



Year 11 Science

Assessment Points

Pupil and Parent Information Booklet



ASPIRATION – COMMITMENT - ACHIEVEMENT

Dear pupil,

You are now less than a year away from sitting your actual GCSE exams. The upcoming assessments are designed to give you, your teachers, and your parents an indication of how you are progressing in your GCSE subjects.

They are also an ideal opportunity for you to get first-hand experience of what your GCSE exams will be like and allow you to develop effective revision strategies in plenty of time for the real thing.

Assessment is a key part of effective preparation, it gives you confidence, the chance to practise and the ability to build up a range of revision techniques so you can find out which are the most effective for you. They also give your teacher and school the chance to identify any gaps in your knowledge or skills so they can help you address this before your final exams.

However, PPE assessments are only effective if you fully prepare for them and do your absolute best. The main message is simple, preparation is everything! If you begin your revision early and give yourself plenty of time to prepare, you are far more likely to be successful.

There is a suggested revision plan included in this pack to help you plan your revision for the year.

One key piece of information that you will have heard in your science lessons, that we would like to reiterate, is that we do not expect you to know everything and remember everything first time around, we fully expect you to make mistakes. The most important thing is that you try your hardest, identify where you made the mistake and correct it, this is how you will learn and improve. **You must attempt to answer every question on the papers.**

This booklet contains information about your upcoming science exams, the dates you will sit them, some hints and tips on how to revise and some information you can use for revision.

If you have any questions not answered in this booklet, please ask your teacher.

Work hard and good luck!

The Science Team

Essential equipment for your science exams

1. Black Biro Pens
2. Pencil
3. Rubber
4. Pencil Sharpener
5. Ruler
6. Scientific Calculator (Make sure you are familiar with how to use this)

Optional Items

1. Highlighter Pen – to highlight any text in the question paper only, cannot be used in your answer

Exam Checklist



- Get a good night's sleep
- Eat a healthy meal
- Review the GCSEPod exam playlist
- Check where your exam is being held
- Arrive 15 minutes early



Year 11 Assessment Information

Assessment	Date	Content
Year 11 AP1	14 th – 25 th November	All Science Paper 2 Content
Year 11 AP2	6 th – 17 th March	All Science Paper 1 and Paper 2 Content.
GCSEs	TBC – May 2023	All Science Paper 1 and Paper 2 Content.

Year 11 AP1 – 14th November

PAPERS Paper 2 in Biology, Chemistry and Physics.

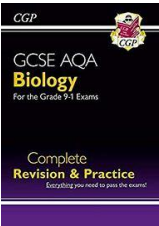
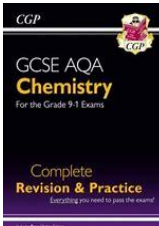
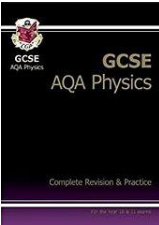
LENGTH 1 hour and 15 minutes **-Combined – Trilogy**

1 hour 45 minutes **Triple Science**

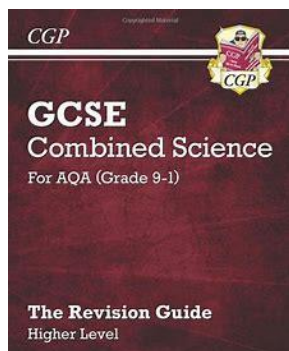
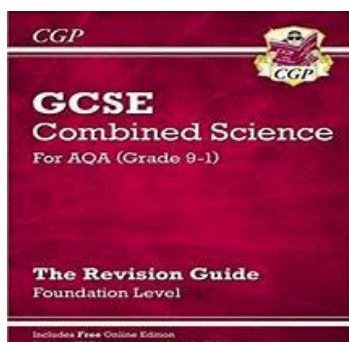
Use contents page in the relevant revision guide to revise. Revision guides are available from the school. Your teacher will let you know which one you need and where you can buy them from.

Paper 2 Information

Triple Science

Subject	How long is the exam?	What should I revise?	What do I need to bring to the exam?
Triple Science Biology	1 Paper 1 hour 45 minutes	All Biology Paper 2 topics  Ecology Variation Homeostasis	Two Black pens Pencil Ruler Rubber Pencil Sharpener Scientific calculator
Triple Science Chemistry	1 Paper 1 hour 45 minutes	All Chemistry Paper 2 topics  Rates of Reaction Organic Chemistry Chemistry of the Atmosphere Chemical Analysis Using Resources	Two Black pens Pencil Ruler Rubber Pencil Sharpener Scientific calculator
Triple Science Physics	1 Paper 1 hour 45 minutes	All Physics Paper 2 topics  Forces Magnetism Waves Space (Triple Only)	Two Black pens Pencil Ruler Rubber Pencil Sharpener Scientific calculator

Combined Science Trilogy – Higher and Foundation



Subject	How long is the exam?	What should I revise?	What do I need to bring to the exam?
<p>Combined Science</p> <p>Trilogy</p> <p>Higher/Foundation</p>	<p>3 Papers</p> <p>1 hour 15 minutes each</p>	<p>All Paper 2 topics</p> <p>Biology Ecology Variation Homeostasis</p> <p>Chemistry Rates of Reaction Organic Chemistry Chemistry of the Atmosphere Chemical Analysis Using Resources</p> <p>Physics Forces Magnetism Waves</p>	<p>Two Black pens Pencil Ruler Rubber Pencil Sharpener</p> <p>Scientific calculator</p>

Year 11 AP2 – 6th -17th March

PAPERS Paper **1 and** Paper **2** in Biology, Chemistry and Physics.

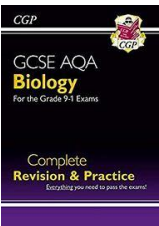
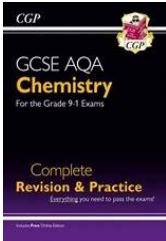
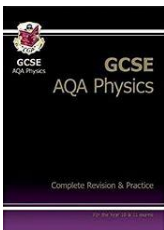
LENGTH 1 hour and 15 minutes **-Combined – Trilogy**

1 hour 45 minutes **Triple Science**

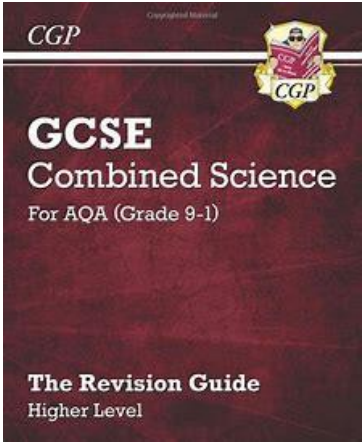
Revision guides are available from the school. Your teacher will let you know which one you need and where you can buy them from.

Paper 1 Information (Paper 2 information found above)

Triple Science

Subject	How long is the exam?	What should I revise?	What do I need to bring to the exam?
Triple Science Biology	1 Paper 1 hour 45 minutes	All Biology Paper 1 topics  Cells Organisation Infectious Disease Bioenergetics	Two Black pens Pencil Ruler Rubber Pencil Sharpener Scientific calculator
Triple Science Chemistry	1 Paper 1 hour 45 minutes	All Chemistry Paper 1 topics  Atomic Structure and the periodic table Bonding Quantitative Chemistry Chemical Changes Energy Changes	Two Black pens Pencil Ruler Rubber Pencil Sharpener Scientific calculator
Triple Science Physics	1 Paper 1 hour 45 minutes	All Physics Paper 1 topics  Energy Electricity Particle model Atomic Structure	Two Black pens Pencil Ruler Rubber Pencil Sharpener Scientific calculator

Combined Science Trilogy – Higher/Foundation

Subject	How long is the exam?	What should I revise?	What do I need to bring to the exam?
<p>Combined Science</p> <p>Trilogy</p> <p>Higher</p>	<p>3 Papers</p> <p>1 hour 15 minutes each</p>	<p>All Paper 1 topics</p>  <p>Biology</p> <ul style="list-style-type: none"> Cells Organisation Infectious Disease Bioenergetics <p>Chemistry</p> <ul style="list-style-type: none"> Atomic Structure and the periodic table Bonding Quantitative Chemistry Chemical Changes Energy Changes <p>Physics</p> <ul style="list-style-type: none"> Energy Electricity Particle Model Atomic Structure 	<p>Two Black pens</p> <p>Pencil</p> <p>Ruler</p> <p>Rubber</p> <p>Pencil Sharpener</p> <p>Scientific calculator</p>

Core Knowledge Organisers – You will receive knowledge organisers to help with your revision. These contain all the core knowledge that you must know. This will not contain all the information in, but it is a good place to start.

AQA BIOLOGY UNIT 1: CELLS

Cells

Prokaryotes

- Single cell
- Small (2-10µm)
- Simple structure
- Cell wall
- Plasma membrane
- Cell membrane
- Cell wall and plasma membrane
- Cell wall
- Plasma membrane
- Cell membrane
- Cell wall
- Plasma membrane
- Cell membrane

Eukaryotes

- Multi-cellular
- Large (10-100µm)
- Complex structure
- Cell wall
- Plasma membrane
- Cell membrane
- Cell wall and plasma membrane
- Cell wall
- Plasma membrane
- Cell membrane
- Cell wall
- Plasma membrane
- Cell membrane

Diffusion

Movement of particles from a high concentration to a low concentration (down a concentration gradient)

To increase rate of diffusion:

- Increase temperature
- Increase surface area
- Increase concentration gradient
- Reduce distance

Osmosis

Water moves from a dilute solution (high water concentration) to a more concentrated solution (low water concentration) through a partially permeable membrane.

Isotonic: means the amount of dissolved solutes is the same on the outside of the cell as the inside, so there is no difference in concentration of water.

Hypertonic: means there are more solutes inside the cell than outside, therefore inside the cell has a lower concentration of water.

Hypotonic: means there are more solutes on the outside of the cell than on the inside, so there is a lower concentration of water on the outside of the cell.

Active Transport

This is the opposite of diffusion. Substances move from an area of low concentration to high concentration, against the concentration gradient. It requires ATP (energy) - this means it needs mitochondria. The ATP is used to change the shape of protein channels in the cell membrane.

Diffusion: High Concentration to Low Concentration

Active Transport: Low Concentration to High Concentration

Root hair cells have more materials than the soil but still need them. Active transport is used for uptake of these materials. Root hair cells therefore have lots of mitochondria.

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AQA Science: Atomic structure and the Periodic table

Elements, Mixtures and Compounds

Rule 1 - If two identical elements combine then the same doesn't change

Rule 2 - When three or more elements combine and one of them is oxygen the ending is -oxide

An element is just a pure substance, for example copper (Cu).

A compound is material that is made of more than one type of atom chemically bonded together. For example Carbon Dioxide (CO₂).

A mixture contains two or more different types of compounds or elements that are not chemically bonded together.

Atomic Structure

1. In 1911 J.J. Thomson suggested the **plum pudding model** - this was an atom that had a ball of positive charge with negative electrons embedded in it.

2. In 1909 Rutherford changed the accepted model using the alpha scattering experiment. The results from the alpha scattering experiment led to the conclusion that the mass of an atom was concentrated in the centre (nucleus) and that the nucleus was positively charged. This led to the plum pudding model being replaced by the nuclear model.

3. Niels Bohr adapted the nuclear model by suggesting that electrons orbit the nucleus at specific distances. A 2D space later, Ernest Rutherford suggested that electrons do not orbit in a fixed path but exist in the probability of finding them within the nuclear model.

Distillation

Distillation can be used to separate liquids from a mixture, if they have different boiling points. Distillation is the process in which evaporation of a liquid is followed by condensation.

Relative Atomic Mass

RAM is the average mass of all the stable isotopes of that element and includes the relative abundance.

Electronic Structure

The electronic structure of an atom can be represented by numbers or by a diagram. The energy level up to eight in the second energy level up to eight in the second energy level.

For example, the electronic structure of sodium is 2,8,1.

AQA Science: Atomic structure and the Periodic table

Development of the Periodic Table

Before the discovery of protons, neutrons and electrons, scientists attempted to classify the elements by arranging them in order of their atomic weights.

The early periodic table was **periodic** in the sense that elements with similar properties were placed in the same groups.

Modern periodic table:

- Groups: vertical columns
- Periods: horizontal rows
- Metals: left side
- Non-metals: right side
- Alloys: mixtures of metals
- Compounds: mixtures of elements

Group 0

The elements in Group 0 of the periodic table are noble gases. They are unreactive and do not easily form compounds because their atoms have stable arrangements of electrons.

Group 1

The elements in Group 1 of the periodic table are alkali metals. They are highly reactive because of the single electron in their outer shell.

Group 7

The elements in Group 7 of the periodic table are halogens. They are highly reactive because they have seven electrons in their outer shell.

AQA Science: Physics Unit 1: Revision Notes - Energy

Energy: ENERGY is transfer of electrical

Energy Store

- Chemical Energy - Increased with increased mass
- Elastic Energy - Increased with increased stretch
- Gravitational Energy - Increased with increased height
- Thermal Energy - Related with temperature (often lost to surroundings)

Energy Transfers

- Electrically - when a circuit is applied
- Chemically - when an object is heated
- Electrically - when an object is powered by electricity

Specific Heat Capacity (SHC)

The amount of energy needed to heat 1 kg of material by 1°C.

$Q = mc\Delta\theta$

Heat Transfer

- Conduction - Transfer of energy through a material
- Convection - Transfer of energy through a fluid
- Radiation - Transfer of energy through electromagnetic waves

DENSITY OF MATERIALS

METHOD:

For regular-shaped objects, measure the sides to calculate their volume, using either:

Vol = width × length × height (for a cuboid) Or **Vol = π × r² × height** (for a cylinder)

For irregular shaped objects measure the volume of water they displace when lowered into a displacement can.

For a liquid, pour it into a measuring cylinder. Use top pan scales to measure the mass of the object. Calculate density using **Density = mass/volume**

BACKGROUND KNOWLEDGE:

Density tells you how much mass there is in a unit volume of material. Dense materials feel heavy for their size.

KEY WORDS: Mass, volume, density, top pan scales.

APPARATUS: Displacement can, measuring cylinder, top-pan scales, 30cm ruler, samples of materials.

DISPLACEMENT CAN HINT: Make sure the can is filled to the spout before you start, then slowly lower your irregular-shaped object into the water so that the water being displaced spills out of the spout into your measuring cylinders. The object displaces its own volume.

You will receive the physics equations you need to learn – make sure you use these to revise. Ask someone to test you on them.



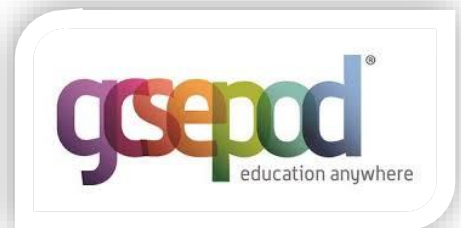
Other ways to revise

TASSOMAI CHECK IT OUT!

You must complete the **FOUR** daily goals for each subject.

These are your homework requirements.
Each subject teacher will be checking weekly!

#workhard Science
#getresults Maths
#bethebest English



**STAY POSITIVE.
WORK HARD.
MAKE IT HAPPEN.**





Suggested Science Revision Plan- 2022-23

	Week beginning	Biology Revision Topics	Chemistry Revision Topics	Physics Revision Topics	Assessments
Week 3	19 th September				
Week 4	26 th September	Ecology	Rates of Reaction		
Week 5	3 rd October			Forces	
Week 6	10 th October	Variation	Organic Chemistry		
Week 7	17 th October		Chemistry of the Atmosphere	Magnetism.	
October Half term	24 th October	Homeostasis	Chemical analysis	Waves	
Week 1	31 st October		Using Resources	Maths skills	
Week 2	7 th November	All Paper 2 Topics			
Week 3	14 th November	All Paper 2 Topics			Year 11 PPE Assessments – All Paper 2 content.
Week 4	21 st November	All Paper 2 Topics			
Week 5	28 th November		Atomic Structure	Atomic Structure (physics)	
Week 6	5 th December	Cells and Transport.			
Week 7	12 th December	Infectious Disease	Bonding		
Christmas Holidays	19 th December			Energy	
Christmas Holiday	26 th December		Chemical Changes		
Week 1	2 nd January	Organisation	Energy Changes	Particle Model	
Week 2	9 th January	Bioenergetics	Quantitative Chemistry	Electricity	
Week 3	16 th January	Ecology	Rates of Reaction	Forces	
Week 4	23 rd January	Homeostasis	Organic Chemistry	Waves	
Week 5	30 th January	Variation	Chemistry of the Atmosphere.	Magnetism.	
Week 6	6 th February	All Biology Paper 1			
Week 7	13 th February	All Chemistry Paper 1			Biology Paper 1



February Half term	20 th February	All Paper 2 Content			
Week 1	27 th February	All Paper 2 Content			Chemistry Paper 1
Week 2	6 th March	All Paper 2 Content			Year 11 PPE Assessments – All Paper 1 and 2 content.
Week 3	13 th March	All Paper 2 Content/ All Physics Paper 1			
Week 4	20 th March	All Physics Paper 1			Physics Paper 1
Week 5	27 th March		Atomic Structure	Atomic Structure	
Easter Holiday	3 rd April	Cells	Bonding	Energy	
	10 th April	Infectious Disease	Chemical Changes	Particle Model	
Week 1	17 th April	All Biology Paper 2	Energy Changes	Electricity	
Week 2	24 th April	Organisation	All Chemistry Paper 2	All Physics Paper 2	
Week 3	1 st May	Bioenergetics	Quantitative Chemistry		
Week 4	8 th May				
Week 5	15 th May	Potential start date for GCSE exams (TBC)			Biology Paper 1
Week 6	22 nd May				Chemistry Paper 1 Physics Paper 1
May Half term	29 th May				
Week 1	5 th June				Biology Paper 2
Week 2	12 th June				Chemistry Paper 2
Week 3	19 th June				Physics Paper 2
Week 4	26 th June				

This will work for trilogy and triple science; triple will just have more content to cover in each topic.

DO NOT REVISE SPACE IF YOU ARE NOT DOING TRIPLE



Revise the correct tier (higher or foundation)

GCSE dates are provisional.

**Speak to you your teacher if you are unsure about how to use this, or
have any other questions.**

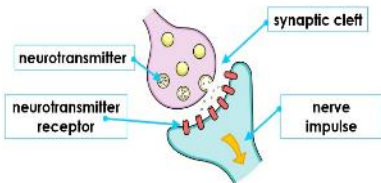
GOOD LUCK!

Reflexes - Prevent harm, avoid conscious parts of the brain (faster)

1. Stimulus e.g. stand on nail
2. Receptor pain
3. Sensory neurone electrical impulse
4. Relay neurone (CNS) CNS
5. Motor neurone electrical impulse
6. Effector muscles

Synapse - Gap between two neurones

1. Electrical impulse arrives at synapse
2. Neurotransmitter diffuses across synapse
3. Bind to receptors on 2nd neurone
4. Electrical impulse passed on



REQUIRED PRACTICAL

Independent Variable:

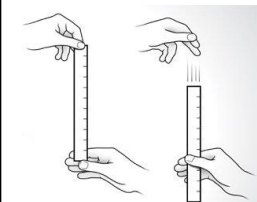
- Number of practices

Dependent Variable:

- Reaction time (distance where ruler is caught converted into a time)

Control Variables:

- Ruler dropped from same height
- Use weaker hand each time
- Same mass of ruler
- Same thickness of ruler

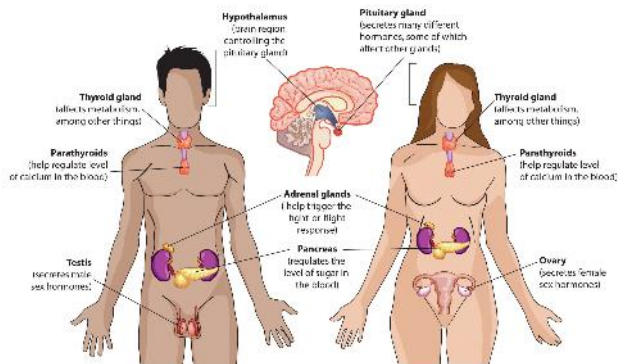


Homeostasis - the maintenance of a constant internal environment.

