous solution is electrolysed using inert electrodes depend on the relative reactivity of the elements involved.

At the negative electrode	Metal will be produced on the electrode if it is less reactive than hydrogen. Hydrogen will be produced if the metal is more reactive than hydrogen.
At the positive electrode	Oxygen is formed at positive electrode. If you have a halide ion (Cl^-, I^-, Br^-) then you will get chlorine, bromine or iodine formed at that electrode.

Reactions of acids

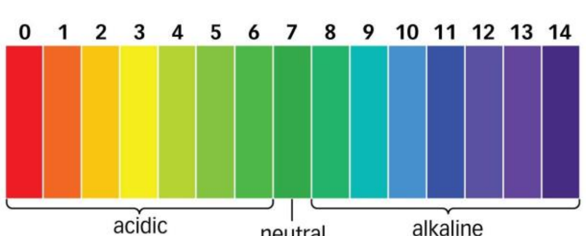
Strong and weak acids (HT ONLY)

Strong acids	*Completely ionised in aqueous solutions e.g. hydrochloric, nitric and sulfuric acids.*
Weak acids	*Only partially ionised in aqueous solutions e.g. ethanoic acid, citric acid.*
Hydrogen ion concentration	*As the pH decreases by one unit (becoming a stronger acid), the hydrogen ion concentration increases by a factor of 10.*

Soluble salts

Soluble salts	*Soluble salts can be made from reacting acids with solid insoluble substances (e.g. metals, metal oxides, hydroxides and carbonates).*
Production of soluble salts	*Add the solid to the acid until no more dissolves. Filter off excess solid and then crystallise to produce solid salts.*

The pH scale and neutralisation



You can use universal indicator or a pH probe to measure the acidity or alkalinity of a solution against the pH scale.

Acids	*Acids produce hydrogen ions (H^+) in aqueous solutions.*
Alkalis	*Aqueous solutions of alkalis contain hydroxide ions (OH^-).*

In neutralisation reactions, hydrogen ions react with hydroxide ions to produce water:

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

AQA GCSE Energy changes

Types of reaction

Endothermic	*Energy is taken in from the surroundings so the temperature of the surroundings decreases*	• Thermal decomposition • Sports injury packs
Exothermic	*Energy is transferred to the surroundings so the temperature of the surroundings increases*	• Combustion • Hand warmers • Neutralisation

The energy change of reactions (HT only)

Reaction profiles	*Show the overall energy change of a reaction*

Breaking bonds in reactants	*Endothermic process*
Making bonds in products	*Exothermic process*

Overall energy change of a reaction

Exothermic	Energy released making new bonds is greater than the energy taken in breaking existing bonds.
Endothermic	Energy needed to break existing bonds is greater than the energy released making new bonds.

Bond energy calculation

Calculate the overall energy change for the forward reaction

$N_2 + 3H_2 \rightleftharpoons 2NH_3$

Bond energies (in kJ/mol): H-H 436, H-N 391, N≡N 945

Bond breaking: 945 + (3 x 436) = 945 + 1308 = 2253 kJ/mol

Bond making: 6 x 391 = 2346 kJ/mol

Overall energy change = 2253 - 2346 = -93kJ/mol

Therefore reaction is exothermic overall.

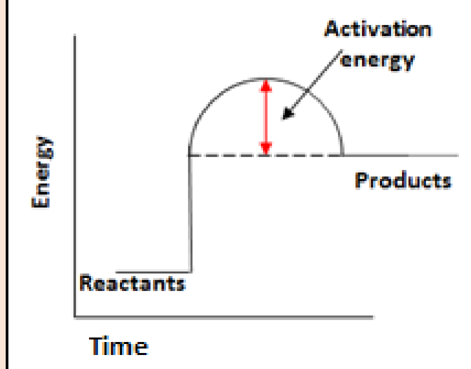
Reaction profiles

Activation energy

Chemical reactions only happen when particles collide with sufficient energy

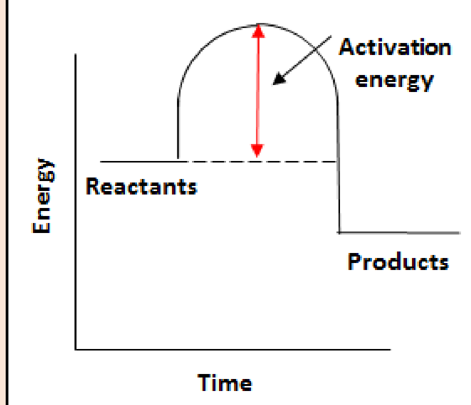
The minimum amount of energy that colliding particles must have in order to react is called the activation energy.

Endothermic



Products are at a higher energy level than the reactants. As the reactants form products, energy is transferred from the surroundings to the reaction mixture. The temperature of the surroundings decreases because energy is taken in during the reaction.

Exothermic



Products are at a lower energy level than the reactants. When the reactants form products, energy is transferred to the surroundings. The temperature of the surroundings increases because energy is released during the reaction.

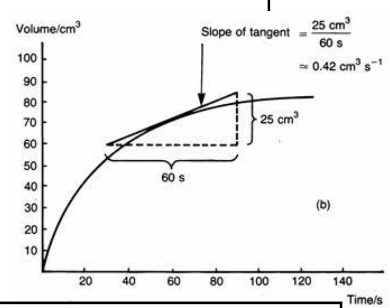
AQA GCSE The rate and extent of chemical change

Rate of reaction

Calculating rates of reactions

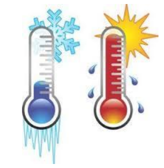
Rate of chemical reaction	***This can be calculated by measuring the quantity of reactant used or product formed in a given time.***	Rate = quantity of reactant used / time taken Rate = quantity of product formed / time taken

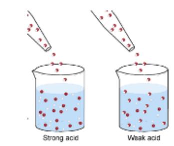
Quantity	Unit
Mass	Grams (g)
Volume	cm^3
Rate of reaction	Grams per cm^3 (g/cm^3) HT: moles per second (mol/s)

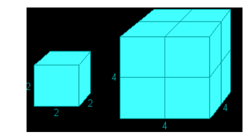


Factors affecting rates

Factors affecting the rate of reaction	
Temperature	***The higher the temperature, the quicker the rate of reaction.***
Concentration	***The higher the concentration, the quicker the rate of reaction.***
Surface area	***The larger the surface area of a reactant solid, the quicker the rate of reaction.***
Pressure (of gases)	***When gases react, the higher the pressure upon them, the quicker the rate of reaction.***



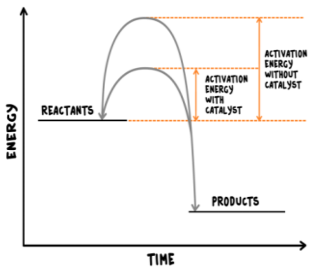




Collision theory and activation energy

Collision theory	***Chemical reactions can only occur when reacting particles collide with each other with sufficient energy.***	Increasing the temperature increases the frequency of collisions and makes the collisions more energetic, therefore increasing the rate of reaction. Increasing the concentration, pressure (gases) and surface area (solids) of reactions increases the frequency of collisions, therefore increasing the rate of reaction.
Activation energy	***This is the minimum amount of energy colliding particles in a reaction need in order to react.***	

Catalysts



If a catalyst is used in a reaction, it is not shown in the word equation.