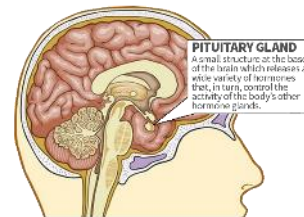
The main things we need to control in the body are:

- Temperature (thermoregulatory centre in the brain)
- Blood glucose (pancreas)
- Water (kidneys)
- Mineral ions/salts (kidneys)
- Urea (waste) (liver and kidneys)

Endocrine System - the glands of the body - secrete hormones

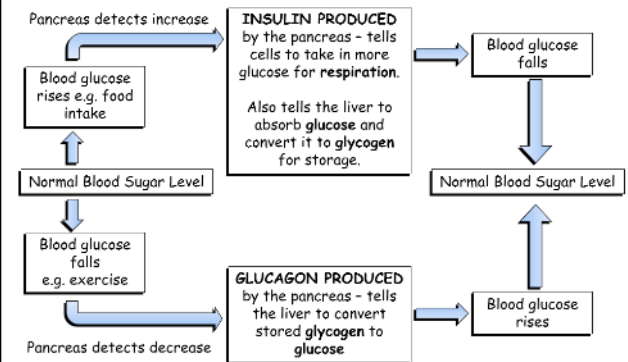


The **pituitary gland** is often referred to as the **master gland** because it stimulates other glands in the body e.g. TSH stimulates the thyroid, FSH and LH stimulate the ovaries.



	NERVOUS SYSTEM	ENDOCRINE SYSTEM
What type of message?	Electrical impulse	Chemical hormone
What do they travel through?	Along neurones	In the blood
Speed?	Faster	Slower
Local or general response?	Local i.e. affects one particular part of the body	General i.e. can affect several organs in the body
How long does the effect last?	Short lasting	Long lasting

Glucose Regulation - Prevent nerve and brain damage



Problem	Hormone	Effect
Too much glucose	insulin	Stores glucose as glycogen and tells cells to increase respiration
Too little glucose	glucagon	Converts glycogen to glucose

Type 1 Diabetes

- Born with it
- Don't make insulin

Treatment

- Insulin injected daily
- Pancreas transplant

Type 2 Diabetes

- Brought on by bad diet/obesity
- Body desensitized to insulin

Treatment

- Careful diet
- Exercise

Menstrual Cycle - 28 days (ovulation day 14)

FSH	<ul style="list-style-type: none"> • From pituitary gland • Egg matures in ovary
Oestrogen	<ul style="list-style-type: none"> • From ovaries • Stops FSH • Thickens uterus lining • Stimulates LH
LH	<ul style="list-style-type: none"> • From pituitary gland • Egg released (ovulation day 14)
Progesterone	<ul style="list-style-type: none"> • Maintains thick uterus lining

Contraception

- Hormonal methods (pill, patch, implant, injection) contain oestrogen and/or progesterone to prevent FSH release so no egg matures.
- Barrier methods (condoms, diaphragm, cap) can also help prevent spread of STDs.
- Intrauterine devices (coils) prevent implantation of embryo.

IVF (HT ONLY)

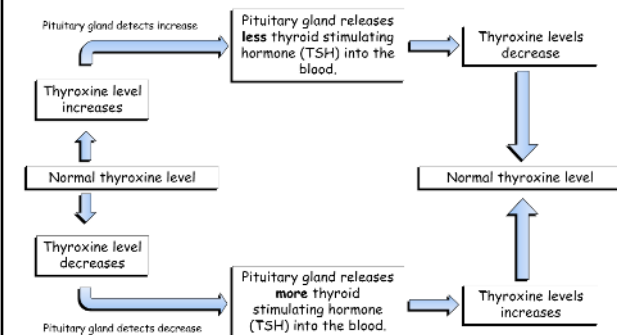
1. Give fertility drugs (FSH and LH)
2. Remove mature eggs from ovaries
3. Mix with sperm in petri dish
4. Incubate until it is an embryo
5. Insert into woman's uterus

IVF Downsides

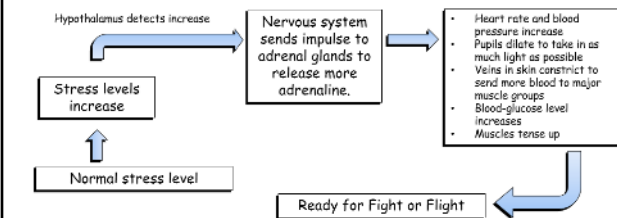
- Expensive, poor success rate, multiple pregnancies (low birth-weight babies)

Negative Feedback (HT) - Prevent nerve and brain damage

Thyroxine - Metabolism, growth, brain development in children



Adrenaline - This is positive feedback.



Brain

Hypothalamus
Controls temperature and water balance.

Medulla
Controls breathing, heart rate, digestion.

Pituitary Gland
Master gland, controls menstrual cycle, thyroid.

Cerebral Cortex
Consciousness, intelligence, memory and language.

Cerebellum
Coordinates muscles, eye balance.

How can we find out how the brain works?

- Study people with brain damage
- Electrically stimulate different parts of the brain
- MRI scans
- Problems with the brain

Eyes

Ciliary Muscle, **Sclera**, **Retina**, **Iris**, **Pupil**, **Cornea**, **Lens**, **Suspensory Ligament**, **Blind Spot**, **Optic Nerve**

The cornea refracts the light but it is the lens that must change shape in order to see the image in focus. The changing of the lens is called **accommodation**.

Distant:

- Ciliary muscles relax
- Suspensory ligaments are pulled tight
- Lens pulled thin
- Less refraction

Close up:

- Ciliary muscles contract
- Suspensory ligaments loosen
- Lens gets short and fat
- More refraction

Myopia - you can see close objects clearly but distant objects look blurred.

- short-sighted.
- The light is focussed in front of the retina - lens is too curved or the eyeball is too long.
- Treatment - concave lens in front of the eye to diverge the light rays before they hit the cornea.

Hyperopia - people can see distant objects but close up objects appear blurry.

- Long sighted.
- The lens is too flat and thin or because the eyeball is too short - light rays are not refracted enough so they focus beyond the retina.
- Treatment - convex lens is used to diverge the light rays before they hit the cornea.

Kidneys

Glucose, mineral ions, urea and water move out of the blood along a concentration gradient. The larger cells and proteins are too big to fit through the cell membranes. All the glucose is reabsorbed but mineral ions and water are **selectively reabsorbed** depending on the needs of the body.

Water balance is controlled by a negative feedback system monitored closely by the **pituitary gland** in the brain

Pituitary gland detects change → **Less ADH released - this prevents the kidneys from reabsorbing water** → **Urine is more dilute** → **Solute concentration decreases / water level increases** → **Pituitary gland detects change**

Pituitary gland detects change → **More ADH released - this makes the kidneys reabsorb more water and put it back into the blood** → **Urine is more concentrated** → **Solute concentration increases / water level decreases** → **Pituitary gland detects change**

Kidney Failure

Infections, accidents or inheritance can lead to kidney failure. Toxins would build up, pH levels would change, cells would be damaged, enzymes would denature.

Treatment:

- Transplant - Tissue match to ensure antigens are similar
- Immunosuppressant drugs are given for the rest of your life to decrease the activity of the immune system.
- Transplanted organs need replacing on average every 9 years.
- Dialysis

1 Arterial blood from the patient enters the dialyzer.

2 The dialyzer removes waste products from blood by filtration.

3 Purified blood is returned to a vein in the patient.

The fluid in the dialysis machine on the other side of the partially permeable membrane has **no urea**, a **normal glucose** concentration and a **normal ion** concentration.

Downsides: 8hrs a few times per week, controlled diet, tired, unwell, expensive, can cause fistulas.

Thermoregulation

receptors in thermoregulatory centre in the hypothalamus along with temperature receptors in the skin detect small changes in body temperature.

Thermoregulatory centre detects increase → **Body temperature increases** → **Body temperature decreases**

- **Sweating** - water evaporates from skin using heat energy.
- **Vasodilation** - blood vessels dilate to allow more blood flow at the surface of the skin.
- **Hairs** lay flat to prevent insulation

Thermoregulatory centre detects decrease → **Body temperature decreases** → **Body temperature increases**

- **Shivering** - Rapid muscle contraction requires energy from respiration which releases heat energy.
- **Vasoconstriction** - blood vessels narrow to allow less blood flow at the surface of the skin.
- **Hairs** stand erect to trap a layer of air insulation.

Waste Products

- Carbon Dioxide - produced during respiration, removed along concentration gradient by lungs (causes uncontrollable release of water when we breathe out)
- Urea - deamination in liver

Excess Amino Acids → **Ammonia** → **Urea**

Plant Hormones

Auxin - builds up to cause growth in shoots (opposite effect in roots)

Phototropism - growth to light (shoots)

Geotropism / Geotropism - growth to gravity (roots)

Auxin released on dark side of shoot

Area of cell elongation

Shoot grows towards sunlight

Plant Shoot, **Normal size cells**

Why do plant shoots grow towards the Sun?

1. Auxin builds up on shaded side.
2. Shaded side grows faster
3. Plant grows in direction of sunlight

Auxin is used as a rooting powder when taking **cuttings** of plants. Also given to **weeds** to disrupt their growth.

Other plant hormones include:

Gibberellins

- Brewing industry to speed up seed germination
- Promote all year round flowering
- Increase fruit size

Ethene

Control fruit ripening for easier transport and longer lasting fruit.

Variation

- Genetic** - inherited e.g. eye colour, hair colour
- Environmental** - scars, tattoos, piercings
- Both** - skin colour (tan), hair style (naturally curly but straightened)

Chromosome - long strands of DNA (23 pairs in normal cells, 23 in sex cells (gametes))
DNA - double helix, all info to make an organism

Sexual Reproduction

- Fertilisation
- Gametes
- Genetic variation in offspring

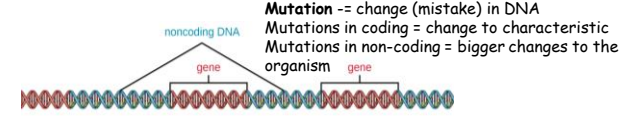
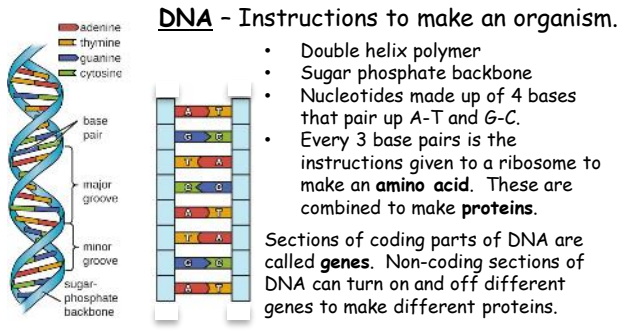
Asexual Reproduction

- No fertilisation
- No gametes
- Identical clones are made
- E.g. runners in plants

Gender Determination

XX = female
 XY = male
 During meiosis, 1 sex chromosome goes into one gamete, and the other goes into a second gamete.
 The punnet square shows there is a 50% chance of having a boy or a girl every time.

	X	Y
X	XX	XY
X	XX	XY



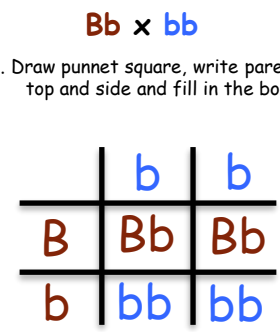
Genome- All genes of an organism
 Human Genome Project - map out all 21000 genes

Advantages of HGP	Issues and Concerns with HGP
<ul style="list-style-type: none"> Cancer diagnosis Forensics Evidence for evolution 	<ul style="list-style-type: none"> Genetic discrimination Re-engineer human species Very expensive

Genetic Crosses

e.g. A heterozygous brown eyed dog mates with a homozygous blue eyed dog. Brown eyes is dominant.

- Write genotype of parents
- Draw punnet square, write parents on top and side and fill in the boxes



- Write out the possible phenotypes of the offspring

50% chance heterozygous brown eyed
50% chance homozygous blue eyed
 or a 1:1 chance of brown : blue

Gene - a section of DNA that codes for 1 characteristic

Allele - different forms of a gene

Genotype - Symbols used to show genes for 1 characteristic e.g. Bb

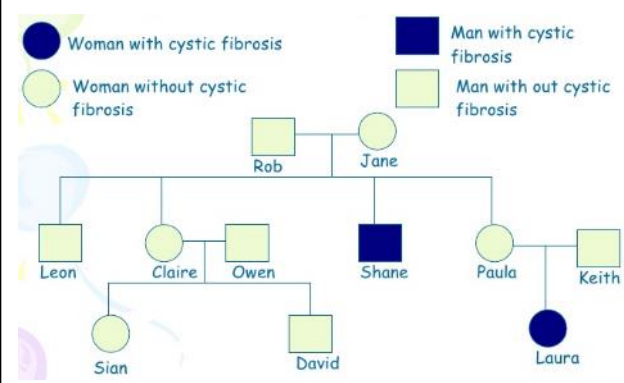
Phenotype - Description of genes e.g. Brown eyes

Homozygous - Both genes are the same i.e. BB or bb

Heterozygous - Both genes are different i.e. Bb

Genetic Diseases

- Polydactyly - **dominant** allele - extra finger or toe
- Cystic Fibrosis - **recessive** allele - excess mucus



Rob and Jane must be Ff (where f means has CF)

Ff x Ff

	F	f
F	FF	Ff
f	Ff	ff

25% chance of CF

Genetic Engineering - adding wanted characteristics to organisms.

e.g. **Making Insulin**

- Remove wanted insulin gene using enzymes
- Take a plasmid from a bacteria (vector)
- Open plasmid and insert insulin gene with DNA ligase
- Put plasmid back in bacteria
- Incubate to allow bacteria to grow and make insulin.

GM Crops

- + Resistant to insects, viruses, fungi
 - + Grow bigger, taste better, more nutritious
 - + Crops can be grown all over the World
 - + Increased crop yield
- Worries over long term effects
 - Reduced biodiversity
 - Could develop allergies to the food
 - Herbicide resistant gene could spread to weeds making superweeds!

Natural Selection

- Variation occurs naturally within a species due to mutations
- Some organisms have adaptations increasing their chances of survival
- These organisms are more likely to reproduce
- The genes responsible for the adaptation are passed on to their offspring.

Reasons why people didn't believe Darwin at first:

- Against religious beliefs
- They didn't know about genes or mutations at the time so Darwin couldn't explain why some organisms had more useful characteristics
- Not enough evidence

Selective Breeding

Humans breed animals/plants to gain desirable characteristics in offspring (takes many generations).
 e.g. disease resistance, increased milk production, behaviour, scented flowers etc.

Downsides - Reduces variation limiting success of survival if conditions change, new diseases might wipe out every member of the same species, inbreeding in animals leads to defects.

Fossils

These can be made from:

- Bones and teeth
- Minerals that have replaced bone and tissue
- Organisms trapped in amber or ice
- Burrows, tracks, where organisms have laid

Softer body parts such as tissue, muscle etc. **decay** if conditions are suitable.

Fossil record - collection of fossils that show evolution of an organism over many years.

- Usually incomplete as most organisms don't become fossils, softer bodies decay, fossils melt underground due to Earth movement, not been found yet,

- Usually need to comment on changes over time e.g. shape, length or number of bones.

Extinction - Living things become extinct because:

- Habitat changes - not adapted to survive
- New predator - not adapted to get away or hide
- Disease - lack of immunity
- New, more successful competitor - better adapted species will get food, space, water etc.

Classification

Carl Linnaeus	Carl Woese
<ul style="list-style-type: none"> Grouped according to characteristics and structures that make up organisms. Kingdom, Phylum, Class, Order, Family, Genus, Species 	<ul style="list-style-type: none"> Three-domain system Based on new chemical analysis techniques that prove some species aren't as closely related as once thought. <ul style="list-style-type: none"> Archaea - primitive bacteria Bacteria - true bacteria Eukaryota - fungi, animals, plants, protists These are sub-divided into K,P,C,O,F,G and S.

Organisms are named using **binomial system** (genus and species in latin) . It is used worldwide regardless of language.

Evolutionary trees show common ancestors . The more recent the common ancestor, the more closely related they are.

History of Genetics

TRIPLE ONLY

- Mendel** studied pea plants and discovered that characteristics are controlled by 2 'units' that can be dominant or recessive.
- In the late 19th century behaviour of chromosomes during cell division was observed.
- In the early 20th century it was observed that chromosomes and Mendel's factors behaved in similar ways, leading to the idea that the factors (genes) were located on chromosomes.
- In the mid-20th century the structure of DNA was determined and the mechanism of gene function worked out.

Protein Synthesis

- DNA strands unwind.
- A corresponding template of ATGC is made called mRNA.
- This leaves the nucleus and binds to a ribosome.
- With the help of tRNA, amino acids are made.
- The protein is then released from the ribosome.

Animal Cloning

TRIPLE ONLY

Adult Cell Cloning - makes copy of adult

- Take nucleus from an adult cell
- Take nucleus out of an egg cell
- Put adult nucleus into empty egg cell
- Electric shock
- When it becomes an embryo, insert into uterus

Embryo Transplant - makes cloned offspring

- Sperm and egg mixed in petri dish
- Grow into an embryo
- Split the embryo into cells
- Each cell develops into an identical embryo
- Insert into host uteruses

Plant Cloning

Cuttings - Cut a bit off and plant it.
- Cheap and quick

Tissue Culture - Cells put in growth medium with hormones. Grown all year, can make lots, more expensive.

Evolution Theories

TRIPLE ONLY

Lamarck - the more a characteristic is used the more developed it becomes and is then passed on to offspring. *(which is nonsense!)*

E.g. Giraffes stretched their necks to reach higher food and passed on the characteristic to their offspring.

Darwin proposed that a mutation made some giraffes have longer necks so they would be more likely to eat, survive and reproduce.

Speciation - making a new species

TRIPLE ONLY

A new species is made by:

Alfred Wallace wanted to publish his findings on natural selection before Darwin which prompted the Origin of the Species.

- Geographical **isolation** (species split by water or mountains)
- Genetic variation in both groups means some are more adapted to survive in their own conditions
- Natural selection - best breed and pass on desirable genes
- Speciation - new species can't interbreed with the other species

Biotic and Abiotic Factors

Abiotic Factors
These are **non-living** factors that can affect an ecosystem.

- Light intensity
- Temperature
- Moisture
- Wind intensity/direction
- CO₂ level
- Oxygen level
- Soil pH

Biotic Factors
These are **living** factors that can affect an ecosystem.

- Competition with other species
- Food availability
- New predators
- New diseases

Key Terms

Habitat - where an organism lives
Population - all organisms of a species in a habitat
Community - populations of different species in a habitat
Ecosystem - the interaction of biotic and abiotic factors

The animals and plants are usually **interdependent**:

- Animals eat plants
- Animals pollinate plants
- Animals eat animals
- Animals use plants to build shelters
- Plants use nutrients from animal droppings

A **stable community** is one where all the species and environmental factors are in balance, so population sizes remain fairly constant e.g. tropical rainforests.

Decay

- Detritus feeders = worms, beetles, maggots
- Decomposers = bacteria, fungi
- They respire using waste, dead organisms etc.

Conditions needed = **WARM, MOIST** and **OXYGEN**

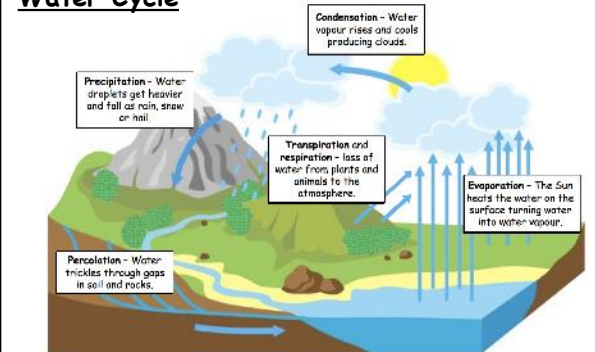
Decay puts nitrates back into the soil and carbon dioxide back into the atmosphere.

Compost Heaps - Decay releases nutrients from dead plants and animals to make fertile soil.

- **Air holes** - let oxygen in, regulate temperature.
- **Warmth** generated by respiring microorganisms.
- Finely shredded waste increases surface area.



Water Cycle



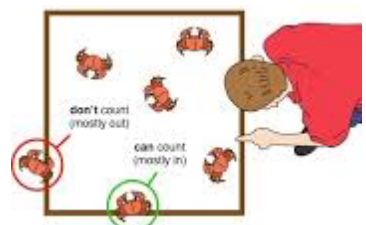
Distribution of Organisms

Where organisms live depends on:

- **Temperature**
- **Amount of light**
- **Availability of water**
- **Availability of nutrients**
- **Availability of oxygen and carbon dioxide**

Quadrats - To estimate a population

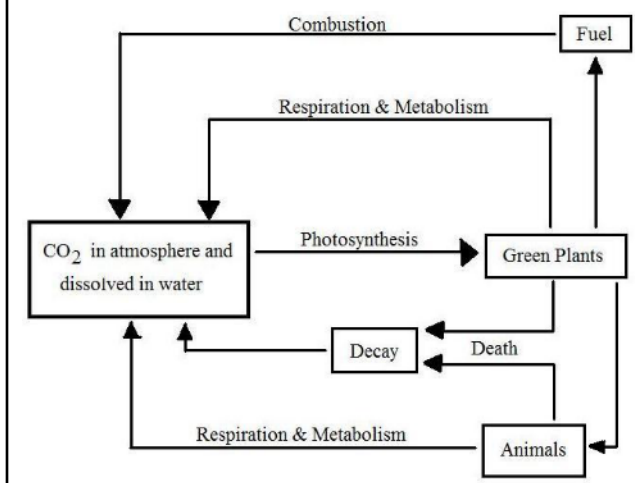
1. Throw randomly (prevent bias) many times
2. Count number of organisms / % coverage
3. Calculate the mean
4. See how many quadrats fit in whole area
5. Multiply number of quadrats by the mean



Line/Belt Transects - To show distribution

1. Lay tape along the area
2. Place quadrat at regular intervals
3. Count number of organisms / % coverage

Carbon Cycle



Remember to follow the path of carbon e.g. CO₂ in air taken in by plants (photosynthesis), plants eaten by animals, animals die (decay), microorganisms respire, CO₂ back in the air.

Adaptations

Structural: the features of an organism's body structure, e.g. shape, size or colour.

Behavioural: how an organism behaves e.g. some species **migrate** to warmer climates during winter months.

Functional: internal processes of an organism e.g. desert animals produce **little sweat** and small amounts of urine to conserve water.

Arctic

- prevent heat loss
- small SA:Vol = lose less heat
- camouflage from prey

Desert

- large SA:Vol = easily lose and gain heat
- camouflage from prey
- no leaves
- water storage
- deep roots

Predators

- Camouflage
- Mimicry
- Poisons and spikes
- Warning colours

Extremophile - organisms with adaptations to live in harsh habitats to reduce competition.

Competition

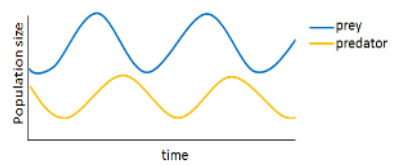
Plants - light, space, water, minerals
 Animals - space, food, water, mates

Food Chains

Grass → Rabbit → Fox
 (producer → primary consumer → secondary consumer)

Always start with a producer (plant) as they produce their own food - they **photosynthesise** using the Sun's energy to produce **glucose**. Some of this glucose is used to produce new biological molecules in the plant, increasing its **biomass** (an energy store). Some of this biomass is passed on to the animal that eats the plant (secondary consumer). Therefore energy is transferred through organisms in a food chain.

Predator-Prey Relationships



The amount of food limits the population of a species. If the population of prey increases then so will the population of predators. But, as the number of predators increase, the number of prey decrease.

The predator-prey cycles are slightly **out of phase** with each other because it takes a short while for a population to **respond** to changes in the other.

If the number of rabbits increase it will take a while for the foxes to reproduce.

Biodiversity a measure of the variety of all the different species of organisms on Earth, or within a particular ecosystem. A high diversity ensures the stability of an ecosystem.

A high biodiversity reduces the dependence of one species on another for:

- Food
- Shelter
- Maintenance of the physical environment

Human population has grown due to:

- Growing more food
- Treatment of diseases
- No natural predators

As human population **increases**, biodiversity **decreases** because:

- Land is used for building houses, shops, industry, roads. This destroys habitats.
- Huge areas of land is used for farming so natural animal and plant populations cannot survive.
- Quarrying for metal ores and rocks destroys habitats.
- Waste pollutes the environment and processing it takes up more land.

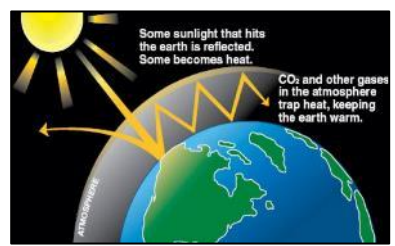
Restoring biodiversity

- Breeding programmes for endangered species
- Protection and regeneration of habitats
- Reintroduction of hedgerows and field margins
- Reduce deforestation and carbon dioxide emissions
- Recycling resources - reduces landfill

Global Warming
More CO₂ being released than taken in e.g. deforestation for rice fields or cattle that both release methane (CH₄)

Greenhouse Effect

1. Sun's energy warms up the surface of the Earth.
2. Most of this energy is radiated back.
3. Layers of CO₂ and CH₄ absorb some of the energy.
4. This warms up the atmosphere and the surface of the Earth.



The greenhouse effect is needed to maintain life but excess gases are causing an increase in temperature.

Global warming could cause:

- **Climate change** - increase severe unpredictable weather, higher temperature sea absorbs less CO₂.
- **Rising sea levels** - ice caps, glaciers
- **Reduced biodiversity** - organisms can't survive as habitats change
- **Changes to migration**
- **Changes to distribution** - some organisms may be able to survive in more places and vice versa.

Pollution

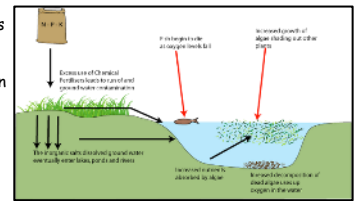
Land

- More people = more sewage which if untreated pollutes soil
- Household waste goes to landfill - toxic chemicals spread into the soil
- Radiation e.g. at Chernobyl
- Herbicides and pesticides can be washed into rivers and streams - become part of food chain (**bioaccumulation**)

Water

- Eutrophication

Fertilisers washed into rivers causes increase in algae and plants. These compete for light so die. Decomposers use up all the oxygen in the water when respiring lowering biodiversity.



Bioindicators can be used to identify low oxygen levels e.g. salmon, bloodworms.

Air

- Global dimming - smog and smoke particulates in the air reflect sunlight reducing the amount reaching us lowering ground temperature.
- Acid rain - Fossil fuels contain sulphur and nitrogen. Combustion results in sulphur dioxide and nitrogen dioxide released. These dissolve in rainwater and form sulphuric and nitric acids lowering rain pH.

Effects of Acid Rain

- Kills leaves, flowers etc and destroys roots
- Lowers pH in lakes, rivers etc until they cannot support life
- Acid snow - when it melts it causes major damage as an 'acid flush'
- Other countries are affected due to winds

What is being done about it?!

- Low sulphur petrol
- Clean chimney fumes from power stations
- Catalytic converters on cars
- Rely more on renewable energy sources.

Decomposition

TRIPLE ONLY

Temperature: Decay is controlled by enzymes so too cold = too slow, too hot = denatured.

Moisture: Makes it easier for microorganisms to digest food and prevents drying out.

Oxygen: For aerobic respiration - grow, reproduce etc. Aerobic respiration results in an increase in temperature in a compost heap.

Anaerobic respiration in bacteria can produce methane - flammable gas (fuel)

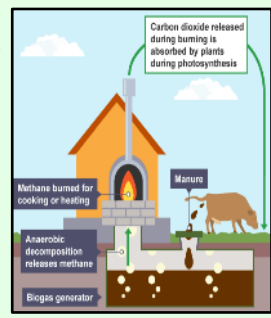
Biogas can be produced on a small scale in a **biogas generator**.

The carbohydrate-containing materials are fed in, and a range of bacteria anaerobically ferment the carbohydrate into biogas.

The remaining solids settle to the base of the digester and can be run off to be used as **fertiliser** for the land.

The **optimum** temperature for biogas production is between 32°C and 35°C.

Cooler Countries - Slow respiration rate - bury generator with thick walls.
Warmer Countries - Denatures enzymes - bury generator so ground keeps it cool during the day.



Deforestation & Peat Bogs

Slash and burn
Land cleared for farming, trees burnt releasing CO₂.

There are 3 main reasons for deforestation:

- Grow staple foods e.g. rice
- To rear more cattle
- To grow crops for biofuel

Deforestation increases atmospheric carbon dioxide levels:

- Less trees therefore less photosynthesis removing CO₂ from the air.
- Burning trees releases CO₂.
- Decay of dead plants by microorganisms respiring releases more CO₂.
- Trees take in lots of CO₂ which is then converted into plant tissue. Removal of trees removes CO₂ sinks.

Often large areas are replaced by one single species. This is called a **monoculture**.

Peat bogs - Carbon store formed very slowly. Plant material that hasn't decayed fully due to acidic conditions and a lack of oxygen.

- **Burning** the peat releases its stored carbon back into the atmosphere as carbon dioxide.
- As peat is mixed in with soil it is exposed to **aerobic** conditions and begins to decompose - which releases carbon as carbon dioxide.

Environmental Change

TRIPLE ONLY

Distribution of organisms is caused by:

- Availability of water
- Temperature
- Concentration of dissolved atmospheric gases in water.

Seasonal Changes	Daylight, amount of rainfall, temperature all change with the seasons. Animals migrate.
Geographical Changes	Changes to soil (structure and pH), altitude, saltiness of water. Organisms have adaptations to survive.
Human Interaction	Negative: Global warming, acid rain, pollution Positive: Maintaining rain forests, reducing pollution, conservation of hedgerows and woodlands
Living Factors	New predator, diseases, new competitors

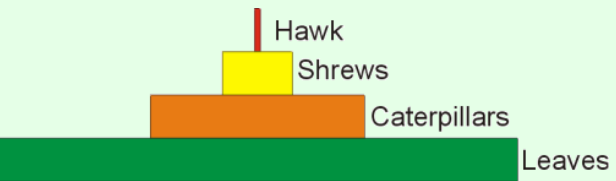
Biomass - mass of organism (no water)

Stages in a food chain are called **Trophic Levels**.

Issues with measuring biomass:

- Kill the organism and dry it out.
- Wet biomass is different depending on conditions, time of day etc.

Pyramid of biomass:



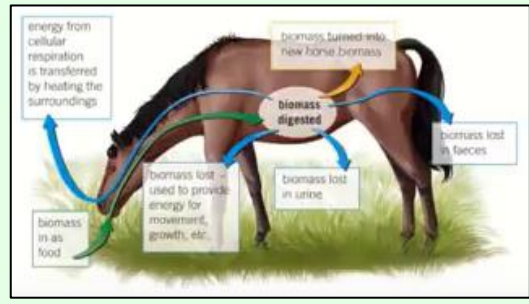
General Biomass Pyramid Rules

- Producer always at the bottom.
- They always look like normal pyramids
- Not all organisms or parts are eaten by the stage above e.g. roots, bones.
- Most biomass taken in is usually used for respiration.
- Food chains are short as so much biomass is lost at each trophic level.

Biomass Transfers

Biomass is lost by organisms because:

- **Faeces** - Herbivores can't digest all the plant material e.g. cellulose, carnivores can't digest bones, hooves, claws. Faeces are broken down by decomposers.
- **Waste** - Excess protein - deamination (urea production) - Respiration - glucose used by plants and animals transfers energy to the surroundings e.g. movement.
- **Temperature** - Mammals and birds use respiration for body heat



Food Security & Efficiency

Food Security = Having enough food for the population

Factors threatening food security:

- **Increasing birth rate** - children to work land, large families in some cultures, some religions don't use contraception.
- **Changing Diets** - People look for new interesting food, deprives local people of traditional food, less nutritional foods take less time to cook.
- **New pests and pathogens** - Global travel, animal and plant movement, climate change = wider spread of pathogens which affects farm animals and crops.
- **Environmental Changes** - Global warming = droughts and flooding of farm land.
- **Cost** - Genetic engineered crops cost more money as do irrigation systems, fertilisers and pesticides.
- **Conflicts** - infrastructure damaged, people fear they can't feed their families.

To make food production efficient:

- Shorter food chains so less biomass lost
- Limit movement of farm animals - less respiration more biomass (disease spreads in intensive farms)
- Warmer temperature - less respiration more biomass
- Fish bred in cages on high protein diets

Downsides: Ethical concerns over animal cruelty and welfare
Cost for lighting and heating

Sustainable Food Production

Sustainable = producing foods in ways that supply the whole human population and can continue for years.

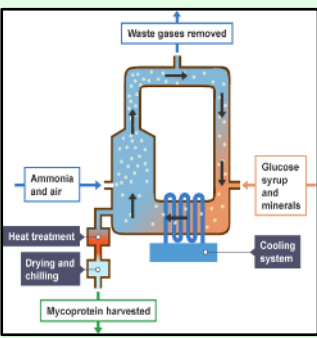
Fishing - To prevent overfishing:

- Larger-holed nets to only catch the bigger, older fish
- Ban fishing during breeding season
- Strict fishing quotas to make sure some fishermen only bring in a limited number of specific types of fish.

Mycoprotein (Quorn)

Produced by fungus called *fusarium* (grows fast on **glucose** syrup) in a fermenter under **aerobic** conditions.

Fungal biomass is harvested and purified and then dried and processed to make mycoprotein. It can be **shaped** and **flavoured**.



Graphs

Motion	Distance-Time	Speed-Time
Stationary		
Constant Speed		
Accelerating		
Decelerating		

Velocity, Acceleration & Weight

Velocity means speed with a direction.
Units: m/s

Acceleration means the rate of change of velocity. Units: m/s²

Weight = Mass x Gravity (gravity = 10)
(N)

Forces
Every force has a reaction force which is equal in size, opposite in direction and acts on a different object

Movement
Objects move by applying a force in one direction, the reaction pushes them in the opposite

Springs (Hooke's Law)

When you add a force (weight) to a spring it extends.

Extension = Stretched length - original length

Force = Constant x Extension
(N) (N/m) (m)

Elastic limit/limit of proportionality. After this point it is permanently deformed

Falling Objects

- When an object is dropped it accelerates as the force of gravity is larger than the force due to air resistance.
- As it gets faster the air resistance increases.
- Eventually the force due to air resistance is equal to the force due to gravity. This is known as terminal velocity.
- At terminal velocity the resultant force is zero.
- The object remains at a constant speed.

Car Safety

Stopping Distance = Thinking Distance + Braking Distance

Thinking Distance is the distance travelled before the driver has reacted.
Affected by: Alcohol, drugs, tiredness, age.

Braking Distance is the distance travelled whilst the brakes have been applied.
Affected by: Weather conditions (Ice/Snow), condition of the tyres/brakes, road surface.

Safety Devices - Seat belts, airbags, crumple zones

These devices make the time taken to slow down in the event of a crash longer, which makes the force felt by the driver smaller.

Moments & Levers (Triple Only)

Moment = Force x perpendicular distance

If an object is balanced then the clockwise moment is equal to the anti-clockwise moment.

Levers and gears are used to transmit and magnify the force applied.

Momentum

$P = m \times v$

The Law of Conservation of Momentum states that the momentum before an event is equal to the momentum afterwards.

$P = 0\text{kgm/s}$ $P = (-20 \times 1) + (10 \times 2) = 0\text{kgm/s}$

Pressure in a fluid (Triple Only)

A fluid (liquid or gas) causes a force at right angles to any surface that touches it.

The deeper an object is in a fluid the greater the pressure, this is because there are more particles above it pressing down on it.

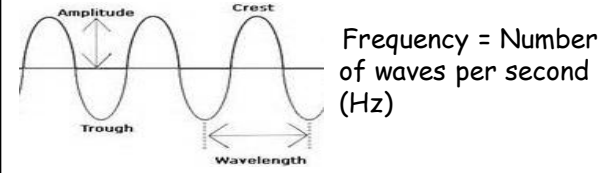
The pressure on the underside of a submerged object is greater than the pressure on top, this causes a resultant force = upthrust

Wave types

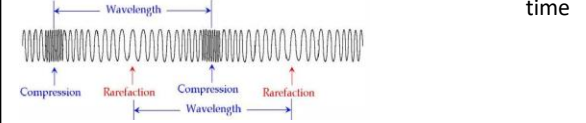
Transverse: The particles move perpendicular to the direction of travel of the wave.
Examples: All EM spectrum eg radio, UV, S-wave

Longitudinal: The particles move parallel to the direction of travel of the wave.
Examples: Sound, P-waves

Labelling a transverse wave



Labelling a longitudinal wave

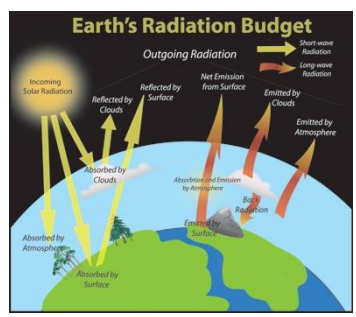


Black body radiation (Triple Only)

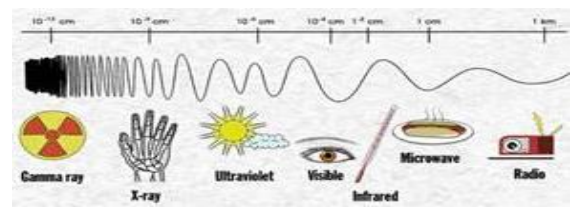
All objects emit and absorb infrared radiation. If it absorbs more than it emits the object's temperature will increase. A perfect black body will emit and absorb all wavelengths of radiation. The hotter a body the higher frequency of radiation it will emit - hotter object appear white/blue cooler ones red.

The Earth

If the radiation absorbed by the Earth is greater than the radiation emitted, the Earth's temperature will increase, this is global warming.



Electromagnetic Spectrum



- * They travel at the speed of light (3×10^8 m/s)
- * They are all transverse waves
- * They can all be reflected
- * They can all be refracted

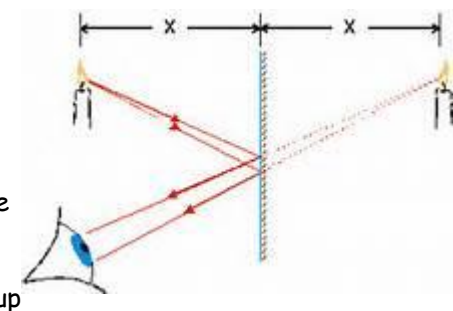
Gamma rays have the most energy and highest frequency, radio the lowest. Radio has the longest wavelength.