Catalyst	A catalyst changes the rate of a chemical reaction but is not used in the reaction.
Enzymes	These are biological catalysts.
How do they work?	Catalysts provide a different reaction pathway where reactants do not require as much energy to react when they collide.

Reversible reactions and dynamic equilibrium

Reversible reactions

Reversible reactions	In some chemical reactions, the products can react again to re-form the reactants.
Representing reversible reactions	A + B ⇌ C + D
The direction	The direction of reversible reactions can be changed by changing conditions: A + B ⇌ C + D (heat →, cool ←)

Energy changes and reversible reactions

If one direction of a reversible reaction is exothermic, the opposite direction is endothermic. The same amount of energy is transferred in each case.

For example: Hydrated copper sulfate ⇌ Anhydrous copper sulfate + Water (endothermic →, exothermic ←)

Equilibrium

Equilibrium in reversible reactions	When a reversible reaction occurs in apparatus which prevents the escape of reactants and products, equilibrium is reached when the forward and reverse reactions occur exactly at the same rate.

Changing conditions and equilibrium (HT)

The relative amounts of reactants and products at equilibrium depend on the conditions of the reaction.

Le Chatelier's Principles	States that when a system experiences a disturbance (change in condition), it will respond to restore a new equilibrium state.
Changing concentration	If the concentration of a reactant is increased, more products will be formed . If the concentration of a product is decreased, more reactants will react.
Changing temperature	If the temperature of a system at equilibrium is increased: - Exothermic reaction = products decrease - Endothermic reaction = products increase
Changing pressure (gaseous reactions)	For a gaseous system at equilibrium: - Pressure increase = equilibrium position shifts to side of equation with smaller number of molecules. - Pressure decrease = equilibrium position shifts to side of equation with larger number of molecules.

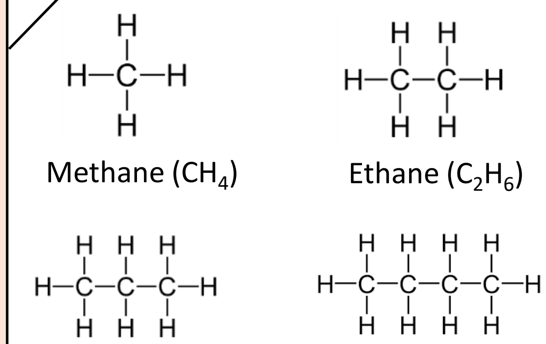
AQA GCSE Organic chemistry 1

Carbon compounds as fuels and feedstock

Crude oil, hydrocarbons and alkanes

Crude oil	*A finite resource*	Consisting mainly of plankton that was buried in the mud, crude oil is the remains of ancient biomass.
Hydrocarbons	*These make up the majority of the compounds in crude oil*	Most of these hydrocarbons are called alkanes.
General formula for alkanes	*C_nH_{2n+2}*	For example: C_2H_6 C_6H_{14}

Display formula for first four alkanes

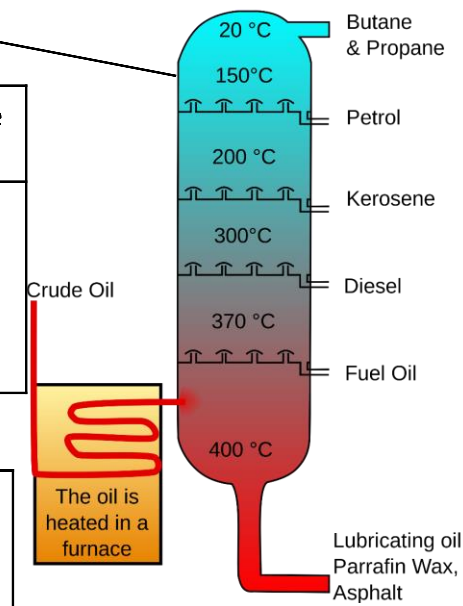


Methane (CH_4), Ethane (C_2H_6), Propane (C_3H_8), Butane (C_4H_{10})

Fractional distillation and petrochemicals

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.

Hydrocarbon chains		
	In oil	Hydrocarbon chains in crude oil come in lots of different lengths.
	Boiling points	The boiling point of the chain depends on its length. During fractional distillation, they boil and separate at different temperatures due to this.



Cracking and alkenes

Alkanes to alkenes	*Long chain alkanes are cracked into short chain alkenes.*
Alkenes	*Alkenes are hydrocarbons with a double bond (some are formed during the cracking process).*
Properties of alkenes	*Alkenes are more reactive that alkanes and react with bromine water. Bromine water changes from orange to colourless in the presence of alkenes.*

Cracking	*The breaking down of long chain hydrocarbons into smaller chains*	The smaller chains are more useful. Cracking can be done by various methods including catalytic cracking and steam cracking.
Catalytic cracking	*The heavy fraction is heated until vaporised*	After vaporisation, the vapour is passed over a hot catalyst forming smaller, more useful hydrocarbons.
Steam cracking	*The heavy fraction is heated until vaporised*	After vaporisation, the vapour is mixed with steam and heated to a very high temperature forming smaller, more useful hydrocarbons.

Decane → pentane + propene + ethane

$C_{10}H_{22} \rightarrow C_5H_{12} + C_3H_6 + C_2H_4$

Alkenes and uses as polymers	*Used to produce polymers. They are also used as the starting materials of many other chemicals, such as alcohol, plastics and detergents.*
Why do we crack long chains?	*Without cracking, many of the long hydrocarbons would be wasted as there is not much demand for these as for the shorter chains.*

Properties of hydrocarbons

Combustion	During the complete combustion of hydrocarbons, the carbon and hydrogen in the fuels are oxidised, releasing carbon dioxide, water and energy.

Complete combustion of methane:
Methane + oxygen → carbon dioxide + water + energy

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

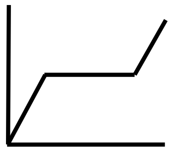
Boiling point (temperature at which liquid boils)	*As the hydrocarbon chain length increases, boiling point increases.*
Viscosity (how easily it flows)	*As the hydrocarbon chain length increases, viscosity increases.*
Flammability (how easily it burns)	*As the hydrocarbon chain length increases, flammability decreases.*

Purity, formulations and chromatography

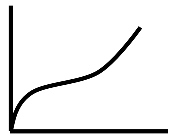
AQA Chemical analysis

Pure substances

Pure substances	*A pure substance is a single element or compound, not mixed with any other substance.*	Pure substances melt and boil at specific temperatures. Heating graphs can be used to distinguish pure substances from impure.