Uses

- Radio - TV and Radio
- Microwaves - Satellite communication
- Infrared - Cooking food, remote controls
- Visible - To see, fibre optics
- x-rays and gamma - Medical imaging and treatments

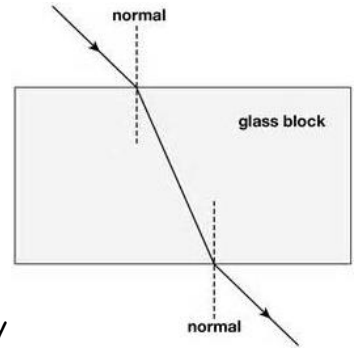
Reflection

The image created by a mirror is:
* Virtual
* Equal in size
* Equal in distance
* Right way up



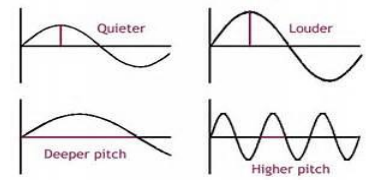
Refraction

* Light slows as it enters a denser medium (glass).
* It bends towards the normal
* Light speeds back up as it leaves the glass and bends away



Sound (Triple Only)

- * Sound is a longitudinal wave.
- * It travels MUCH slower than light
- * Sound travels faster in solids, slowest in gases.
- * It needs a medium (particles) to travel through, it will not pass through a vacuum.
- * Reflected sound is called an echo.
- * The range of human hearing is 20-20000Hz



- * Large amplitude = Loud
- * High frequency = High pitched

Uses of sound

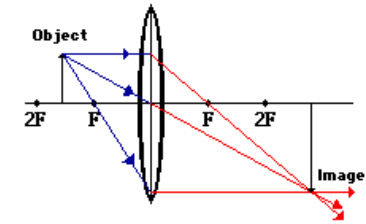
Ultra sound (sound above the range of human hearing) can be used to produce images of the body.

Seismic Waves (Triple Only)

P-waves pass through solids and liquids, S-waves only pass through solids. This allows us to build up a picture of the Earth's inner structure

Lenses (Triple Only)

Convex lenses bring parallel rays of light to a focus. The image produced can be real or virtual. Concave lenses always produce a virtual image.



The image produced is real (the rays meet), upside down and magnified (The image arrow is bigger than the object)

Visible Light (Triple Only)

A red object absorbs all wavelengths of light except red which is reflected. If all wavelengths are reflected the object will appear white, if all wavelengths are absorbed the object will appear black.

A red filter will absorb all wavelengths of light except red which is transmitted. If a red filter is placed next to a green one no light will pass through, it will look black.

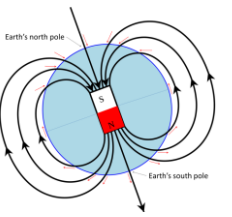
Permanent and Induced Magnets

Permanent magnets always have a magnetic field around them.
 North pole and north pole - repel
 South pole and south pole - repel
 North pole and south pole - attract

Induced magnets are materials (**iron, steel, nickel and cobalt**) which become magnetic when they are placed in a magnetic field. They lose their magnetism when they are removed from the field.

Induced magnets always attract!

The Earth's liquid iron core produces a magnetic field. It's south magnetic pole is actually at the Earth's geographical North pole. So the north pole of a compass points north

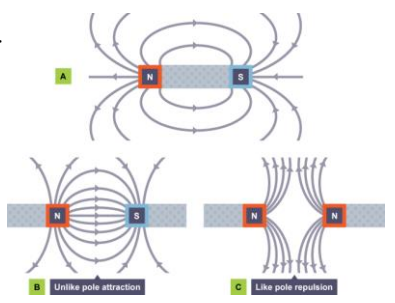


Magnetic Fields

Magnetic field lines always point north to south.

We can plot the field lines by using:

- a) iron filings
- b) Plotting compasses.

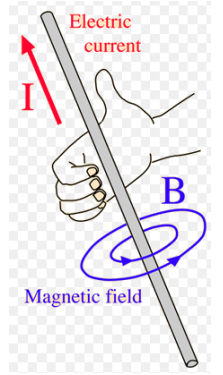


The strongest part of a magnetic field is at the poles, you can see this as the field lines are closest together.

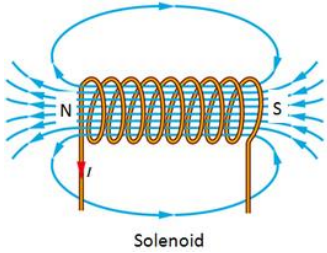
The further away you move from the pole the weaker the magnetic field becomes.

The Motor Effect

When an electrical current passes through a wire it produces a magnetic field in the direction shown in the diagram.



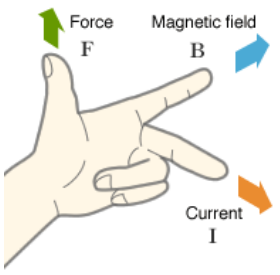
The larger the electrical current the stronger the magnetic field produced.



Solenoid
 Coiling the wire to form a solenoid produces a magnetic field similar to a bar magnet. The strength of the magnetic field can be increased by increasing the current or adding an iron core

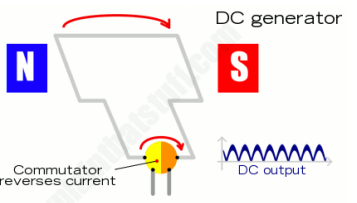
Fleming's Left Hand Rule

If a wire carrying a current is placed in a magnetic field they both exert a force on each other. The force on the wire is shown using Fleming's Left Hand rule.



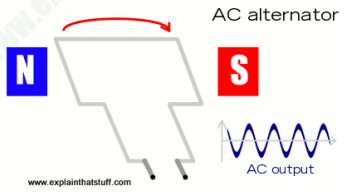
The Generator Effect (Triple Only)

As a coil of wire spins in a magnetic field an electrical current is produced



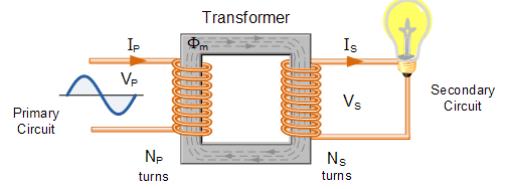
An alternating current (AC) is produced, unless a commutator is used which only allows the current to travel in one direction. This is a direct current (DC). The current produced can be increased by:

- * Spinning the coil faster
- * Having more coils
- * Stronger magnetic field.



Transformers (Triple Only)

Transformers increase (step-up) or decrease (step-down) the voltage. If there are more coils in the secondary side the voltage will be stepped up.



Transformers are used to step-up the voltage, which reduces the current, this makes it more efficient as less energy is wasted as heat. Step-down transformers are then used to make the voltage safe for public use.

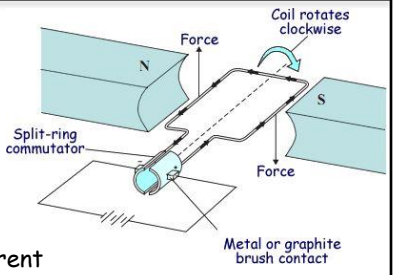
If we assume that the transformer is 100% efficient then;

$$\text{Power}_p = \text{Power}_s$$

$$\text{So: } I_p \times V_p = I_s \times V_s$$

Electric Motor

If a loop of wire is placed within a magnetic field it will rotate. The commutator changes the direction of the current around the loop every half turn, this ensures that it will continue to rotate. The current must be DC!!

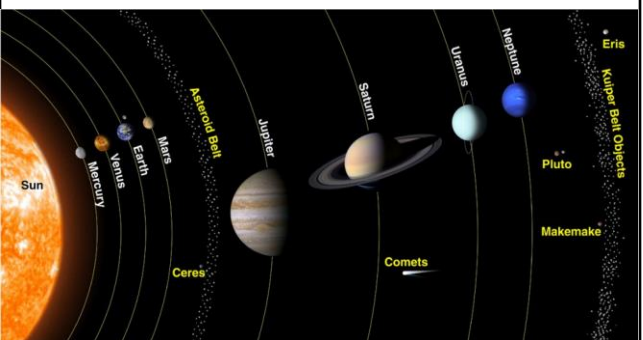


The current produces a magnetic field which opposes the original change in direction.

The Solar System

Our star the sun is orbited by planets, dwarf planets, asteroids and comets. Moons orbit the planets. These are all natural satellites.

The sun was formed from a nebula pulled together by gravity 5 billion years ago.



Life-cycle of a star

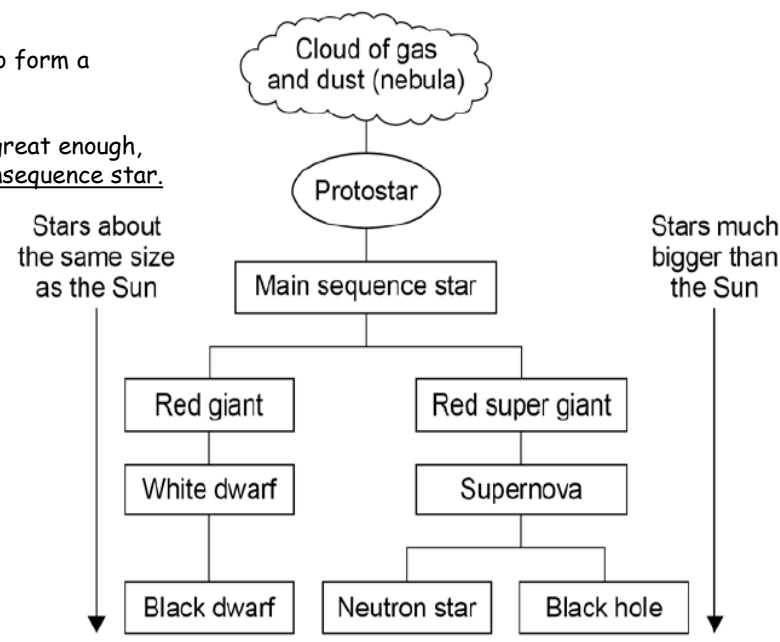
* Gravity pulls dust together in a nebula to form a Protostar.

* When the temperature and pressure is great enough, nuclear fusion begins turning it into a mainsequence star.

* When the hydrogen runs out the star collapses as gravity is greater than the pressure from fusion. Heavier elements start to fuse expanding the star to form a red giant.

* When the heavier elements run out the star becomes either a white dwarf or explodes in a supernova depending on its size.

* The very largest mainsequence stars will eventually become black holes. Slightly smaller stars become neutron stars.



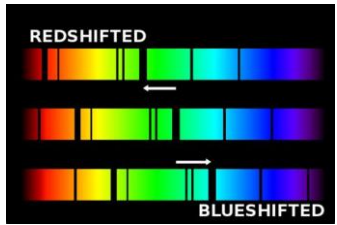
Making Elements

All elements up to iron are made through the fusion of smaller elements in the cores of stars. The larger and hotter the star the heavier the elements it can fuse.

All elements heavier than iron are fused during a supernova explosion. This then distributes these elements across the Universe.

Redshift

Light from a star or galaxy can be used to produce an absorption spectrum. This includes absorption lines, which indicate the elements present.



If a star or galaxy is moving towards us then the light from it shows a blueshift.

If the star or galaxy is moving away from us then it shows a red-shift. **ALL GALAXIES SHOW RED-SHIFT**

The further away a galaxy is the faster it is moving away from us. We know this as it shows more redshift.

This proves that the universe is EXPANDING, this provides evidence for the BIG BANG theory.

The Big Bang theory

The Big Bang Theory suggests that the Universe started with a very small hot, dense region and has been expanding ever since.

This is supported by evidence from the red-shift of galaxies, observations of certain types of supernova and CMBR.

Cosmic Microwave Background Radiation (CMBR) is the left over radiation from the Big Bang and provides further evidence for the theory.

Evidence

Measurements have shown that the expansion of the Universe is increasing in speed.

Theories about Dark Mass and Dark Energy help to explain these observations, however more evidence is needed to confirm these ideas.

Objects in Orbit

All objects in orbit are accelerating and their velocity is changing, this is because their direction is always changing. If it is a circular orbit then the speed will be constant.

If the speed of the object in orbit increases then the radius of the orbit must increase in order to keep it stable. If the speed reduces the radius must also reduce.

Elements, Mixtures and Compounds

Rule 1 - If two identical elements combine then the name doesn't change

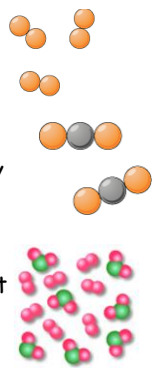
Rule 2 - When two elements join the end is usually ide.

Rule 3 - When three or more elements combine and one of them is oxygen the ending is ate

An element is just a pure substance, for example oxygen (O₂)

A compound is a material that is made up of more than one type of atom chemically bonded together, for example Carbon Dioxide (CO₂)

A mixture contains two or more different types of compounds or elements that are not chemically bonded together

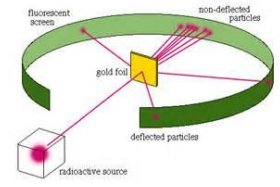


Atomic Structure

1. In 1901 JJ Thompson suggested the **plum pudding model** - this was an **atom** that the atom is a ball of positive charge with negative electrons embedded in it.

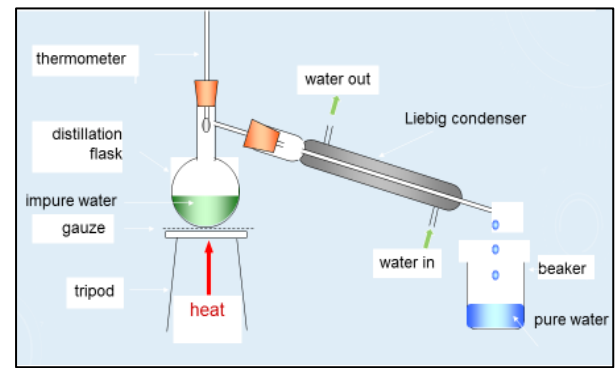


2. In 1909 Rutherford changed the accepted model using his alpha scattering experiment. The results from the alpha particle scattering experiment led to the conclusion that the mass of an atom was concentrated at the centre (nucleus) and that the nucleus was charged. This nuclear model replaced the plum pudding model.



3. Niels Bohr adapted the nuclear model by suggesting that electrons orbit the nucleus at specific distances.
4. 20 years later, James Chadwick provided the evidence to show the existence of neutrons within the nucleus.

Distillation



Distillation can be used to separate liquids from a mixture, if they have different boiling points. Distillation is the process in which evaporation of a liquid is followed by condensation

The Atom

Mass Number → 12
Atomic Number → 6

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

Atoms are very small, having a radius of about 0.1 nm (1 × 10⁻¹⁰ m).

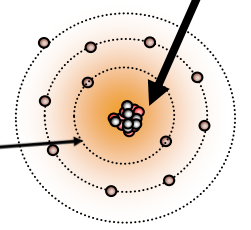
The radius of a nucleus is less than 1/10 000 of that of the atom (about 1 × 10⁻¹⁴ m).

The Nucleus
a dense core of protons and neutrons containing nearly all the mass of the atom

The mass number tells us the number of protons + neutrons.

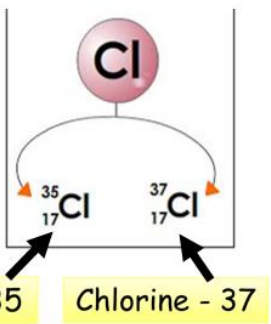
The number of protons in an atom is known as its atomic number, this is also the number of electrons

'Shells' of electrons
electrons are really very very tiny so the atom is mostly empty space.



Relative Atomic Mass

RAM is the average mass of all the stable isotopes of that element and includes the relative abundance.



Element	Relative mass of isotope	Relative abundance
Chlorine	35	3
	37	1

$$\text{R.A.M.} = \frac{(35 \times 3) + (37 \times 1)}{3 + 1} = 35.5$$

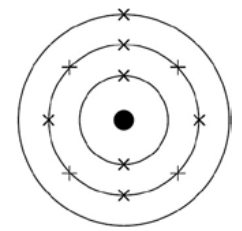
Electronic Structure

The electrons in an atom occupy the lowest available energy levels (innermost available shells).

The electronic structure of an atom can be represented by numbers or by a diagram.

Up to two electrons can occupy the lowest energy level, up to eight in the second energy level and up to eight in the third energy level.

For example, the electronic structure of sodium is 2,8,1.



Development of the Periodic Table

Before the discovery of protons, neutrons and electrons, scientists attempted to classify the elements by arranging them in order of their atomic weights.



Newlands

The early periodic tables were incomplete and some elements were placed in inappropriate groups if the strict order of atomic weights was followed.



Mendeleev

Mendeleev overcame some of the problems by leaving gaps for elements that he thought had not been discovered and in some places changed the order based on atomic weights.

Elements with properties predicted by Mendeleev were discovered and filled the gaps. Knowledge of isotopes made it possible to explain why the order based on atomic weights was not always correct.



Transition Metals (Triple Only)

The transition elements are metals with similar properties. Their properties are different from those found in Group 1. Lots of transition metals are used as catalysts.

Properties of transition metals:

- High melting + boiling point
- Form positive ions
- Good electrical conductors
- High thermal conductivity
- Malleable
- Form colored compounds

Copper Good conductor of heat and electricity	Iron Alloys are very strong	Manganese Resistant to corrosion
Cobalt Strong when alloyed with other metals	Chromium Can speed up reactions (Catalyst)	Nickel Alloys are resistant to corrosion

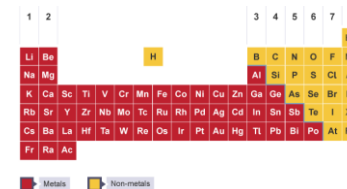
Metals and non-metals

Elements that react to form positive ions are metals. Elements that do not form positive ions are non-metals.

The formation of ions can be worked out using the Periodic Table:

- Group 1 elements form 1+ ions, group 2 elements form 2+ ions and group 3 elements form 3+ ions.
- Group 5 elements form 3- ions, group 6 elements form 2- ions and group 7 elements form 1- ions.
- Group 0 do not form ions due to having a stable structure/full outer shell.

The majority of elements are metals. Metals are found to the left and towards the bottom of the periodic table. Non-metals are found towards the right and top of the periodic table.



Group 0

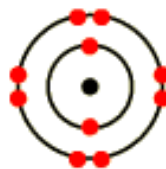
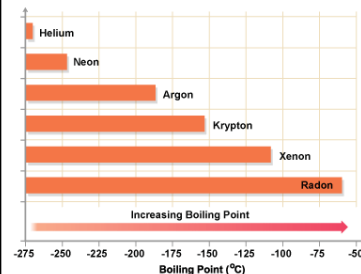
The elements in Group 0 of the periodic table are called the noble gases.

They are unreactive and do not easily form molecules because their atoms have stable arrangements of electrons.

The noble gases have eight electrons in their outer shell, except for helium, which has only two electrons.

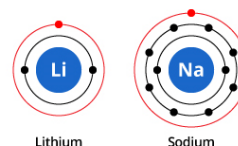
The boiling points of the noble gases increase with increasing relative atomic mass (down the group).

He
Ne
Ar
Kr
Xe
Rn



Group 1

The elements in Group 1 of the periodic table are known as the alkali metals and have characteristic properties because of the single electron in their outer shell.

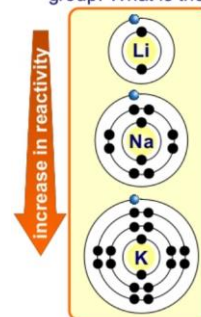


Lithium

Sodium

How does electron structure affect reactivity?

The reactivity of alkali metals **increases** going down the group. What is the reason for this?



- The atoms of each element get larger going down the group.
- This means that the outer shell electron gets further away from the nucleus and is shielded by more electron shells.
- The further an electron is from the positive nucleus, the easier it can be lost in reactions.
- This is why the reactivity of the alkali metals increases going down group 1.

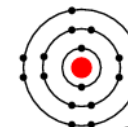
Group 7

The elements in Group 7 of the periodic table are known as the halogens and have similar reactions because they all have seven electrons in their outer shell.



F

The halogens are non-metals and consist of molecules made of pairs of atoms.



Cl

In Group 7, the further down the group an element is the higher its relative molecular mass, melting point and boiling point.

In Group 7, the reactivity of the elements decreases going down the group.

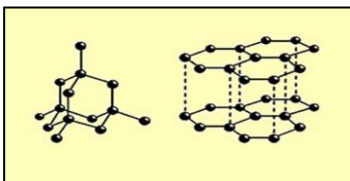
A more reactive halogen can displace a less reactive halogen from an aqueous solution of its salt.

Displaced is just a chemist's word for pushed out.

chlorine + sodium bromide → sodium chloride + bromine



Giant Covalent Structures 2



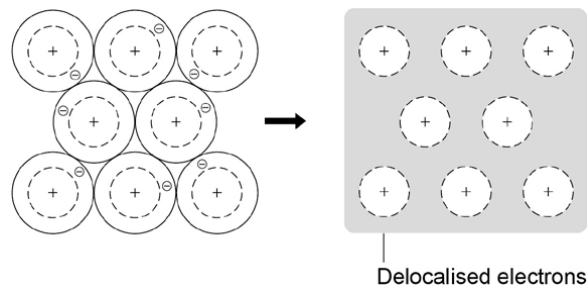
Diamond and graphite are both allotropes of carbon.

In Diamond each carbon atom is bonded to four other carbon atoms by very strong covalent bonds and therefore has no free electrons. The four strong covalent bonds give diamond a very high melting point.

In Graphite each carbon is bonded to 3 carbon atoms with weak intermolecular forces between the layers, which allows the layers to easily slide over each other. They also have a delocalised electron which allows graphite to conduct electricity. Graphite is used in lubricants as the layers can slide.

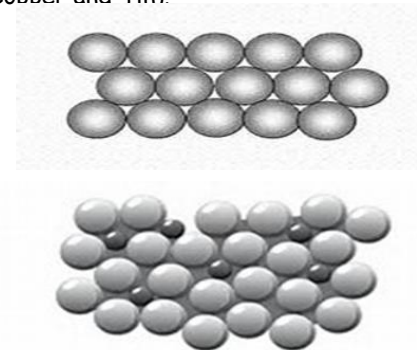
Metallic Bonding

Metals consist of giant structures of atoms arranged in a regular pattern. The electrons in the outer shell of metal atoms are delocalised and so are free to move through the whole structure. The sharing of delocalised electrons gives rise to strong metallic bonds.



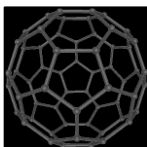
Giant Metallic Structures

Metals also form alloys. In alloys they contain at least two different types of atom which distorts the rigid regimented structure of the metal. As the layers are unable to slide over each other this causes metal alloys to be much stronger than the pure metals. Examples of alloys include Bronze (Copper and tin), Steel (Iron and Carbon) and Brass (Copper and Tin).

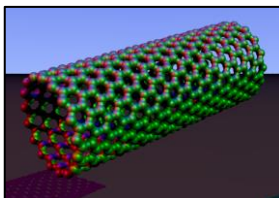


Giant Covalent Structures 3

Fullerenes are molecules of carbon atoms with hollow shapes, based on hexagonal rings of carbon atoms but they may also contain five or seven carbon atoms. Buckminsterfullerene C_{60} was the first to be discovered.



Carbon nanotubes are cylindrical fullerenes with high length to diameter ratios, this makes them useful for nanotechnology, electronics and materials.

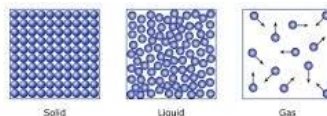


Fullerenes are often good lubricants due to their ability to roll.

Particle Model

The particles in a solid are tightly packed together and can only vibrate. They cannot be pushed any closer together.

The particles in a liquid are in contact with each other, but are arranged randomly. They can roll over each other, that is why a liquid can be poured.



The particles in a gas can move around freely. There are large spaces between the particles, so they can be pushed closer. This is why a gas can be compressed

In melting and boiling the strength of the forces between particles becomes less due to the increased kinetic energy, resulting in more space between the particles and more random arrangement

Nanoparticles (TRIPLE)

Nanoscience refers to structures that are $1-100$ nm in size, of the order of a few hundred atoms.

Nanoparticles, are smaller than fine particles (PM_{2.5}), which have diameters between 100 and 2500 nm (1×10^{-7} m and 2.5×10^{-6} m).

Coarse particles (PM₁₀) have diameters between 1×10^{-5} m and 2.5×10^{-6} m. Coarse particles are often referred to as dust.

Nanoparticles may have properties different from those for the same materials in bulk because of their high surface area to volume ratio. It may also mean that smaller quantities are needed to be effective than for materials with normal particle sizes.

Unit name	Unit symbol	Meaning
gigametre	Gm	one billion metres
megametre	Mm	one million metres
kilometre	km	one thousand metres
metre	m	one metre
millimetre	mm	one thousandth of a metre
micrometre	μ m	one millionth of a metre
nanometre	nm	one billionth of a metre

As the side of cube decreases by a factor of 10 the surface area to volume ratio increases by a factor of 10.

Conservation of mass

Mass is never lost or gained in chemical reactions. We say that mass is always **conserved**. In other words, the total mass of products at the end of the reaction is equal to the total mass of the reactants at the beginning.

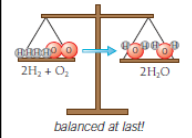
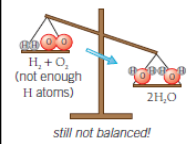
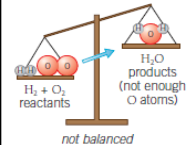


Figure 1 Balancing an equation

Balancing equations rules

- Never change the chemical formula
- Total number of reactants must equal total number of products
- Never put a small number yourself
- The big number in front applies to all the atoms in the compound/element
- The small number behind an element applies to that element only
- Use big numbers only and start with 2

Relative formula mass M_r

Mass number = number of protons + number of neutrons
Atomic number = number of protons
Neutron number = mass number – atomic number

The mass of a molecule is called the relative formula mass, M_r . This is calculated by adding up the relative atomic masses of all the atoms in the molecule.

Element	Number of atoms in compound	Mass Number (A_r)	Relative atomic mass of atom(s) in compound
C	1	12	12
O	2	16	32
Relative Formula Mass (M_r) of carbon dioxide (CO_2) is....			44

Examples of M_r below:

$H_2SO_4 \rightarrow M_r = (1 \times 2 = 2) + 32 + (16 \times 4 = 64) = 98$

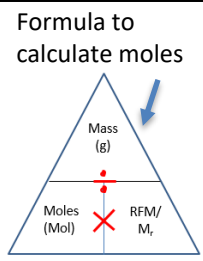
$Ca(OH)_2 \rightarrow M_r = 40 + (16 \times 2 = 32) + (1 \times 2 = 2) = 74$

$Mg(HCO_3)_2 \rightarrow M_r = 24 + (1 \times 2 = 2) + (12 \times 2 = 24) + (16 \times 6 = 96) = 146$

$Al_2(SO_4)_3 \rightarrow M_r = (27 \times 2 = 54) + (32 \times 3 = 96) + (16 \times 12 = 192) = 342$

Moles and Reacting Masses

One mole of a substance contains the same number of the stated particles, atoms, molecules or ions as one mole of any other substance. The number of atoms, molecules or ions in a mole of a given substance is the Avogadro constant which is 6.02×10^{23} per mole.



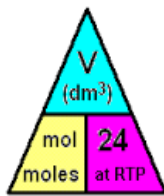
The rules for working out **reacting masses & example:**

- If (28 g) of iron reacts with copper sulphate solution, what mass of copper will be made?
- Step 1.** Write down the balanced symbol equation.
 $Fe_{28g} + CuSO_4 \rightarrow Cu_{?} + FeSO_4$
 - Step 2.** Write down the relative atomic/formula masses.
 $Fe = 56$ $Cu = 64$
 - Step 3.** Write down the ratio of reactants and products.
 $Fe : Cu = 1 : 1$
 - Step 4.** Convert to ratio of reacting masses.
 $Fe : Cu = 1 : 1 = 56 g : 64 g$
 - Step 5.** Calculate the scale factor and apply this to the ratio of reacting masses.
 $scale\ factor = (28\ g) / 56\ g = 0.5$
 $mass\ of\ Cu\ made = 64\ g \times 0.5 = 32\ g$

Limiting Reactant (LR)
 Is the reactant that gets used up first in a reaction. This is the reactant that is NOT in excess. Therefore, the amounts of product formed in a chemical reaction are determined by the LR

Volume of Gases

One **mole** of any gas has a **volume** of **24 dm³** or **24,000 cm³** at rtp (room temperature (20°C) and pressure (1 atmosphere)). This volume is called the **molar volume** of a gas.



Concentrations

The **concentration** of a solution is usually expressed as the amount of **solute (mol)** dissolved in a given **volume (dm³)** of solution.



Figure 1 The orange squash is getting less concentrated going left to right (the darker colour indicates more squash is in the same volume of its solution)



Figure 2 Volumetric flasks are used to make up solutions. They have a graduation mark around their narrow necks. Water is added to the solute until the bottom of its meniscus (the curve at the surface of the solution when viewed from the side) is level with the mark

Concentration continued...

The equations to calculate concentration:

$$concentration\ (g/dm^3) = \frac{amount\ of\ solute\ (g)}{volume\ of\ solution\ (dm^3)}$$

If you are working in centimetres cubed (cm³), convert the volume to dm³ by dividing it by 1000, and use the equation above. Alternatively, substitute your data in cm³ into the following equation:

$$concentration\ (g/dm^3) = \frac{amount\ of\ solute\ (g)}{volume\ of\ solution\ (cm^3)} \times 1000$$

- * to convert cm³ → dm³, divide by 1000 (0.001 dm³)
- * to convert dm³ → cm³, multiply by 1000 (1000 cm³)

You can increase the concentration of an aqueous solution by:

- adding more solute and dissolving it in the same volume of its solution
- evaporating off some of the water from the solution so you have the same mass of solute in a smaller volume of solution.

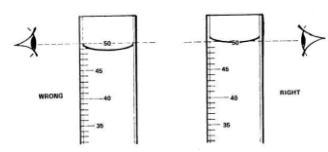
Titrations (TRIPLE ONLY)

Measuring the **EXACT** volumes of acid and alkali that are needed to react together. **What is this reaction called? NEUTRALISATION**



You can measure the exact volumes of acid and alkali needed to react with each other using a technique called **titration**. The point at which the acid and alkali have reacted completely is called the **end point** of the reaction. You judge when the end point has been reacted using an acid/base indicator.

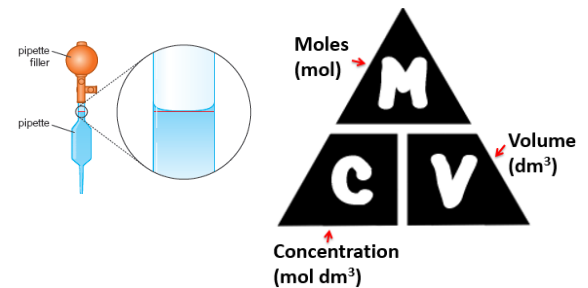
Measuring to the meniscus



such as **Phenolphthalein Indicator**. It turns colourless in an neutral solution and pink in an alkaline solution.

Titration continued...Carrying out a titration

1. First wash the pipette with distilled water, then with some alkali. Empty alkali into a conical flask.
 2. Add a few drops of indicator to the conical flask. Swirl
 3. Rinse a **burette** with distilled water and then with some acid. Acid added to burette, starting volume of acid is read accurately.
 4. Record the reading on the burette. Open tap to release a bit of acid into flask, swirl.
 5. Repeat step 4 until acid in burette has almost run in, then add one drop at a time. Neutralisation occurs. The volume of acid recorded.
 6. Repeat 3 times. Discard anomalous results. Repeat the titrations until two results are within of 0.1 cm³ each other. These precise results are called **concordant**. Calculate a mean.
 7. Calculate the concentration of the acid or alkali.
- A **volumetric pipette** is used to accurately measure a volume of an alkali.
 - A **pipette filler** is used to draw solution into the pipette safely.
 - **Neutralisation** is a change in colour when acid and alkali have been mixed = titration is complete.
 - **Titre** is the volume recorded from a burette



Percentage yield and Atom economy (TRIPLE)

$$\% \text{ yield} = \frac{\text{mass of product obtained}}{\text{maximum theoretical mass of product}} \times 100$$

- The reaction may be reversible – as products form they react to re-form the reactants again. You show reversible reactions using this symbol \rightleftharpoons instead of the normal arrow between reactants and products. Chemists can manipulate reversible reactions by the conditions they choose in the reaction vessels in chemical plants.
- Some reactants may react to give unexpected or unwanted products in alternative reactions.

- Some of the product may be lost in handling or left in the apparatus.
- The reactants may not be pure (as in the case of the lime kiln).
- Some of the desired product may be lost during its separation from the reaction mixture.

$$\text{Atom economy} = \frac{\text{mass of wanted product from equation}}{\text{total mass of products from equation}} \times 100$$

Yield Industrial processes –

Industrial processes need as high a percentage yield as possible, because this:

- 1) Reduces the waste of reactants
- 2) Reduces the cost of the process

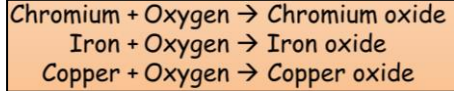
Atom Industrial processes –

Industrial processes need as high an atom economy as possible, because this:

- 1) Reduces the production of unwanted products
- 2) Makes the process more *sustainable*
- 3) Conserve the Earth's resources and minimise pollution

Extraction of Metals + Metal Oxides

Metals react with oxygen to form metal oxides



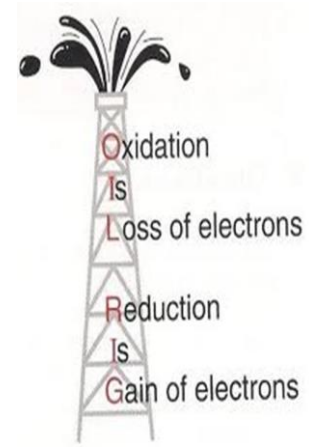
Many metals are found in the ground as metal compounds. The metal needs to be extracted. For metals that are below carbon in the reactivity series this can be done by heating the metal compound with carbon. The carbon removes the oxygen from the metal oxide.

K	Potassium	↑ Most reactive
Na	Sodium	
Ca	Calcium	
Mg	Magnesium	
Al	Aluminium	
C	Carbon	
Zn	Zinc	
Fe	Iron	
Sn	Tin	
Pb	Lead	
H	Hydrogen	
Cu	Copper	↓ Least reactive
Ag	Silver	
Au	Gold	
Pt	Platinum	
C	H	

Reactivity Series of Metals

- Copper oxide + Carbon → Carbon dioxide + Copper
- Lead oxide + Carbon → Carbon dioxide + Lead
- Iron oxide + Carbon → Carbon dioxide + Iron

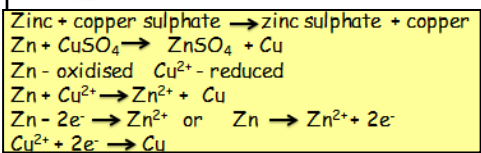
Oxidation and Reduction



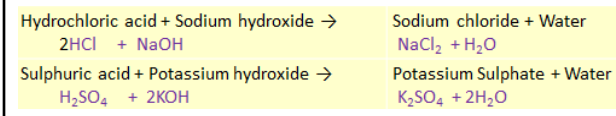
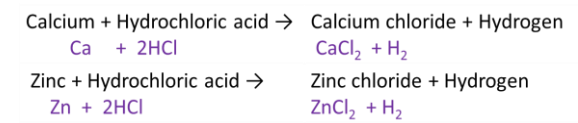
Oxidation is the gain of oxygen and the loss of electrons, reduction is the loss of oxygen and gain of electrons.

A chemical reaction where both oxidation and reduction occur is called a redox reaction.

The equation below shows a word equation, a balanced symbol equation, ionic and half equations which show the movement of electrons.



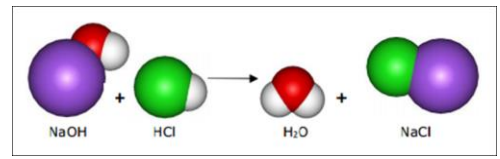
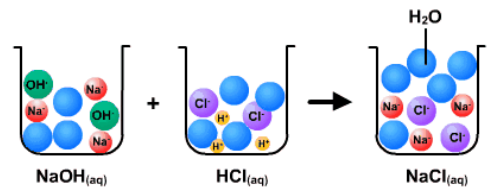
Metals + Acids and Metal Carbonates + Acid



Neutralisation

The acid used will determine the salt produced in a neutralisation reaction:

- hydrochloric acid produces chlorides
- nitric acid produces nitrates
- sulfuric acid produces sulfates



Soluble salts (Required practical)

Soluble salts can be made from acids by reacting them with solid insoluble substances, such as metals, metal oxides, hydroxides or carbonates.

The solid is added to the acid until no more reacts and the excess solid is filtered off to produce a solution of the salt.

Salt solutions can be crystallised to produce solid salts.



Soluble salts (Required practical): Method

1. Sulfuric acid is warmed in a water bath

2. Weigh 2g of black copper oxide powder

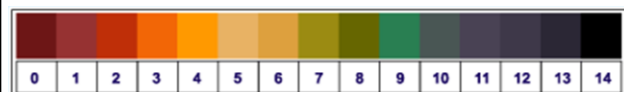
3. Add copper oxide to the sulphuric acid until a blue solution is formed and excess copper oxide sinks to the bottom of the tube.

4. Filter the unreacted copper oxide from the solution and collect the filtrate

5. Transfer the solution to an evaporating dish and heat gently

6. Leave to cool, copper sulfate crystals will form. Remove and dry crystals.

pH and Acids + Alkalis



Acids produce H^+ (as H_3O^+) ions in water and they taste sour. They also corrode metals and have a pH of less than 7. They also turns blue litmus paper to red.

Alkalis produce OH^- ions in water and they taste bitter with a pH greater than 7. Alkalis turns red litmus paper to blue.

A solution is defined as an acid if the concentration of H^+ ions is greater than the concentration of OH^- ions. $[H^+] > [OH^-]$

A solution is defined as alkali/base if the concentration of hydrogen ions is less than the concentration of hydroxide ions. $[H^+] < [OH^-]$

Strong and weak acids

A strong acid is completely ionised in aqueous solution. $HCl + H_2O \rightarrow H^+ + Cl^-$

Examples of strong acids are hydrochloric, nitric and sulfuric acids.

A weak acid is only partially ionised in aqueous solution. $CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H^+$

Examples of weak acids are ethanoic, citric and carbonic acids.

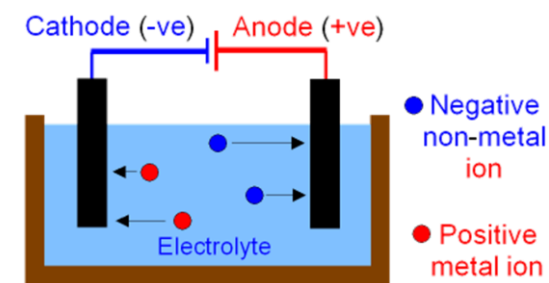
For a given concentration of aqueous solutions, the stronger an acid, the lower the pH.

As the pH decreases by one unit, the hydrogen ion concentration of the solution increases by a factor of 10.