Melting point of a pure substance

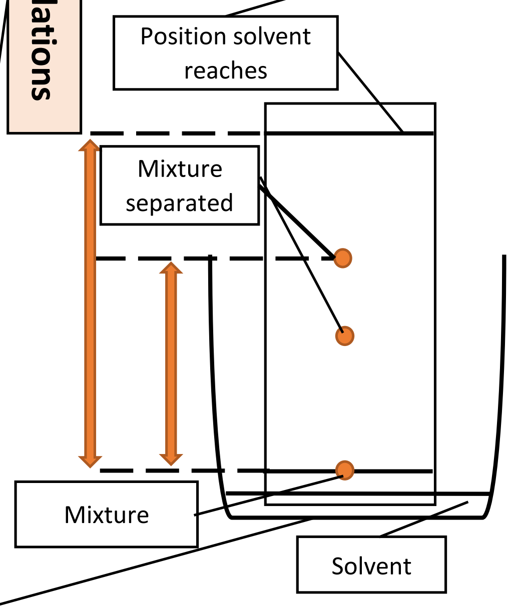


Melting point of an impure substance

Formulations

Formulation	*A formulation is a mixture that has been designed as a useful product.*
How are formulations made?	*By mixing chemicals that have a particular purpose in careful quantities.*
Examples of formulations.	*Fuels, cleaning agents, paints, medicines and fertilisers.*

Chromatography



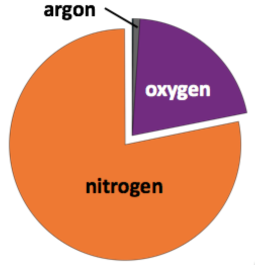
Chromatography	*Can be used to separate mixtures and help identify substances.*	Involves a mobile phase (e.g. water or ethanol) and a stationary phase (e.g. chromatography paper).
R_f Values	*The ratio of the distance moved by a compound to the distance moved by solvent.*	$R_f = \frac{\text{distance moved by substance}}{\text{distance moved by solvent}}$
Pure substances	*The compounds in a mixture separate into different spots.*	This depends on the solvent used. A pure substance will produce a single spot in all solvents whereas an impure substance will produce multiple spots.

Identification of common gases

Gas	Test	Positive result
Hydrogen	*Burning splint*	'Pop' sound.
Oxygen	*Glowing splint*	Re-lights the splint.
Chlorine	*Litmus paper (damp)*	Bleaches the paper white.
Carbon dioxide	*Limewater*	Goes cloudy (as a solid calcium carbonate forms).

AQA GCSE Chemistry of the atmosphere

Composition and evolution of the atmosphere



Proportions of gases in the atmosphere

Gas	Percentage
Nitrogen	*~80%*
Oxygen	*~20%*
Argon	*0.93%*
Carbon dioxide	*0.04%*

The Earth's early atmosphere

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 oceans formed, carbon dioxide dissolved into it*	This formed carbonate precipitates, forming sediments. This reduced the levels of carbon dioxide in the atmosphere.

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.

CO_2 and methane as greenhouse gases

Greenhouse gases

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 to the Earth, warming up the global temperature.*

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 footprints

The total amount of greenhouse gases emitted over the full life cycle of a product/event. This can be reduced by reducing emissions of carbon dioxide and methane.

Global climate change

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

Common atmospheric pollutants

Atmospheric pollutants from fuels

Combustion of fuels	*Source of atmospheric pollutants. Most fuels may also contain some sulfur.*
Gases from burning fuels	*Carbon dioxide, water vapour, carbon monoxide, sulfur dioxide and oxides of nitrogen.*
Particulates	*Solid particles and unburned hydrocarbons released when burning fuels.*

Properties and effects of atmospheric pollutants

Carbon monoxide	*Toxic, colourless and odourless gas. Not easily detected, can kill.*
Sulfur dioxide and oxides of nitrogen	*Cause respiratory problems in humans and acid rain which affects the environment.*
Particulates	*Cause global dimming and health problems in humans.*

AQA GCSE Using resources 1

Using the Earth's resources and obtaining potable water

Using the Earth's resources and sustainable development

Earth's resources	*Used to provide warmth, shelter, food and transport for humans*	Natural resources and resources from agriculture provide: timber, food, clothing and fuels.
		Finite resources from the Earth, oceans and atmosphere are processed to provide energy and materials.
Chemistry and resources	*Research and techniques improve agricultural and industrial processes*	These improvements provide new products and improve sustainability.
Plastics	*Normally made using ethene from crude oil*	However, the raw material ethene can also be obtained from ethanol, which can be produced during fermentation. Industries are now starting to use a renewable crop for this process.

Potable water

Sterilising agents include chlorine, ozone and UV light.

Potable water	*Water of an appropriate quality is essential for life*	Human drinking water should have low levels of dissolved salts and microbes. This is called potable water.
UK water	*Rain provides water with low levels of dissolved substances*	This water collects in the ground/lakes/rivers. To make potable water an appropriate source is chosen, which is then passed through filter beds and then sterilised.
Desalination	*Needs to occur is fresh water is limited and salty/sea water is needed for drinking*	This can be achieved by distillation or by using large membranes e.g. reverse osmosis. These processes require large amounts of energy.

Waste water treatment

Waste water	*Produced from urban lifestyles and industrial processes*	These require treatment before used in the environment. Sewage needs the organic matter and harmful microbes removed.
Sewage treatment	*Includes many stages*	- Screening and grit removal - Sedimentation to produce sludge and effluent (liquid waste or sewage). - Anaerobic digestion of sludge - Aerobic biological treatment of effluent.

Alternative methods of extracting metals (HT)

Metals ores	*These resources are limited*	Copper ores especially are becoming sparse. New ways of extracting copper from low-grade ores are being developed.
Phytomining	*Plants absorb metal compounds*	These plants are then harvested and burned; their ash contains the metal compounds.
Bioleaching	*Bacteria is used to produce leachate solutions that contain metal compounds*	The metal compounds can be processed to obtain the metal from it e.g. copper can be obtained from its compounds by displacement or electrolysis.

Life cycle assessment and recycling

Life cycle assessment

LCAS	*Life cycle assessments are carried out to assess the environmental impact of products*	They are assessed at these stages: - Extraction and processing raw materials - Manufacturing and packaging - Use and operation during lifetime - Disposal
Values	*Allocating numerical values to pollutant effects is difficult*	Value judgments are allocated to the effects of pollutants so LCA is not a purely objective process.

Ways of reducing the use of resources

Reduce, reuse and recycle	*This strategy reduces the use of limited resources*	This, therefore, reduces energy sources being used, reduces waste (landfill) and reduces environmental impacts.
Limited raw materials	*Used for metals, glass, building materials, plastics and clay ceramics*	Most of the energy required for these processes comes from limited resources. Obtaining raw materials from the Earth by quarrying and mining causes environmental impacts.
Reusing and recycling	*Metals can be recycled by melting and recasting/reforming*	Glass bottles can be reused. They are crushed and melted to make different glass products. Products that cannot be reused are recycled.