$[H^+]$	pH	Example
1×10^0	0	HCl
1×10^{-1}	1	Stomach acid
1×10^{-2}	2	Lemon juice
1×10^{-3}	3	Vinegar
1×10^{-4}	4	Soda
1×10^{-5}	5	Rainwater
1×10^{-6}	6	Milk
1×10^{-7}	7	Pure water
1×10^{-8}	8	Egg whites
1×10^{-9}	9	Baking soda
1×10^{-10}	10	Tums® antacid
1×10^{-11}	11	Ammonia
1×10^{-12}	12	Mineral lime - $Ca(OH)_2$
1×10^{-13}	13	Drano®
1×10^{-14}	14	NaOH

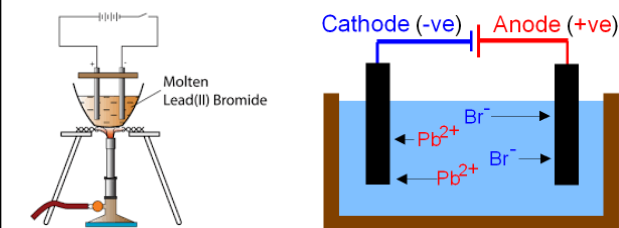
Electrolysis

When an ionic compound is melted or dissolved in water, the **ions** are free to move about within the liquid or solution. These liquids and solutions are able to conduct electricity and are called electrolytes. Passing an electric current through electrolytes causes the ions to move to the electrodes. Positively charged ions move to the negative electrode (the cathode), and negatively charged ions move to the positive electrode (the anode).



Electrolysis of molten ionic compounds

When a simple ionic compound (eg lead bromide) is electrolysed in the molten state using inert electrodes, the metal (lead) is produced at the cathode and the non-metal (bromine) is produced at the anode.



Cathode (-ve electrode)



Anode (+ve electrode)



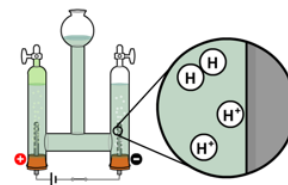
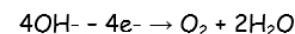
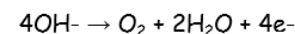
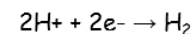
Electrolysis Extended

At the negative electrode, hydrogen is produced if the metal is more reactive than hydrogen.

At the positive electrode oxygen is produced unless the solution contains halide ions when the halogen is produced.

This is due to water molecules breaking down in aqueous solution to form hydrogen and hydroxide ions.

At the cathode positively charged ions gain electrons, whereas as the negatively charged ions lose electrons at the anode. These are both examples of oxidation and reduction. These can be represented as half equations.



At the cathode

Whether hydrogen or a metal is produced at the cathode depends on the position of the metal in the metal **reactivity series**:

- the metal is produced at the cathode if it is less **reactive** than hydrogen
- hydrogen is produced at the cathode if the metal is more reactive than hydrogen

Rules for determining products

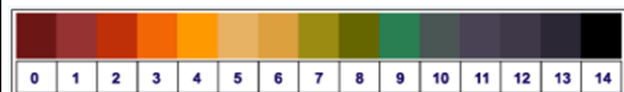
At the anode

Oxygen is produced (from hydroxide ions), unless **halide** ions (chloride, bromide or iodide ions) are present. In that case, the negatively charged halide ions lose electrons and form the corresponding **halogen** (chlorine, bromine or iodine).

The table summarises the product formed at the anode during the electrolysis of different **electrolytes** in solution.

Negative ion	Element given off at anode
Chloride, Cl^-	Chlorine, Cl_2
Bromide, Br^-	Bromine, Br_2
Iodide, I^-	Iodine, I_2
Sulfate, SO_4^{2-}	Oxygen, O_2
Nitrate, NO_3^-	Oxygen, O_2

pH and Acids + Alkalis



Acids produce H^+ (as H_3O^+) ions in water and they taste sour. They also corrode metals and have a pH of less than 7. They also turns blue litmus paper to red.

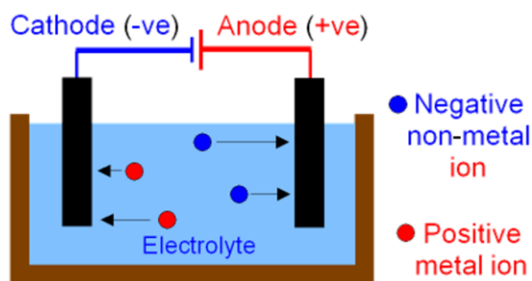
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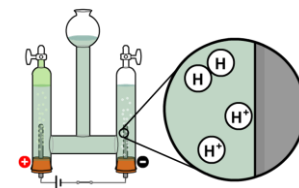
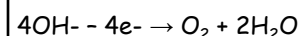
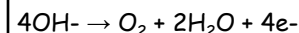
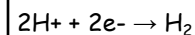


Electrolysis Extended

At the negative electrode, hydrogen is produced if the metal is more reactive than hydrogen. At the positive electrode oxygen is produced unless the solution contains halide ions when the halogen is produced.

This is due to water molecules breaking down in aqueous solution to form hydrogen and hydroxide ions.

At the cathode positively charged ions gain electrons, whereas as the negatively charged ions lose electrons at the anode. These are both examples of oxidation and reduction. These can be represented as half equations.

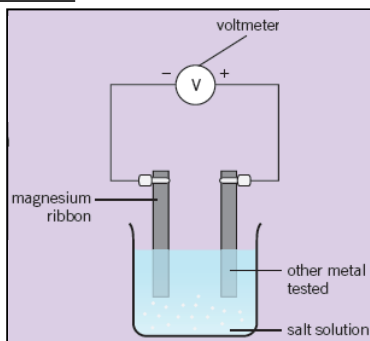


Cells and batteries continued...

- Metals lose electrons and form positive ions.
- When 2 metals are dipped in a salt solution and joined by a wire, the more reactive metal will donate electrons to the less reactive metal. This forms a simple electrical cell.
- The greater the difference in reactivity between the 2 metals, the higher the voltage produced by the cell.

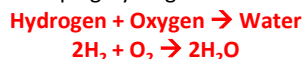
Investigating chemical cells

This apparatus is used to investigate the voltage produced by different metals paired with magnesium ribbon. You can compare magnesium against zinc, iron, copper & tin in your electrical cells.



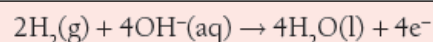
Fuel Cells

Scientists are developing hydrogen as a fuel.

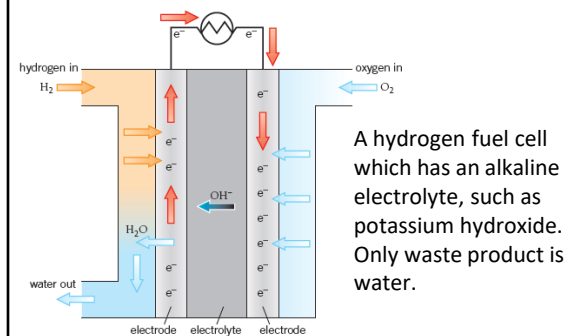
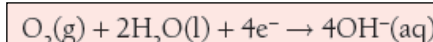


- The world relies on fossil fuels. However, they are non-renewable and they cause pollution.
- Hydrogen is one alternative fuel. It can be burned in combustion engines or used in fuel cells to power vehicles.
- Hydrogen gas is oxidised and provides a source of electrons in the hydrogen fuel cell, in which the only waste product is water.

Hydrogen gas is supplied as a fuel to the negative electrode. It diffuses through the graphite electrode and reacts with hydroxide ions to form water and provides a source of electrons to an external circuit.



Oxygen is supplied to the positive electrode. It diffuses through the graphite and reacts to form hydroxide ions, accepting electrons from the external circuit.



A hydrogen fuel cell which has an alkaline electrolyte, such as potassium hydroxide. Only waste product is water.

Advantages of hydrogen fuel cells –

- Do not need to be electrically recharged
- No pollutants are produced
- Can be a range of sizes for different uses

Disadvantages of hydrogen fuel cells–

- Hydrogen is highly flammable
- Hydrogen is sometimes produced for the cell by non-renewable sources
- Hydrogen is difficult to store

Exothermic and endothermic reactions

Exothermic reactions **release** thermal energy (heat) into their surroundings. They can occur spontaneously and some are explosive. Most chemical reactions are exothermic. Temperature **increases**.

What are some examples?

- combustion
- respiration
- neutralization of acids with alkalis
- reactions of metals with acids
- $Mg(s) + HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$
- the Thermite Process.
- Endothermic reactions absorb thermal energy, and so cause a **decrease** in temperature.

What are some examples?

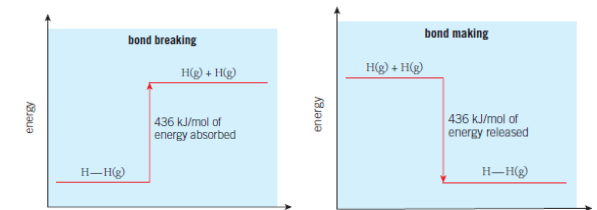
- thermal decomposition, e.g. calcium carbonate in a blast furnace
- photosynthesis
- some types of electrolysis
- Sherbet
- $NH_4NO_3(s) + H_2O(l) \rightarrow NH_4^+(aq) + NO_3^-(aq)$

Bond energy calculations

The energy needed to break a bond between 2 atoms is called the **bond energy** for that bond. They are measured in KJ/mol.

Table 1 Common bond energies

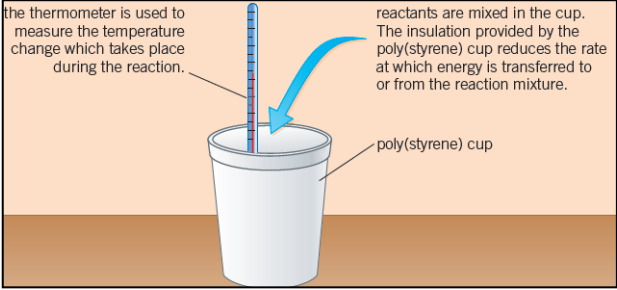
Bond	Bond energy in kJ/mol	Bond	Bond energy in kJ/mol
C—C	347	H—Cl	432
C—O	358	H—O	464
C—H	413	H—N	391
C—N	286	H—H	436
C—Cl	346	O=O	498
Cl—Cl	243	N≡N	945



Breaking and making a particular bond always involves the same amount of energy

Investigating temperature changes

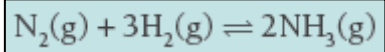
Record the initial temperatures of any solutions, and the maximum and minimum temperatures reached in the course of the reaction.



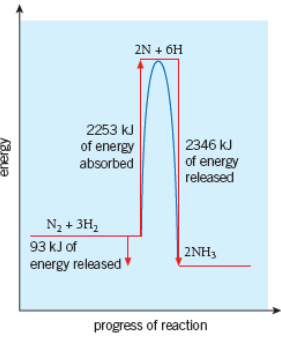
Using energy transfers from reactions

- Exothermic changes can be used in hand warmers and self heating cans. Crystallisation of the supersaturated solution is used in reusable warmers. However, disposable, one-off hand warmers heat up the surrounding for longer.
- Endothermic changes can be used in instant cold packs for sports injuries.

The formation of ammonia. The energy released, 93KJ, is from the formation of 2 moles of ammonia (see balanced equation below). So if you wanted to know the energy change for the reaction per mole of ammonia formed, it would release exactly half this, i.e. 46.5kJ/mol.



- In chemical reactions, energy must be supplied to break the bonds between atoms in the reactants.
- When new bonds are formed between atoms in a chemical reaction, energy is released.
- In an exothermic reaction, the energy released when new bonds are formed is greater than the energy absorbed when bonds are broken.
- In an endothermic reaction, the energy released when new bonds are formed is less than the energy absorbed when bonds are broken.
- You can calculate the overall energy change in a chemical reaction using bond energies.



Reaction profiles and Activation energy

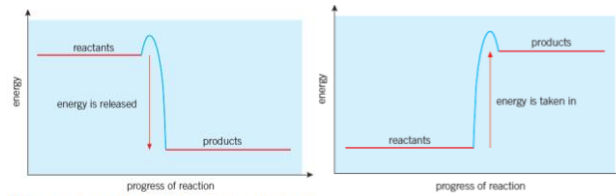


Figure 1 The reaction profile for an exothermic reaction. Figure 2 The reaction profile for an endothermic reaction.

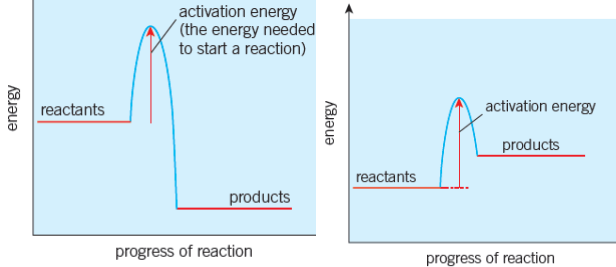


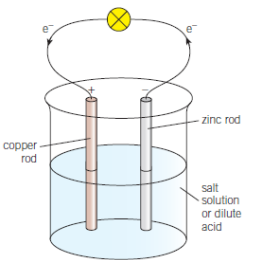
Figure 3 This reaction profile shows the activation energy for an exothermic reaction. Figure 4 This reaction profile shows the activation energy for an endothermic reaction.

Bond breaking is endothermic whereas bond making is exothermic.

Cells and batteries $Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$

The sulfate ions do not change in the displacement reaction above. They are spectator ions.
 So you can leave them out of the equation and write an ionic equation:
 $Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$
 You can think of this redox reaction as two half equations.
 One will represent reduction:
 $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$
 The Cu^{2+} ions are reduced to Cu.
 The other will be an oxidation reaction:
 $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$
 The Zn atoms are oxidised to Zn^{2+} ions.

An electrical cell made from zinc and copper → The electrons flow from the more reactive metal (zinc) to the less reactive metal (copper). So zinc acts as the negative terminal of the cell, providing electrons to the external circuit.

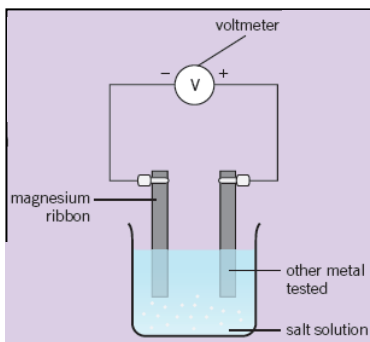


Cells and batteries continued...

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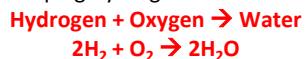
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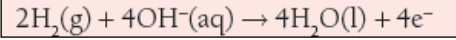
Fuel Cells

Scientists are developing hydrogen as a fuel.

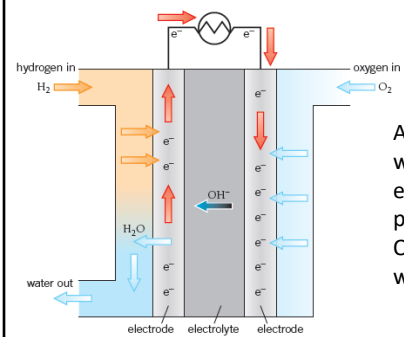
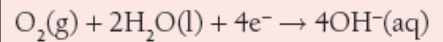


- The world relies on fossil fuels. However, they are non-renewable and they cause pollution.
- Hydrogen is one alternative fuel. It can be burned in combustion engines or used in fuel cells to power vehicles.
- Hydrogen gas is oxidised and provides a source of electrons in the hydrogen fuel cell, in which the only waste product is water.

Hydrogen gas is supplied as a fuel to the negative electrode. It diffuses through the graphite electrode and reacts with hydroxide ions to form water and provides a source of electrons to an external circuit.



Oxygen is supplied to the positive electrode. It diffuses through the graphite and reacts to form hydroxide ions, accepting electrons from the external circuit.



A hydrogen fuel cell which has an alkaline electrolyte, such as potassium hydroxide. Only waste product is water.

Advantages of hydrogen fuel cells –

- 1) Do not need to be electrically recharged
- 2) No pollutants are produced
- 3) Can be a range of sizes for different uses

Disadvantages of hydrogen fuel cells–

- 1) Hydrogen is highly flammable
- 2) Hydrogen is sometimes produced for the cell by non-renewable sources
- 3) Hydrogen is difficult to store

AQA BIOLOGY UNIT 1: CELLS

Cells

Eukaryotic cells

Animal cell

- Nucleus: Controls cell
- Ribosomes: Protein synthesis
- Cell Membrane: Controls what goes in and out the cell
- Mitochondria: Respiration
- Chloroplast: Photosynthesis
- Cytoplasm: Where chemical reactions occur

Plant cell

- Cytoplasm
- Nucleus
- Ribosome
- Mitochondrion
- Cell membrane
- Chloroplast
- Vacuole
- Cell wall

Found in plant cells

Prokaryotic cells - no membrane bound organelles (loose DNA)

Bacterial cell

- Cell wall
- Cell membrane
- Molecule of circular DNA
- Cytoplasm

Yeast cell

- Cell wall
- Cell membrane
- Nucleus
- Cytoplasm
- Mitochondria

Magnification

Fraction of a metre	Unit	Symbol
One thousandth = $0.001 = 1/1000 = 10^{-3}$	millimetre	mm
One millionth = $0.000001 = 1/1000\ 000 = 10^{-6}$	micrometre	μm
One thousand millionth = $0.000\ 000\ 001 = 1/1000\ 000\ 000 = 10^{-9}$	nanometre	nm

To calculate actual size:

1. Measure the organelle with a ruler.
2. Multiply this by 1000 to get a value in micrometres
3. Divide this by the magnification

e.g. The diagram below is a drawing of an organelle from a ciliated cell as seen with an electron microscope.

Calculate the actual length of the organelle as shown by the line AB in the diagram. Express your answer to the nearest micrometre (μm).

1. Measure it in mm = 40mm
2. Multiply by 1000 = 40000 μm
3. Divide by magnification $40000 / 20000 = 2\mu\text{m}$

Magnification is the number of times larger an image is compared with the real size of the object.

Resolution is the ability to distinguish between 2 separate points.

Specialised Cells - Cells that have differentiated

Neurone		<ul style="list-style-type: none"> • Long and thin. • Have a myelin sheath to prevent loss of impulse. • Form connections with other neurones. • Can carry electrical impulses in one direction.
Sperm		<ul style="list-style-type: none"> • Contain digestive enzymes for breaking down the outer layer of an egg cell. • Many mitochondria. • Have long tail.
Red Blood		<ul style="list-style-type: none"> • Large surface area. • Small diameter. • No nucleus. • Contain haemoglobin.
Root Hair		<ul style="list-style-type: none"> • Found close to xylem • Thin membrane. • Large surface area.
Cone Cells		<ul style="list-style-type: none"> • Outer segment filled with visual pigment that changes chemically in coloured light. • Lots of mitochondria so that you constantly see in colour. • Specialised synapses connecting to the optic nerve.

Chromosomes

Humans have **23 pairs** of chromosomes (46 in total) in all adult cells.

Chromosomes 23 = sex chromosomes (**XY = male** **XX = female**)

Karyotype - visual appearance of our chromosomes.

What are the differences?

1. 47 instead of 46
2. Extra chromosome 21 (called Trisomy-21 (Down's Syndrome))
3. Normally 21 should be 2 chromosomes

Mitosis and Meiosis - cell division

Mitosis (in humans)

- Occurs all over the body
- Makes new cells with 23 pairs of chromosomes
- Cells divide once
- Makes new body cells.

Interphase: DNA copies

Different stages of mitosis:

- Prophase** - chromosomes condense
- Metaphase** - chromosomes line up in the middle
- Anaphase** - chromosomes pulled apart by spindle fibres
- Telophase** - 2 new nuclei form

Meiosis (in humans)

- Occurs in testes and ovaries
- Makes cells with 23 chromosomes
- Cells divide twice
- Makes gametes (sperm and egg)

Advantages:

- Treat blindness
- Organ transplants
- Treat paralysis

Disadvantages:

- Ethical issues with embryos
- Religious issues

Diffusion

Movement of particles from a high concentration to a low concentration (down a concentration gradient)

To increase rate of diffusion:

- Increase temperature
- Increase surface area
- Increase concentration gradient
- Shorten distance

Large organisms have a small **surface area:volume** so require specialised exchange surfaces with large surface area so diffusion is fast enough.

Small Intestine: Villi increase surface area
Blood flow maintains conc. Gradient
Thin wall 1 cell thick

Lungs: Alveoli increase surface area

Blood flow and thin walls like the villi

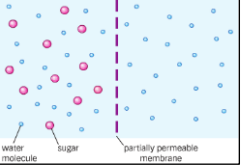
Bacteria multiply by **binary fission**.