AQA ENERGY – part 1

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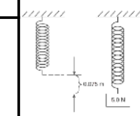
Energy pathways

Mechanical	*Force acts upon an object*
Electrical	*Electric current flow*
Heat	*Temperature difference between objects*
Radiation	*Electromagnetic waves or sound*

Energy stores and changes

Kinetic energy	*Energy stored by a moving object*	½ X mass X (speed)^2 ½ mv^2
Elastic Potential energy	*Energy stored in a stretched spring, elastic band*	½ X spring constant X (extension)^2 ½ ke^2 (Assuming the limit of proportionality has not been exceeded)
Gravitational Potential energy	*Energy gained by an object raised above the ground*	Mass X gravitational field strength X height mgh



System	*An object or group of objects that interact together*	EG: Kettle boiling water.
Energy stores	*Kinetic, chemical, internal (thermal), gravitational potential, elastic potential, magnetic, electrostatic, nuclear*	Energy is gained or lost from the object or device.
Ways to transfer energy	*Light, sound, electricity, thermal, kinetic are ways to transfer from one store to another store of energy.*	EG: electrical energy transfers chemical energy into thermal energy to heat water up.
Unit	*Joules (J)*	

Work	*Doing work transfers energy from one store to another*	By applying a force to move an object the energy store is changed.	Work done = Force X distance moved W = Fs
Power	*The rate of energy transfer*	1 Joule of energy per second = 1 watt of power	Power = energy transfer ÷ time P = E ÷ t Power = work done ÷ time, P = W ÷ t

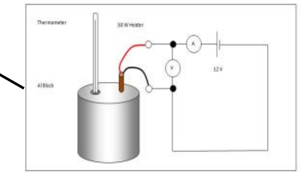
	Units
Specific Heat Capacity	*Joules per Kilogram degree Celsius (J/Kg°C)*
Temperature change	*Degrees Celsius (°C)*
Work done	*Joules (J)*
Force	*Newton (N)*
Distance moved	*Metre (m)*
Power	*Watts (W)*
Time	*Seconds (s)*

Specific heat capacity

Change in thermal energy = mass **X** specific heat capacity **X** temperature change

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

Specific Heat Capacity	*Energy needed to raise 1kg of substance by 1°C*	Depends on: mass of substance, what the substance is and energy put into the system.



Energy Conservation and Dissipation

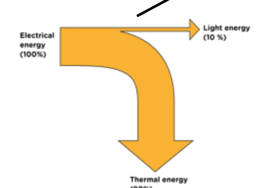
HIGHER: efficiency can be increased using machines.

Efficiency = Useful power output / Total power input

Efficiency = Useful output energy transfer / Total input energy transfer

Efficiency	*How much energy is usefully transferred*	
Dissipate	*To scatter in all directions or to use wastefully*	When energy is 'wasted', it dissipates into the surroundings as internal (thermal) energy.
Ways to reduce 'wasted' energy	*Energy transferred usefully*	Insulation, streamline design, lubrication of moving parts.
Principle of conservation of energy	*The amount of energy always stays the same.*	Energy cannot be created or destroyed, only changed from one store to another.

Closed system	*No change in total energy in system*
Open system	*Energy can dissipate*



Useful energy	*Energy transferred and used*
Wasted energy	*Dissipated energy, stored less usefully*

Prefix	*Multiple*	Standard form
Kilo	*1000*	10^3
Mega	*1000 000*	10^6
Giga	*100 000 000*	10^9

	Units
Energy (KE, EPE, GPE, thermal)	*Joules (J)*
Velocity	*Metres per second (m/s)*
Spring constant	*Newton per metre (N/m)*
Extension	*Metres (m)*
Mass	*Kilogram (Kg)*
Gravitational field strength	*Newton per kilogram (N/Kg)*
Height	*Metres (m)*

HIGHER: When an object is moved, energy is transferred by doing work.

Work done = Force X distance moved

Frictional forces cause energy to be transferred as thermal energy. This is wasted.

Reducing friction - using wheels, applying lubrication. Reducing air resistance – travelling slowly, streamlining.

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AQA ENERGY – part 2

Global Energy Resources

Using fuels

Transport	*Petrol, diesel, kerosene produced from oil*	Used in cars, trains and planes.
Heating	*Gas and electricity*	Used in buildings.
Electricity	*Most generated by fossil fuels*	Used to power most devices.

Using renewable energy will need to increase to meet demand.

Renewable energy makes up about 20% of energy consumption.

Fossil fuel reserves are running out.

Energy demand is increasing as population increases.

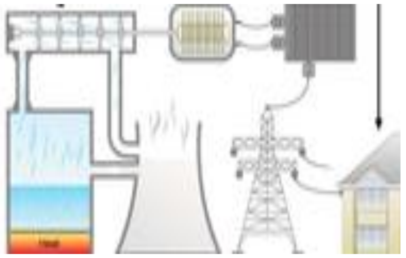
Energy resources

Non-renewable energy resource	*These will run out. It is a finite reserve. It cannot be replenished.*	e.g. Fossil fuels (coal, oil and gas) and nuclear fuels.
Renewable energy resource	*These will never run out. It is an infinite reserve. It can be replenished.*	e.g. Solar, Tides, Waves, Wind, Geothermal, Biomass, Hydroelectric

National Grid

Power station – NB: You need to understand the principle behind generating electricity. An energy resource is burnt to make steam to drive a turbine which drives the generator.

Power station	*Generates electricity*	Fuel burnt releasing thermal energy →	Water boils into steam →	Steam turns turbine →	Turbine turns generator →	Generator induces voltage
National Grid	*Transports electricity across UK*	Power station →	Step-up transformer →	Pylons →	Step-down transformer →	House, factory



Energy resource	*How it works*	Uses	Positive	Negative
Fossil Fuels (coal, oil and gas)	*Burnt to release thermal energy used to turn water into steam to turn turbines*	Generating electricity, heating and transport	Provides most of the UK energy. Large reserves. Cheap to extract. Used in transport, heating and making electricity. Easy to transport.	Non-renewable. Burning coal and oil releases sulfur dioxide. When mixed with rain makes acid rain. Acid rain damages building and kills plants. Burning fossil fuels releases carbon dioxide which contributes to global warming. Serious environmental damage if oil spilt.
Nuclear	*Nuclear fission process*	Generating electricity	No greenhouse gases produced. Lots of energy produced from small amounts of fuel.	Non-renewable. Dangers of radioactive materials being released into air or water. Nuclear sites need high levels of security. Start up costs and decommission costs very expensive. Toxic waste needs careful storing.
Biofuel	*Plant matter burnt to release thermal energy*	Transport and generating electricity	Renewable. As plants grow, they remove carbon dioxide. They are 'carbon neutral'.	Large areas of land needed to grow fuel crops. Habitats destroyed and food not grown. Emits carbon dioxide when burnt thus adding to greenhouse gases and global warming.
Tides	*Every day tides rise and fall, so generation of electricity can be predicted*	Generating electricity	Renewable. Predictable due to consistency of tides. No greenhouse gases produced.	Expensive to set up. A dam like structure is built across an estuary, altering habitats and causing problems for ships and boats.
Waves	*Up and down motion turns turbines*	Generating electricity	Renewable. No waste products.	Can be unreliable depends on wave output as large waves can stop the pistons working.
Hydroelectric	*Falling water spins a turbine*	Generating electricity	Renewable. No waste products.	Habitats destroyed when dam is built.
Wind	*Movement causes turbine to spin which turns a generator*	Generating electricity	Renewable. No waste products.	Unreliable – wind varies. Visual and noise pollution. Dangerous to migrating birds.
Solar	*Directly heats objects in solar panels or sunlight captured in photovoltaic cells*	Generating electricity and some heating	Renewable. No waste products.	Making and installing solar panels expensive. Unreliable due to light intensity.
Geothermal	*Hot rocks under the ground heats water to produce steam to turn turbine*	Generating electricity and heating	Renewable. Clean. No greenhouse gases produced.	Limited to a small number of countries. Geothermal power stations can cause earthquake tremors.

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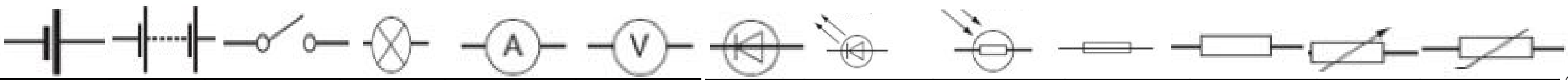
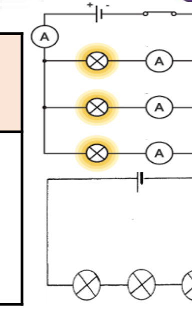


Circuit symbols

Cell	Battery	Switch	Lamp	Ammeter	Volt meter	Diode	LED	LDR	Fuse	Resistor	Variable resistor	Thermistor
Store of chemical energy	*Two or more cells in series*	*Breaks circuit, turning current off*	*Lights when current flows*	*Measures current*	*Measures potential difference*	*Current flows one way*	*Emits light when current flows*	*Resistance low in bright light*	*Melts when current is too high*	*Affects the size of current flowing*	*Allows current to be varied*	*Resistance low at high temp*

Electrons carry current. Electrons are free to move in metal.



AQA Electricity

Current, potential difference and resistance

Current and Charge

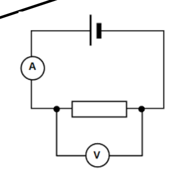
Current	*Flow of electrical charge*	Ampere (A)
Potential difference (p.d.)	*How much electrical work is done by a cell*	Volts (V)
Charge	*Amount of electricity travelling in a circuit*	Coulombs (C)

Charge = Current X time — $Q = I \times t$

Controlling current

Changing current	*Change the p.d. of the cells*
	Add more components

Ammeter	*Set up in series with components*
Voltmeter	*Set up parallel to components*



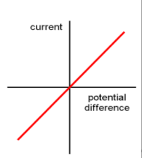
$R = V \div I$

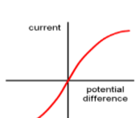
Resistance = Potential difference ÷ Current

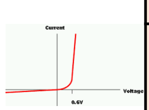
Resistance (Ω)	*A measurement of how much current flow is reduced*
The higher the resistance, the more difficult it is for current to flow.	
Increasing resistance, reduces current.	
Increasing voltage, increases current.	

Thermistor	LDR
Resistance varies with temperature	*Resistance varies with light intensity*
Resistance decreases as temperature increases.	Resistance decreases as light increases.

Current – Potential difference graphs







Ohmic conductor	*At a constant temperature, current is directly proportional to the p.d. across the resistor.*
Filament lamp	*As current increases, the resistance increases. The temperature increases as current flows.*
Diode	*Current flows when p.d. flows forward. Very high resistance in reverse.*

Series and parallel circuits

Series circuit	Current is the same in all components.	Total p.d. from battery is shared between all the components.	Total resistance is the sum of each component's resistance.
Parallel circuit	Total current is the sum of each component's current.	p.d. across all components is the same.	Total resistance is less than the resistance value of the smallest individual resistor.

Series	Parallel
A circuit with one loop	*A circuit with two or more loops*

Total p.d	*If cells are joined in series, add up individual cell values*

Energy transfers

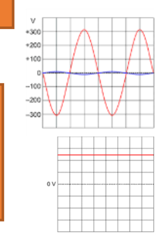
Work is done when charge flowing.

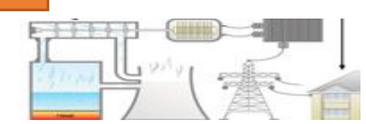
Power (W) = potential difference X current — $R = V \times I$

Power = (current)^2 X resistance — $P = I^2 \times R$

Energy transferred = Power X time — $E = P \times t$

Domestic uses and safety





National Grid	*Distributes electricity generated in power stations around UK*

Step-up transformers	Step-down transformers
Increase voltage, decrease current	*Decrease voltage, increase current*
Increases efficiency, reduces heat loss.	Makes safer for houses.

Alternating current	Direct current
p.d. switches direction many times a second, current switches direction	*p.d. remains in one direction, current flows the same direction*
Generator.	Cell or battery.

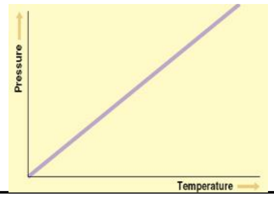
'Earthing' a safety device; Earth wire joins the metal case.

Mains supply
Frequency 50Hz, 230V

3 pin plug		
Live - Brown	Carries p.d from mains supply.	p.d between live and earth = 230V
Neutral - Blue	Completes the circuit.	p.d. = 0V
Earth – Green and Yellow stripes	Only carries current if there is a fault.	p.d. = 0V

AQA PARTICLE MODEL OF MATTER

Particle model



State	Particle arrangement	Properties
Solid	*Packed in a regular structure. Strong forces hold in place so cannot move.*	Difficult to change shape.
Liquid	*Close together, forces keep contact but can move about.*	Can change shape but difficult to compress.
Gas	*Separated by large distances. Weak forces so constantly randomly moving.*	Can expand to fill a space, easy to compress.

	Units
Density	*Kilograms per metre cubed (kg/m³)*
Mass	*Kilograms (kg)*
Volume	*Metres cubed (m³)*
Energy needed	*Joules (J)*
Specific latent heat	*Joule per kilogram (J/kg)*
Change in thermal energy	*Joules (J)*
Specific heat capacity	*Joule per kilogram degrees Celsius (J/kg°C)*
Temperature change	*Degrees Celsius (°C)*
Pressure	*Pascals (Pa)*

Kinetic theory of gases

- Pressure of a fixed volume of gas increases as temperature increases (temperature increases, speed increases, collisions occur more frequently and with more force so pressure increases).
- Temperature of gas is linked to the average kinetic energy of the particles.
- If kinetic energy increases so does the temperature of gas.
- No kinetic energy is lost when gas particles collide with each other or the container.
- Gas particles are in a constant state of random motion.