Growth is exponential i.e. $1 \rightarrow 2 \rightarrow 4 \rightarrow 8 \rightarrow 16 \rightarrow 32 \rightarrow 64...$

Osmosis

Water travels from a **dilute solution** (high water concentration) to a **more concentrated solution** (low water concentration).

The water moves across a **partially permeable membrane**.

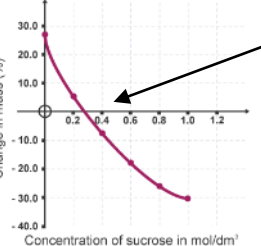


Isotonic means the amount of dissolved solutes is the same on the outside of the cell as the inside, so there is no difference in concentration of water.

Hypotonic means there are more solutes inside the cell than outside, therefore inside the cell has a lower concentration of water.

Hypertonic means there are more solutes on the outside of the cell than on the inside. So there is a lower concentration of water on the outside of the cell.

- **Turgid** - When a cell fills with water (plant cell wall protects cell from bursting)
- **Flaccid** - When a cell loses water



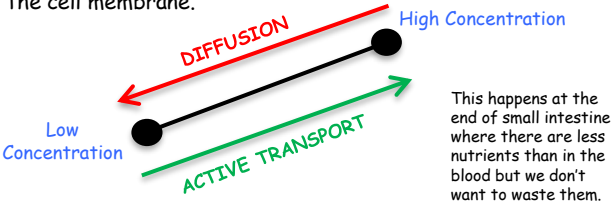
The solution is isotonic where the line crosses the x-axis i.e. 0.3 mol/dm³.
Potato gains mass in a hypotonic solution but loses mass in a hypertonic solution.

Active Transport

This is the opposite of diffusion.

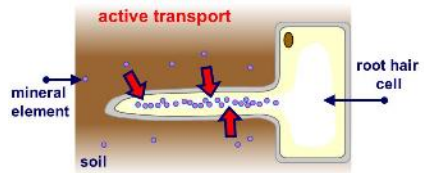
Substances move from an area of low concentration to high concentration, **against the concentration gradient**.

It requires **ATP** (energy) - this means it need **mitochondria**. The ATP is used to change the shape of **protein channels** in the cell membrane.



This happens at the end of small intestine where there are less nutrients than in the blood but we don't want to waste them.

Root hair cells have more minerals than the soil but still needs them. Active transport is used for uptake of these minerals.



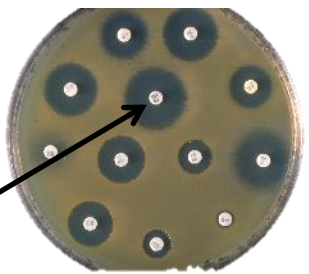
Root hair cells therefore have lots of mitochondria.

REQUIRED PRACTICAL: Growing Bacteria

- Flame the loop - sterilises it
- Lift lid slightly - prevent airborne bacteria getting into it
- Seal with 2 bits of tape - allows air to get in but keeps lid on for safety
- Incubate at 25°C - prevents pathogens growing

Antibiotics on bacteria on the jelly.

Big space around disk = most bacteria killed



AQA BIOLOGY UNIT 2: ORGANISATION

Tissues and Organs

Tissues: cells working together

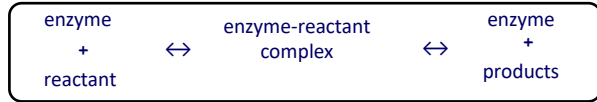
Animal	Glandular	<ul style="list-style-type: none"> • Ribosomes - make enzymes and hormones • Vesicles to store enzymes and hormones
	Muscular	<ul style="list-style-type: none"> • Long, thin cells contracts • Lots of mitochondria for energy
	Epithelial	<ul style="list-style-type: none"> • Goblet cells make mucus • Cells have cilia
Plant	Mesophyll	<ul style="list-style-type: none"> • Lots of chloroplasts • Photosynthesis
	Epidermal	<ul style="list-style-type: none"> • Thin and translucent to allow light through
	Xylem	<ul style="list-style-type: none"> • Transports water
	Phloem	<ul style="list-style-type: none"> • Transports sugars

Organs: tissues working together

Stomach: Glandular: Makes enzymes and acid
Epithelial: mucus protects lining
Muscular: contracts, churns food

Enzymes - biological catalyst made from protein in ribosomes

- Enzymes have an active site (shape)
- Active site fits a substrate and breaks it down



Denature: Active site changes
No longer recognises substrate

- **Temperature** - too cold too slow
- optimum = 37°C
- too hot = denatures
- **pH** - enzymes only work at specific pH
- stomach enzymes need pH 1-2 (acid)
- intestinal enzymes need pH 7-8 (bile)

Digestive Enzymes

Carbohydrase (e.g. amylase)	Large sugars (starch) → Simple sugars (glucose)	Salivary glands, pancreas, Small intestine	pH7-8 37°C
Protease (e.g. pepsin)	Protein → Amino acids	Stomach Pancreas Small intestine	Stomach = pH1-2 37°C
Lipase (e.g. pancreatic lipase)	Fats → Fatty acids and glycerol	Stomach Pancreas Small intestine	pH 7-8 37°C

Commercial Use - speed up reactions, increase yields but need to monitor temperature and pH.

Industry	Function of Enzymes
Diet foods	change glucose into fructose, which is sweeter so less is needed and is used in 'slimming' foods (isomerase).
Baby food	start off digestion of food (proteases and lipases)
Biological detergent	break down stains (proteases and lipases).

REQUIRED PRACTICAL: Food Tests

Type of Food	Name of Test	Positive Result	Negative Result
Starch	Iodine	Blue/Black	Brown
Glucose	Benedict's (must be heated)	Green → Yellow → Brick red	Blue
Protein	Biuret	Lilac	Blue
Lipids	Emulsion	Cloudy precipitate	Clear

Health and Risk Factors

- Communicable disease:** Any disease transmitted from one person or animal to another, also called contagious disease.
- Non Communicable disease:** Medical condition or disease that is non-infectious or non-transmissible.

Risk Factors:

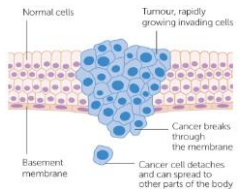
- Cardiovascular disease:** diet/obesity, age, genetics and exercise.
- Lung disease:** smoking and cleanliness of the environment.
- Liver disease:** alcohol, diet/obesity, genetics, drugs and viral infection
- Type 2 diabetes:** genetics, diet/obesity and exercise

Cancer

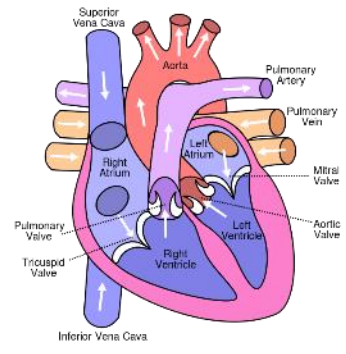
When our cells divide, mutations can occur in the DNA which lead to abnormal cells.

Malignant cancer can spread to other parts of the body. We call this **metastasis**.

A cancer cell can detach from the tumour and be carried by the blood to other parts of the body. The cancer cell can become stuck in a capillary by an organ and then begin growing until it has invaded that organ too.



The Heart



Double circulation

Right = lungs for gas exchange

Left = Rest of body

Needed because humans are more active and lungs are very delicate so blood can't be at a high pressure but must be to go round the rest of the body.

What could happen if our coronary arteries narrow?

Plaque (fatty deposit) builds on the walls of the blood vessel.

The blood vessel can become blocked or in some cases the blood pressure increases causing some plaque to break away.

The plaque blocks narrower vessels causing blood clots and a lack of oxygen to tissue and organs.

- Lack of oxygen
- Lack of glucose
- For respiration
- No energy for contraction of cardiac muscle
- Heart stops (cardiac arrest)

CHD and Other Heart Defects

Procedure	How they work	Advantages	Disadvantages
Statins	Drugs that lower blood cholesterol levels preventing plaque forming	Cheap Preventative	Can cause side effects
Stents	Insert a balloon and wire mesh to artery. Inflate balloon and leave wire in place	Invasive Minor surgery	Anticoagulant drugs are needed which prevents blood clotting
Bypass Surgery	Piece of vein is grafted from leg to bypass the blocked coronary artery	Permanent solution	Expensive Scars Major surgery
Mechanical Valve Replacement	Synthetic valve used to replace faulty one.	Last longer	Need anticoagulant drugs
Biological Valve Replacement	Animal valve used to replace faulty one	No drugs needed	Only lasts 15 years
Pacemaker	Device used to trigger the heart to beat in its normal rhythm	Keeps heart beating properly	Surgical procedure Can stop working near machinery and electronic devices
Heart Transplant	Donor heart used to replace patient's heart	Permanent solution	Major surgery Rejection Immunosuppressant drugs needed

Blood Vessels

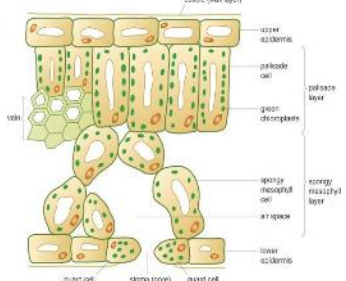
Blood Vessel	Diagram	Type of Blood	Pressure	Special Features
Artery		Oxy	High	Thick muscular elastic walls Smaller lumen
Capillary		Both	Med	1 cell thick walls for fast diffusion
Vein		Deoxy	Low	Large lumen Valves to prevent back flow of blood

Blood

- Red Blood Cells** - haemoglobin carries oxygen, biconcave disk increases surface area, no nucleus to fit in more haemoglobin.
- White blood cells** - fight pathogens
- Plasma** - transports dissolved substances
- Platelets** - bits of cytoplasm used to form blood clots

Plants and Photosynthesis

Roots	<ul style="list-style-type: none"> Uptake of water and minerals Large surface area due to root hair cells Protein channels for active transport Meristems - plant stem cells
Stem	<ul style="list-style-type: none"> Hold leaves in position Waxy epidermis to prevent water loss Xylem - transports water Phloem - transports sugars
Leaves	<ul style="list-style-type: none"> Broad, flat to increase surface area Contain 4 types of tissue to carry out photosynthesis (see below) Guard cells close stomata at night to prevent water loss by transpiration Waxy epidermis to prevent water loss



How is the leaf adapted for efficient photosynthesis?

- Sun hits palisade cells at top
- Palisade - lots of chloroplasts
- Spongy mesophyll allows gas movement
- Xylem brings water
- Phloem maintains concentration gradient by removing glucose
- Guard cells open to allow carbon dioxide to diffuse into the leaf.

Transpiration and Translocation

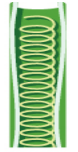
Phloem

- Phloem vessels are made of long, thin-walled cells that form tubes.
- Sugars and amino acids dissolved in sap are transported in the phloem by a process called **translocation**.
- The ends of the phloem tubes are called **sieve plates** and they have small holes in them to allow transport in both directions.
- Phloem cells have no nuclei. They have **companion cells** next to them to control them which are filled with mitochondria.



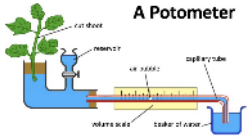
Xylem

- Xylem tubes are made from long cells with thick, reinforced walls made from **lignin**.
- The vessel has a large hollow lumen for water and minerals to flow through in one direction.
- The cell walls are waterproof which makes the cells die which results in wood in trees!



Transpiration Stream

- Higher concentration of water in soil than in roots
- Water moves into roots by osmosis
- Higher concentration of water in roots than in leaves
- Water moves up the xylem by osmosis to the leaves
- Water lost through stomata and used for photosynthesis maintains concentration gradient.
- This causes more water to be drawn in by the roots. This is called the transpiration stream



AQA BIOLOGY UNIT 3: INFECTIOUS DISEASES

Pathogens - microorganisms that cause disease

	Bacteria	Virus	Fungi
Size	1000nm	20-40nm	2-10µm
Method of reproduction	Grow then divide in two	Invade host cells and tell nucleus to make copies	They release spores which travel through the air
How they make you feel ill	Produce toxins that travel around the body	Make cells burst open	Produce toxic chemicals

Malaria

Caused by a protist called **Plasmodium**. Vector = mosquito



- Mosquito bite injects sporozoites into blood.
- Sporozoites invade liver cells.
- Sporozoites turn into merozoites and burst open liver cells.
- Merozoites invade red blood cells, digest haemoglobin, replicate and burst open red blood cells.
- Merozoites taken back up into mosquito.

Prevention:

- Eggs laid in stagnant water - drain pools, spray them with insecticide, spray with oil to prevent oxygen getting to the eggs,
- Mosquito nets and repellent spray.
- Chloroquine

Name of disease	Type of pathogen	Transmission/how to prevent spread	Symptoms	Treatments
Salmonella	Bacteria	Uncooked poultry, dirty work surfaces Cook food thoroughly	Nausea, diarrhoea	Antibiotics
Gonorrhoea	Bacteria	Unprotected sex Wear condoms	Discharge, painful genitals	Antibiotics
Malaria	Protist	Mosquito bites Mosquito nets, drain pools, chloroquine	Tired, headache, vomiting	N/A
HIV	Virus	Blood contact, exchange of bodily sexual fluids, sharing needles Condoms, don't do heroin	Symptoms from various diseases caused by developing AIDs	N/A
Measles	Virus	Droplet infection, sneezes MMR vaccine	Red rash on skin	Painkillers to reduce the symptoms

White Blood Cells

- Phagocytes - Engulf (phagocytosis, non-specific)
- Lymphocytes - Make antibodies (specific proteins that bind to antigens)
- Lymphocytes - Make antitoxins (counteract toxins made by bacteria)

Vaccines

Contain dead or inactive pathogens

- White blood cells make **antibodies**
- Antibodies remove dead/inactive pathogen
- If exposed to real pathogen, antibodies are made **quickly** before they can multiply.

MMR Vaccine = Measles, Mumps and Rubella

Drug Trials

Stage 1: Tested on animals, cells and tissue
Check for toxicity

Stage 2: Tested on human volunteers
Check dosage and side effects

Stage 3: Tested on patients to see if it is effective

Double blind - no one knows who gets the real drug - no bias

Placebo - fake drug (looks same, taken same way) It is a control.

Thalidomide

- Tested as sleeping pill
- Not tested on pregnant women
- Given to pregnant women for morning sickness
- Babies have limb deformities
- Only given now for leprosy

Medicines - A drug is a chemical that alters how the body works. They alter the normal chemical reactions in the body.

Antibiotics - kill **bacteria** or prevent them from multiplying.

THEY DON'T KILL VIRUSES because viruses live inside cells.

Painkillers - relieve the **symptoms** only

Antivirals - target specific viruses and slow down replication.

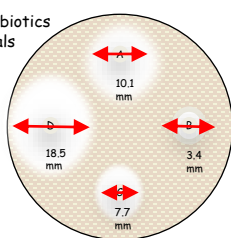
Antibiotic Resistance

- Mutation occurs when bacteria multiply
- Mutation makes bacteria resistant to antibiotic
- Antibiotic kills all the others
- No competition for food or space
- New colony of resistant bacteria grows

e.g. MRSA

Causes: Incorrect use of antibiotics
Not completing the full course of antibiotics
Over-sterile environments e.g. hospitals

To calculate clear zone: πr^2



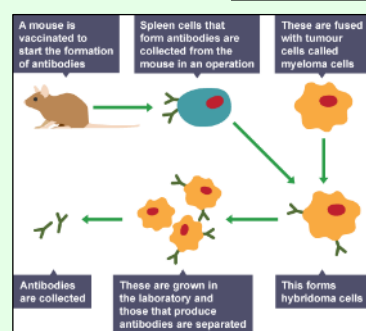
Resistant: 6mm or less
Intermediate: 7-11 mm
Susceptible: 12 mm or more

Monoclonal Antibodies

Monoclonal antibodies are identical copies of antibodies that have been made in laboratories.

TRIPLE ONLY

- Pregnancy test kits** to identify the small levels of a hormone called hCG, which is present in the urine of pregnant women.
- Locate blood clots** as they bind to clots.
- Diagnose and then treat some cancers.** They can bind to the cancerous cells and help the person's immune system attack them.



Advantages: Monoclonal antibodies only bind to the specific cancer cells that need treatment. Healthy cells are not affected at all. In contrast conventional drug treatment is carried all around the body in the blood and can have a devastating effect on healthy cells as well as cancer cells.

Disadvantages: Monoclonal antibodies create more side effects, the most common being an allergic reaction to the drug. An allergic reaction can include these symptoms: chills, fever, an itchy rash, feeling sick, breathlessness, wheezing, headaches, flushes and faintness, changes in blood pressure.

Plant Diseases

Some plant diseases are caused by bacteria, fungi and also by vectors e.g. aphids.

TRIPLE ONLY

Name of disease	Type of pathogen	How it is spread	Symptoms	Prevention/Treatment
Tobacco Mosaic Virus	Virus	Direct contact with diseased plant material and by insects	Mosaic pattern damaging cells preventing photosynthesis	Field hygiene and pest control
Rose Black Spot	Fungi	Spores carried by wind and spread by rain from leaf to leaf	Purple spots on leaves, dead leaves, poor flowers	Remove and burn affected leaves, fungicides

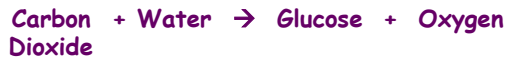
Aphids - penetrate phloem and take products of photosynthesis. Also act as vectors transferring pathogens to the plants.

- Mineral Deficiencies** - Soil lacking nitrates = less protein so less growth.
- Soil lacking magnesium = chlorosis = less chlorophyll so less photosynthesis - yellow leaves

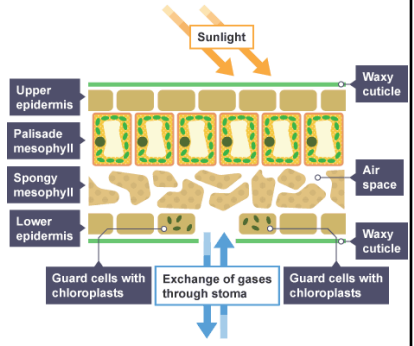
Detecting Diseases

- Fast detection - discoloration, visible pests, stunted growth.
- Compare growth with normal plants or data online
- DNA analysis to identify pathogens (monoclonal antibodies)

Photosynthesis



- Gases diffuse through stomata
- Palisade cells have lots of chloroplasts
- Xylem brings water
- Spongy to allow gases to move through leaf.



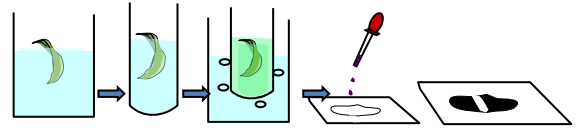
Uses of glucose:

- Respiration - energy - growth
- Starch - storage
- Protein - glucose + nutrients from the soil
- Fats - stored in seeds
- Cellulose - cell walls

Starch Testing a Variegated Leaf

We test for the presence of **starch** in leaves in order to determine that photosynthesis has occurred. Glucose is rapidly converted into starch for **storage** in the chloroplast and cytoplasm.

De-starching is the process by which the starch reserves in a plant are depleted by depriving the plant of either light or carbon dioxide. We need to **remove all traces of starch** in leaves so that we can provide evidence that photosynthesis takes place during the experiment.

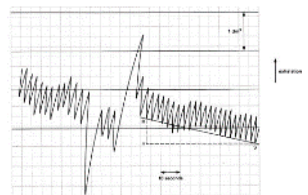


- Boiling ethanol breaks down cellulose and removes chlorophyll.
- Iodine solution turns blue/black where starch is present i.e. where photosynthesis has taken place.

Measuring HR and BR

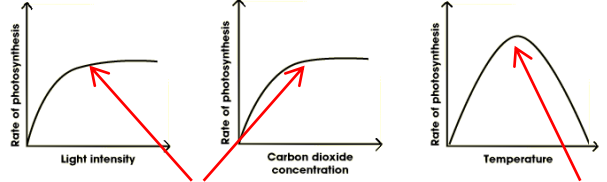
HR - heart rate monitor
BR - spirometer

Tidal volume - normal volume breathed in and out.