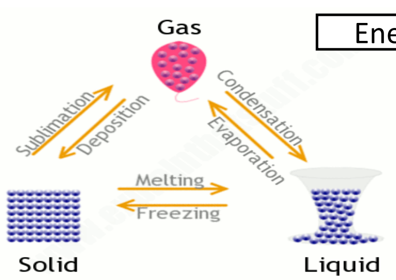
P = m ÷ V

Density = mass ÷ volume.

Density	*Mass of a substance in a given volume*

Change of state

Freezing	Liquid turns to a solid. Internal energy decreases.
Melting	Solid turns to a liquid. Internal energy increases.
Boiling / Evaporating	Liquid turns to a gas. Internal energy increases.
Condensation	Gas turns to a liquid. Internal energy decreases.
Sublimation	Solid turns directly into a gas. Internal energy increases.
Conservation of mass	When substances change state, mass is conserved.
Physical change	No new substance is made, process can be reversed.



Internal energy and energy transfers

Specific Heat Capacity	*Energy needed to raise 1kg of substance by 1°C*	Depends on: • Mass of substance • What the substance is • Energy put into the system.

Change in thermal energy = mass **X** specific heat capacity **X** temperature change.

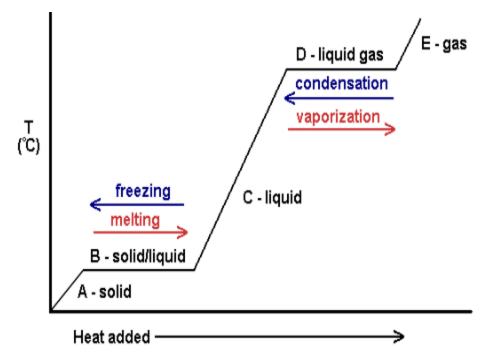
ΔE= m **X** c **X** Δθ

Internal energy		
	Energy stored inside a system by particles	Internal energy is the total kinetic and potential energy of all the particles (atoms and molecules) in a system.
	Heating changes the energy stored within a system	Heating causes a change in state. As particles separate, potential energy stored increases. Heating increases the temperature of a system. Particles move faster so kinetic energy of particles increases.

Specific Latent Heat	*Energy needed to change 1kg of a substance's state*
Specific Latent Heat of Fusion	*Energy needed to change 1kg of solid into 1 kg of liquid at the same temperature*
Specific Latent Heat of Vaporisation	*Energy needed to change 1kg of liquid into 1 kg of gas at the same temperature*

Energy needed = mass **X** specific latent heat.

ΔE= m X L

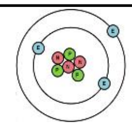
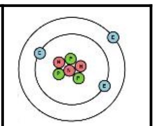


Radius of an atom
1 X 10^{-10}m

Electrons gained	Electrons lost
Negative ion	Positive ion

Atom	*Same number of protons and electrons*
Ion	*Unequal number of electrons to protons*
Mass number	*Number of protons and neutrons*
Atomic number	*Number of protons*

Particle	*Charge*	*Size*	*Found*
Neutron	*None*	*1*	*In the nucleus*
Proton	*+*	*1*	*In the nucleus*
Electron	*-*	*Tiny*	*Orbits the nucleus*

Isotope	$^{6}_{3}Li$		$^{7}_{3}Li$	
Different forms of an element with the same number of protons but different number of neutrons				

Atom structure

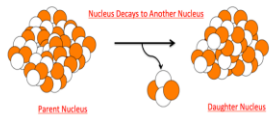
Discovery of the nucleus

Democritus	Suggested idea of atoms as small spheres that cannot be cut.
J J Thomson (1897)	Discovered electrons– emitted from surface of hot metal. Showed electrons are negatively charged and that they are much less massive than atoms.
Thomson (1904)	Proposed *'plum pudding'* model – atoms are a ball of positive charge with negative electrons embedded in it.
Geiger and Marsden (1909)	Directed beam of alpha particles (He^{2+})at a thin sheet of gold foil. Found some travelled through, some were deflected, some bounced back.
Rutherford (1911)	Used above evidence to suggest alpha particles deflected due to electrostatic interaction between the very small charged nucleus, nucleus was massive. Proposed mass and positive charge contained in nucleus while electrons found outside the nucleus which cancel the positive charge exactly.
Bohr (1913)	Suggested modern model of atom – electrons in circular orbits around nucleus, electrons can change orbits by emitting or absorbing electromagnetic radiation. His research led to the idea of some particles within the nucleus having positive charge; these were named protons.
Chadwick (1932)	Discovered neutrons in nucleus – enabling other scientists to account for mass of atom.

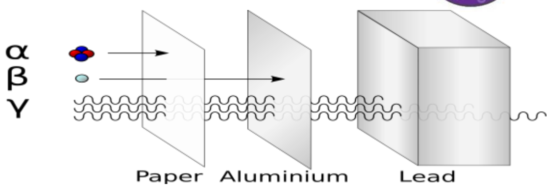
AQA ATOMIC STRUCTURE

Atoms and Isotopes

Atoms and Nuclear Radiation



Decay	*Range in air*	*Ionising power*	*Penetration power*
Alpha	Few cm	Very strong	Stopped by paper
Beta	Few m	Medium	Stopped by Aluminium
Gamma	Great distances	Weak	Stopped by thick lead



Radioactive decay	*Unstable atoms randomly emit radiation to become stable*
Detecting	*Use Geiger Muller tube*
Unit	*Becquerel*
Ionisation	*All radiation ionises*

Decay	*Emitted from nucleus*	*Changes in mass number and atomic number*		Example
Alpha (α)	*Helium nuclei ($^{4}_{2}He$)*	*-4*	*-2*	$^{238}_{92}U \rightarrow ^{234}_{90}Th + ^{4}_{2}He$
Beta (β)	*Electron ($^{0}_{-1}e$)*	*0*	*+1*	$^{14}_{6}C \rightarrow ^{14}_{7}N + ^{0}_{-1}e$
Gamma (γ)	*Electromagnetic wave*	*0*	*0*	$^{99}_{43}Tc \rightarrow ^{99}_{43}Tc + \gamma$
Neutron	*Neutron*	*-1*	*0*	

AQA FORCES – part 1

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Forces and their interactions

Each Kg has a gravitational pull of 9.8N.

Unit	*Newton (N)*	1N
Kilo	*Kilonewton (KN) = 1000*	1X 10^3
Mega	*Meganewton (MN) = 1000,000*	1 X 10^6

Centre of mass	*The weight of an object acts through a single point*

Gravity

Gravitational field strength	*Gravity exerted around an object.*	Earth's gfs = 9.8N/kg

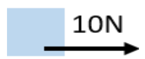
Weight = mass X gravitational field strength | W = m X g

Weight	*Force acting upon an object due to gravity*	Newton (N)
Mass	*How much matter*	Kilograms (Kg)

Scalar and vector quantities

Scalar	*A quantity that only has magnitude (size)*	e.g. mass, time, speed, temperature, energy,
Vector	*A quantity that only has magnitude and direction*	e.g. force, velocity, momentum

An arrow can be used to show vectors	*Length of arrow = magnitude of vector*
	Direction of arrow = direction of vector



Velocity	*Speed + direction*	The speed of a car is 30m/s. A car moves forward with a velocity of 30m/s
Distance	*How far*	The table is 1m long
Displacement	*Distance + direction*	The beach is 1km due east of the town

Area	*Metres squares (m^2)*
Weight	*Newton (N)*
Mass	*Kilograms (kg)*
Gravitational field strength	*Newton per kilogram (N/Kg)*
Force	*Newton (N)*
Work done	*Joules (J)*
Distance	*Metres (m)*
Moment	*Newton-metres (Nm)*

Contact and Resultant forces

Force	*Push or pull*	Stretch, squash, turn.
Contact force	*Exerted between two objects when they touch*	Friction, air resistance, tension.
Non-contact force	*Exerted between two objects without touching*	Gravity, electrostatic forces, magnetic forces.

Resultant force	*The overall effect of all of the forces acting upon an object*	Two forces acting in the same direction are added.
		Two forces acting in the opposite direction are taken away.

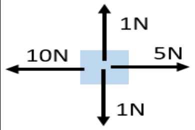
HIGHER ONLY

Resolving forces	*An object pulled with a force at an angle*	A single force can be split into two components acting at right angles to each other.

The component forces combined have the same effect.

Free body diagram	*Show magnitude and direction of all forces upon an object*

Object moves left with a force of 5N



Work done against frictional forces, temperature of object rises.

If force is at right angles to direction of movement, NO work is done.

Work done and energy transfer

Work done	*When work is done, energy is transferred*	Work done = force X distance moved W = F X s
		1J of work is done when 1N of force moves an object through a distance of 1m, in the direction of the force.

Forces and elasticity

One force	*The object changes speed or direction*
More than one force	*The object changes shape*

Two balanced forces can stretch a object.

Two balanced forces can compress an object.

Three balanced forces can bend an object.

Elastic deformation	*The object has been stretched but returns to its original length*
Inelastic deformation	*The object has been stretched but does not return to its original length*
Extension	*The difference between stretched and unstretched lengths*

Limit of proportionality

Beyond this point the spring is permanently deformed

Stretching a spring	Force = spring constant X extension, F = k X e
	EPE = ½ X spring constant X (extension)^2, EPE = ½ ke^2

Elastic Potential energy (EPE)	*Energy stored in a stretched spring*

Force	*Newton (N)*
Spring constant	*Newton per metre (N/m)*
Extension	*Metres (m)*
EPE	*Joules (J)*

AQA FORCES – part 2

Observing and recording motion

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Describing motion

Aeroplane banks to change direction	Velocity changes.	
Car travelling around a bend	Constant speed, direction changes.	
Satellite orbiting the Earth	Constant speed, direction changes.	

Changing velocity	*Objects in a circular motion, change direction but keep a constant speed*

HIGHER ONLY

Velocity	*The speed of an object with direction*	Vector

Speed of sound 330m/s.

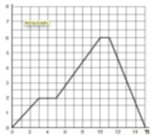
Speed = distance ÷ time — v = s ÷ t

Speed	*How fast an object moves*	Scalar
Displacement	*Includes the distance and direction an object moves*	vector
Distance	*How far an object moves*	scalar

Speed is rarely constant.

Car on motorway	*30m/s*	Walking	*1.5m/s*
Train	*60m/s*	Running	*3m/s*
Jet plane	*200m/s*	Cycling	*6m/s*

Distance-time graph	*Shows how far an object moves along a straight line*
Speed of object	*Use the gradient of graph*



Gradient = vertical ÷ horizontal

Accelerating objects: *It takes time for objects to reach top speed*	Draw a tangent to the curve, work out gradient.

HIGHER ONLY

Distance travelled	*Area under the graph shape*

HIGHER ONLY

Velocity-time graph	*Shows speed of an object*
Accelerating	*Object getting faster*
Decelerating	*Object slowing down*

Acceleration = change in velocity ÷ time taken

Acceleration	*Change in velocity*	Vector

Constant acceleration

(final velocity) ^{2} – (initial velocity) ^{2} = 2 X acceleration X distance

$V^2 - u^2 = 2 \text{ X } a \text{ X } s$

Falling objects

Falling objects accelerate due to gravity.	In no air resistance, objects accelerate at 9.8m/s^2	Air resistance slows falling objects down.
Terminal velocity	*Weight of an object is balanced by resistive forces*	Object moves at a constant velocity. Resultant force = 0.

Forces and braking

Frictional forces decelerate a moving object and bring it to rest.

Speed affects both thinking and braking distances.

Typical reaction time = 0.7s

Thinking distance	*Distance travelled whilst the driver reacts*
Braking distance	*Distance travelled whilst the car is stopped by the brakes*
Stopping distance	*Total thinking and braking distances*

Factors affecting stopping distances		
	Drivers reaction times	Drinking alcohol, taking drugs, tired.
	Braking distances	Weather conditions, worn brakes or tyres, road surface, size of braking force.

Braking and kinetic energy	
Work done by braking force, reduces kinetic energy	Kinetic energy decreases, temperature of brakes increases due to frictional forces.

Forces, acceleration and Newton's Laws of motion

Inertia	*When objects continue in the same state of motion*

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Speed or direction only changes if a resultant force acts on the object

Newton's first Law	*Balanced forces*	When the resultant force on an still object = 0, the object is stationary.
		When the resultant force on a moving object = 0, the object is at a constant speed.
Newton's second Law	*Unbalanced forces*	When the resultant force is greater than 0, the object accelerates. It could speed up, slow down or change direction.
Newton's third Law	*Equal and opposite forces*	When two objects interact the forces exerted are equal and in an opposite direction.

Acceleration is proportional to resultant force.

Acceleration is inversely proportional to mass.

Force = mass X acceleration

HIGHER ONLY — F = m X a

Inertial mass	*How difficult it is to change the velocity of an object*

Inertial mass = force ÷ acceleration

If the mass is large, to change velocity a big force is needed.

Momentum

Is a vector

HIGHER ONLY — p = m X v

Momentum = mass X velocity

HIGHER ONLY

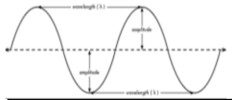
Conservation of momentum

When two objects collide, the momentum they have before the collision = the momentum they have after the collision

Closed system = no external forces acting on it.

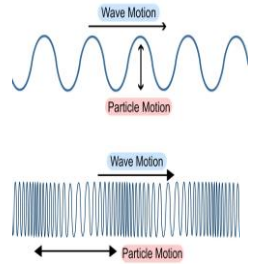
Speed / velocity	*Metres per second (m/s)*
Distance	*Metres (m)*
Time	*Seconds (s)*
Acceleration	*Metres per second squared (m/s^2)*
Force	*Newton (N)*
Mass	*Kilogram (Kg)*
Momentum	*Kilograms metres per second (Kgm/s)*

AQA Waves



Wave speed	Wave speed = frequency X wavelength	V = f X λ
Wave period	Wave period = 1 ÷ frequency	T = 1 ÷ f
Speed	Speed = distance ÷ time	v = d ÷ t

Wavelength	***Distance from one point on a wave to the same point of the next wave***
Amplitude	***The maximum disturbance from its rest position***
Frequency	***Number of waves per second***
Period	***Time taken to produce 1 complete wave***



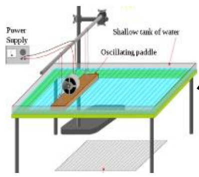
Transverse wave	***Vibration causing the wave is at right angles to the direction of energy transfer***	Energy is carried outwards by the wave.	Water and light waves, S waves.
Longitudinal wave	***Vibration causing the wave is parallel to the direction of energy transfer***	Energy is carried along the wave.	Sound waves, P waves.

Transverse and Longitudinal waves

Waves in air, fluids and solids

Properties

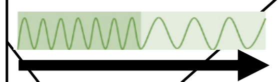
Measuring speed

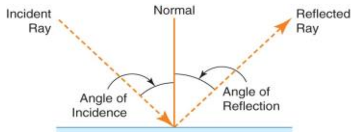


In water, use a ripple tank.

In air, use echoes.

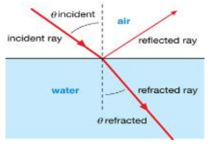
Sound waves travelling through different mediums, the frequency stay constant.





Angle of incidence = angle of reflection (i) = (r)

Reflection	Wave bounces off the surface.
Refraction	Waves changes direction at boundary.
Transmitted	Passes through the object.
Absorbed	Passes into but not out of, transfers energy and heats up the object.



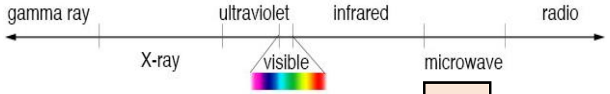
Light refracts as it slows down in a denser substance

Electromagnetic waves

e.g. Gamma

Short wavelengths have high frequency and high energy.

Electromagnetic wave	***Continuous spectrum of transverse waves***



	Units
Distance	***Metres (m)***
Wave speed	***Metres per second (m/s)***
Wavelength	***Metres (m)***
Frequency	***Hertz (Hz)***
Period	***Seconds (s)***

HIGHER: Properties

Absorbed light changes into thermal energy store.

Black surfaces	***Good emitters, good absorbers***
White surfaces	***Poor emitters, poor absorbers***
Shiny surfaces	***Good reflectors***

EM waves refract

Specular	Flat surface reflection.
Diffuse	Rough surface reflection.

EM wave	Danger	Use
Radio	Safe.	Communications, TV, radio.
Microwave	Burning if concentrated.	Mobile phones, cooking, satellites.
Infrared		Heating, remote controls, cooking.
Visible	Damage to eyes.	Illumination, photography, fibre optics.
Ultra violet	Sunburn, cancer.	Security marking, disinfecting water.
X-ray	Cell destruction, mutation, cancer.	Broken bones, airport security.
Gamma		Sterilising, detecting and killing cancer.

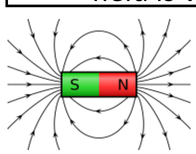
Low frequency, long wavelength.

White	Wave lengths reflected
Black	Wave lengths absorbed

High frequency, short wavelength

AQA MAGNETISM AND ELECTROMAGNETISM

Permanent and Induced Magnetism



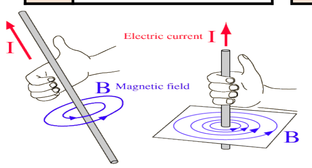
Magnets

Magnetic	***Materials attracted by magnets***	Uses non-contact force to attract magnetic materials.
North seeking pole	***End of magnet pointing north***	Compass needle is a bar magnet and points north.
South seeking pole	***End of magnet pointing south***	Like poles (N – N) repel, unlike poles (N – S) attract.
Magnetic field	***Region of force around magnet***	Strong field, force big. Weak field, force small. Field is strongest at the poles.
Permanent	***A magnet that produces its own magnetic field***	Will repel or attract other magnets and magnetic materials.
Induced	***A temporary magnet***	Becomes magnet when placed in a magnetic field.

Magnetic field around a wire

Electric current flowing in a wire produces a magnetic field around it.

- If current is small, magnetic field is very weak.
- Current large enough, iron filings show circular magnetic field.
- Further away from the wire, magnetic field is weaker.
- Reverse current, magnetic field direction reverses.

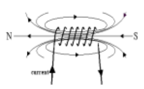


Right hand rule

Thumb	Direction of current.
Fingers	Direction of magnetic field.

Solenoid

Solenoid	***A long coil of wire***	Magnetic field from each loop adds to the next.



Electromagnet

Electromagnet	***Lots of turns of wire increase the magnetising effect when current flows***
	Turn current off, magnetism lost.

Increase strength of magnetic field

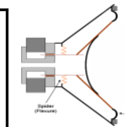
- ***Use larger current***
- ***Use more turns of wire***
- ***Put turns of wire closer together***
- ***Use iron core in middle***

Relay

Relay	***A device using a small current to control a larger current in another circuit***	Solenoid is wound around an iron core. Small current magnetises the solenoid. This attracts to electrical contacts, making a complete circuit. Current flows from battery to starter motor.

Motor effect

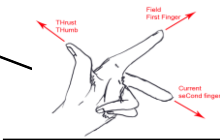
Split-ring commutator	***Split ring touching two carbon brush contacts***	
Loud speakers	***Converts variations in electrical current into sound waves .***	Varying current flows through a coil that is in a magnetic field. A force on the wire moves backwards and forwards as current varies. Coil connected to a diaphragm. Diaphragm movements produce sound waves.
Generators	***Coil of wire rotating inside a magnetic field. The end of the coil is connected to slip rings.***	Produces altering current.
Microphones	***Converts pressure variations in sound waves into variations in current in electrical circuits.***	
Electric motor	***Coil of wire rotates about an axle***	Current flows through the wire causing a downward movement on one side and an upward movement on the other side.



Fleming's left-hand rule

To predict the direction a straight conductor moves in a magnetic field.

Thumb	Direction of movement.
First finger	Direction of magnetic field.
Second finger	Direction of current.



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Magnetic fields from the permanent magnet and current in the foil interact. This is called the motor effect.

- Reverse the current , foil moves upwards.
- Aluminium foil placed between two poles of a strong magnet, will move downwards when current flows through the foil.
- Size of force acting on foil depends on magnetic flux density between poles, size of current, length of foil between poles.

F = B X I X l

Force = magnetic flux density X current X length

If current and magnetic field are parallel to each other , no force on wire.

Magnetic flux	***Lines drawn to show magnetic field***	Lots of lines = stronger magnets.
Magnetic flux density	***Number of lines of magnetic flux in a given area***	Measures the strength of magnetic force.