Limiting factors

- Light
- Carbon dioxide concentration
- Temperature



Something else limits the rate (temperature, CO₂, amount of chlorophyll)

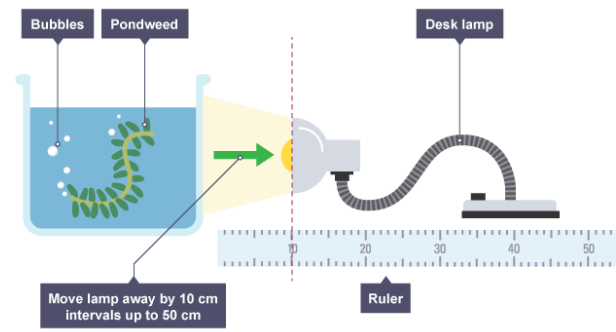
Controlled by **enzymes** that are too slow when cold and **denature** when too hot

Greenhouses

- + Control the conditions (heat, CO₂, water, light, pests, weeds)
- + Grow plants all year round
- + Grow plants not native to certain countries
- + Increased crop yields
- Costs to maintain conditions
- Conditions need to be monitored

Hydroponics: Plants grown in mineral solution rather than water - control nutrients, no fungal infections from soil.

REQUIRED PRACTICAL: Photosynthesis

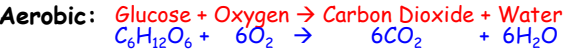


In the experiment above:

1. Pondweed is in water with sodium carbonate solution (to provide CO₂ for photosynthesis)
2. Move light bulb different distances and count the bubbles of oxygen that are produced per minute.

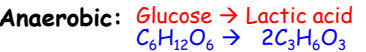
The closer the light, the more oxygen is made because the rate of photosynthesis increases.

Respiration - energy RELEASE not made (exothermic)



- Occurs in mitochondria
- Needs oxygen
- Releases a lot of energy (ATP)

Some microorganisms (e.g. yeast) respire anaerobically producing ethanol and CO₂. This is called **fermentation** and is used to make bread and alcohol.



- Occurs in mitochondria
- No oxygen
- Leads to **oxygen debt** (which is why you breathe heavily after sport to pay it back)
- Very little energy is released.

Exercise effect on HR and BR

Heart Rate increases - more oxygen to muscle
- more glucose to muscle
- more CO₂ and water to lungs

Breathing Rate increases - more oxygen into blood
- more CO₂ and water out of the blood

Stored glycogen in muscle turned into glucose.

Metabolic Rate: The speed of chemical reactions in the body.

- Older = slower
- Female = slower
- High fat to muscle ratio = slower
- Could be inherited

Metabolic reactions:

- Respiration - catabolic (big → smaller molecules)
- Photosynthesis - anabolic (small → bigger molecules)
- Break down of proteins to urea in **liver** - catabolic
- Enzymes breaking down food - catabolic
- Combining glucose with nitrate ions to form amino acids and then protein - anabolic

Anabolic reactions require **energy** from cellular respiration.

Carbohydrates	Energy
Protein	Cell repair, growth and replacement
Fat	Energy and insulation
Fibre	Digestion
Minerals	Calcium - Bones, Iron - Blood
Vitamins	Immune system

Energy CANNOT be created or destroyed

Energy types

- * Gravitational Potential - Increased with height
- * Kinetic Energy - Increased with speed
- * Elastic Energy - Increased when stretched or squashed
- * Thermal Energy - Gained when heated, often lost (wasted) to the surroundings

Energy Transfers

- * Mechanically - When a force is applied
- * Heating - When an object is heated
- * Electrically - When an object is powered by electricity

A ball rolling down a hill: Gravitational Potential Energy is turned mechanically into kinetic energy

Gravitational Energy $E_p = M \times G \times h$
(J) (Kg) (N/Kg) (m)

The higher an object or the more mass it has the more gravitational energy it has.

Kinetic Energy $E_k = \frac{1}{2} \times \text{mass} \times \text{Velocity}^2$
(J) (Kg) (m/s)

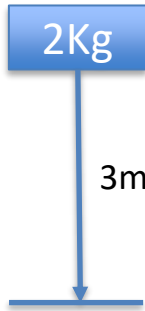
The faster and heavier an object the more kinetic energy it has.

Calculating Velocity

$$E_p = M \times G \times H$$

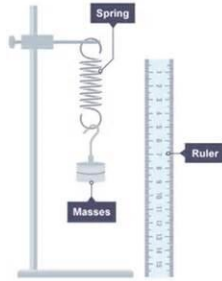
$$= 2 \times 10 \times 3 = 60J$$

$$E_p = E_k \Rightarrow E_k = 60J$$

$$V = \sqrt{\frac{E_k}{\frac{1}{2} \times m}} = \sqrt{\frac{60}{\frac{1}{2} \times 2}} = 7.7m/s$$


A blue box labeled '2Kg' has a blue arrow pointing downwards to a horizontal line, with '3m' written next to the arrow.

Springs



When you add a force (weight) to a spring it extends.

Extension = Stretched length - original length

The energy stored in a spring can be calculate:

$$E_e = \frac{1}{2} \times \text{spring constant} \times \text{extension}^2$$

(J) (N/m) (m)

Power is a measure of how quickly energy is used. The shorter the time the more powerful it is.

$$\text{Power} = \frac{\text{Energy (J)}}{\text{Time (s)}}$$

Specific heat capacity (SHC)

The amount of energy needed to heat a 1Kg material by 1°C.

Heat Energy = Mass x SHC x Change in Temp
(J) (Kg) (J/Kg°C) (°C)

$$C = \frac{E}{m \times \Delta\theta} \quad m = \frac{E}{c \times \Delta\theta} \quad \Delta\theta = \frac{E}{m \times c}$$

This experiment only gives an estimate for the values calculated as energy is lost to the surroundings.

Renewable Sources of electricity
ALL turn a turbine to turn a generator.

- * Wind (Wind turns a turbine)
- * Hydroelectric (water turns a turbine)
- * Waves/Tide (The sea turns a turbine)
- * Geothermal (Heat from volcanoes used to boil water - make steam - turn a turbine)
- * Biomass (Living material burnt to boil water)

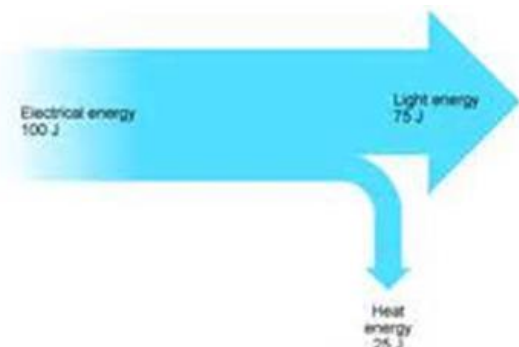
Advantages of ALL

- * Don't give out CO₂ which causes global warming
- * Renewable (will NOT run out)

Disadvantages

They are **all** more expensive than fossil fuels

- * Wind - NOT always windy
- * Hydroelectric - Can damage habitats
- * Waves/Tides - Can damage habitats
- * Geothermal - Only a few places on Earth
- * Biomass - Carbon neutral (gives out CO₂ when burnt)



A large blue arrow pointing right is labeled 'Electrical energy 100 J'. A smaller blue arrow branches off downwards from the main arrow, labeled 'Heat energy 25 J'. The remaining part of the main arrow is labeled 'Light energy 75 J'.

Heat Transfer

1. The higher the thermal conductivity of a material the higher the rate of heat transfer by conduction.

$$\text{Efficiency} = \frac{\text{Useful Energy Out}}{\text{Total Energy In}} \times 100$$

$$\text{Efficiency} = \frac{\text{Useful Power Out}}{\text{Total Power In}} \times 100$$

Answers for efficiency must be written as a percentage or a decimal E.g 80% or 0.8

Static Electricity (Triple only)
 Examples: Hair standing up after taking a jumper off, rubbing a balloon on your hair.

Static electricity is a build up of **negative charges (electrons)** which are then released. An object is charged if electrons are added or removed.

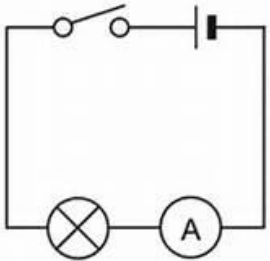
Circuit Symbols

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

Current
 Current is the flow of charge (electrons) around a circuit.

- * It is measured in **Amps (A)**
- * It is measured using an **Ammeter**
- * In a **series** circuit the current is the **same** everywhere.
- * In a **parallel** circuit the current **splits** at each branch. The current through the cell is **equal** to the current through all the branches added together.


The ammeter must be placed in the circuit to take a reading.



Potential Difference (Voltage)
 Potential Difference is the amount of **energy** transferred to a component by each unit of **charge**.

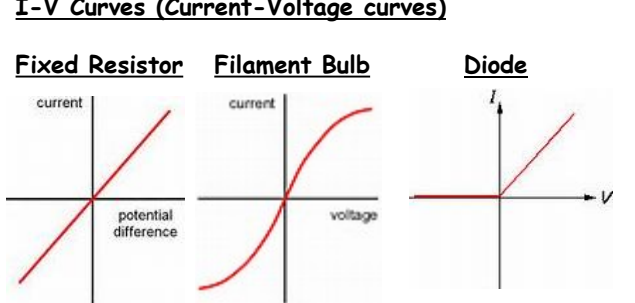
- * It is measured in **Volts (V)**
- * It is measured using a **Voltmeter**
- * In a **series** circuit the PD of the cell is shared between all the components. The component with the highest **resistance** receives the most PD.
- * In a **parallel** circuit each branch receives the **same** PD as the cell.

The voltmeter must be placed in parallel with a component in order to measure the PD across it.



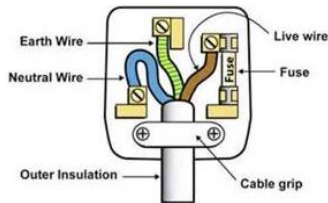
Resistance
 Resistance is the measure of how hard it is for current to pass through a component.

- * It is measured in Ohms (Ω)
- * It is calculated using $R=V/I$
- * If you add resistors in **series** the resistance **increases**, if you add resistance in **parallel** the resistance **decreases**.



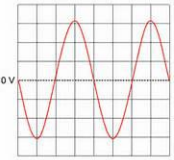
Electrical Safety

The plug and wires are coated in plastic which doesn't conduct electricity.



AC & DC

* **Alternating Current (AC)** the current changes direction. UK mains supply is **230V** and **50Hz**.



* **Direct Current (DC)** flows in the same direction. DC comes from a **battery** or from a **AC supply** which has passed through a **diode**.

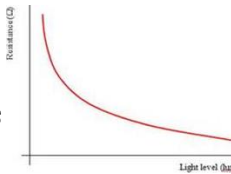
* The trace works like a graph, with time on the x-axis and voltage on the y-axis.

* **Fixed Resistor** - Straight line shows it is a constant resistance. The steeper the line the lower the resistance.

* **Filament Bulb** - Resistance **increases** as the bulb heats up and **ions vibrate** more.

* **Diode** - Only allows current to flow in **one direction**.

Thermistors and LDR's
 They have the same shaped graph



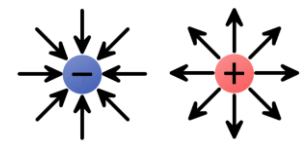
* **LDR's** - Street lighting, cameras

* **Thermistors** - Ovens, fridges, central heating

Safety Devices

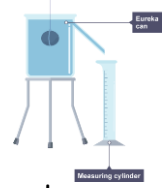
* **Earth Wire** - Only needed for devices with a **metal casing**. Provides a safe route for the current if the live wire touches the casing.

Electrical fields (Triple only)
 Field lines travel away from the positive and towards the negative.



The closer you are to the charge, the stronger the electrical field

Density:



Density = $\frac{\text{Mass (kg)}}{\text{Volume (m}^3\text{)}}$

Calculating the density of an irregular shape, can be done using a Eureka can and measuring the volume of water displaced.

Internal Energy




The energy in a substance is stored in its particles, this is called internal energy.

Internal energy = kinetic energy + potential energy.

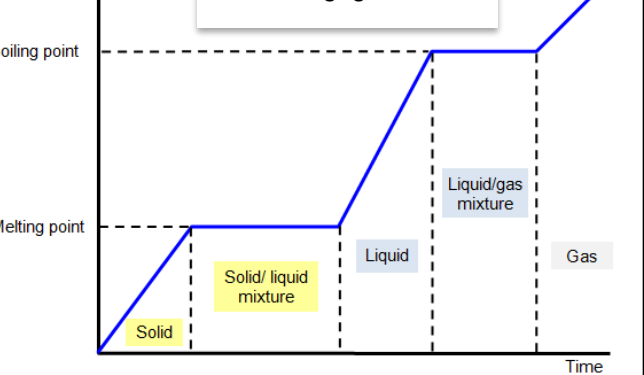
Temperature: This is linked to the kinetic energy of the gas.

Changing State

When a material changes state (melting or boiling) its internal energy increases, but its temperature does not. This means that its kinetic energy remains constant until it has changed state.

State of matter	Diagram of structure	Movement of particles	Can it be compressed?	Density
Solid		Vibrate around a fixed position. They don't have enough energy to move apart	No, the particles have no space between them to move into.	High, there are lots of particles in a unit of area.
Liquid		They have enough energy to move from place to place but are still attracted to each other	No, the particles have no space between them to move into.	Quite high, there are lots of particles in a unit of area.
Gas		They have so much energy that they are not attracted to each other. Collisions with containers cause pressure.	Yes, the particles have lots of space between them to move into.	Low, there are few particles in a unit of area.

The higher its temperature the higher its kinetic energy. If the temperature remains constant so does the kinetic energy of the particles.



Specific Latent Heat

The specific latent heat of a substance is the energy needed to change 1kg of the substance with no change in state.

Energy = Mass x Specific Latent Heat

(J) (kg) (J/kg)

$E = m \times L$

Specific heat of fusion: when turning from a solid into a liquid

Specific heat of vapourisation: when turning from a liquid into gas

Pressure and volume

Pressure x Volume = constant

(Pa) (m³)

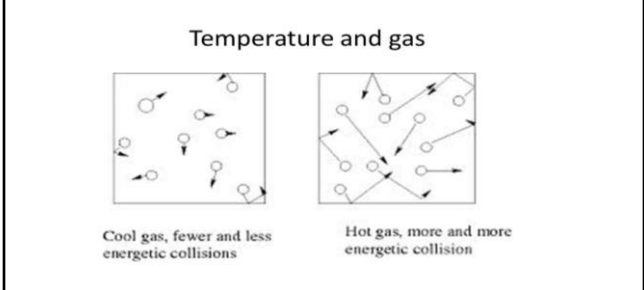
so $P_1 \times V_1 = P_2 \times V_2$

Increasing the volume of a gas (making the container bigger) whilst keeping the temperature constant will decrease the pressure of the gas.



Temperature and pressure

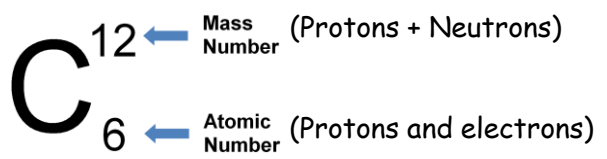
Increasing the temperature of a gas increases the kinetic energy of the gas particles, this increases the number of collisions with the surface, this increases the pressure acting on the sides of the container.



Particles move in different directions with a range of speeds.

As the particles hit the side of the container they create a net force which acts at right angles to the wall of the container

Atoms



Number of Neutrons =
 Mass Number - Atomic number (12 - 6 = 6)

Isotopes: An isotope is an atom with the same number of protons but different number of neutrons.

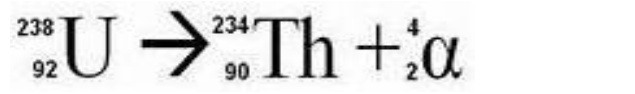
Ions: An atom that has gained (positive ion) or lost (negative ion) electrons.

Some atoms are radioactive, they give out radiation from the nucleus. This is measured in Becquerels (Bq)

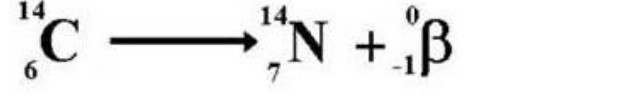
Alpha, Beta & Gamma

Name	What it is	What is its charge	What is its mass	Ionising Power	Absorbed by
Alpha	Helium nucleus	+2	+4	High	Paper/air
Beta	Electron	-1	Tiny	Medium	Thin steel
Gamma	EM Wave	0	0	Low	Thick Lead

Alpha Decay (Atomic number -2, mass number -4)

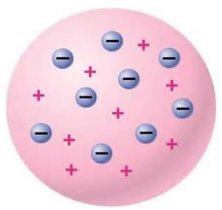


Beta Decay (Atomic number +1, mass number 0)



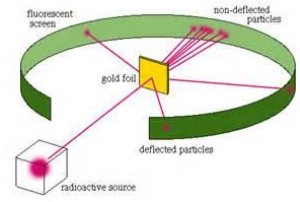
Atomic Structure

1. In 1901 JJ Thompson suggested the '**plumb pudding**' model for the atom. With negative particles stuck in the middle of positive charge



2. In 1909 Rutherford changed the accepted model using his alpha scattering experiment.

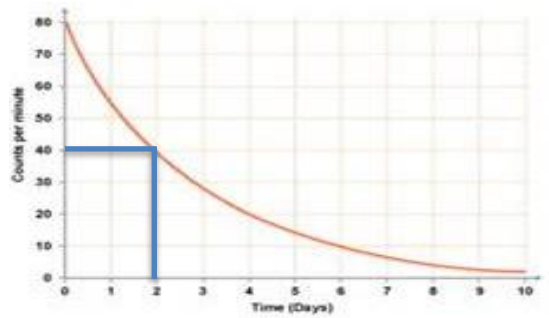
3a. He fired alpha particles at a sheet of gold foil.
 3b. He expected them all to pass straight through
 3c. Rarely one would bounce back



3d. This proved that the center of the atom was very small, held most of the mass and had a positive charge.
 3e. The current model of the atom that we use today was born.

Half-life

The half-life of a radioactive source is **the time taken for half the material to decay.**



The half-life of the material above is 2 days.
 The starting count was 80 half of it = 40
 The time to get to 40 was 2 days.

In this example it would take: 2 days to get to 50%, 4 days to 25%, 6 days to get to 12.5%

Nuclear fission (Triple Only)

1. Large radioactive atoms split in half (fission) because they are unstable.
2. When this happens a huge amount of energy is released.
3. Neutrons are released which hit and split more atoms, this is called a chain reaction.
4. This is the source of a nuclear power station or nuclear bomb's energy
5. Unfortunately a lot of radioactive waste is produced which stays radioactive for 1000's of years.

Nuclear Fusion (Triple Only)

1. Small light nuclei are forced together under huge heat and pressure - such as in the core of the sun.
2. The nuclei repel each other as they are both positively charged so it is hard to get them to fuse.
3. If the temperatures and pressures are large enough the nuclei will fuse to create a larger nuclei
4. A huge amount of energy is released
5. Fusion doesn't produce any radioactive waste
6. Scientists are yet to develop the technology to allow fusion to be used to produce electricity.

Radioactivity (Triple Only)

Radioactive atoms decay and release ionizing particles (alpha, beta and gamma)

There is a constant level of naturally occurring radiation all around us, this is known as '**background radiation**'. This is random when measured.

Background radiation comes from rocks, the air, our food and the sun. Very little comes from man-made devices such as powerstations.

Radiation is ionizing, this means it can damage your DNA and in large doses can cause cancer. It can also be used to kill cancerous cells.

Professionals working with radioactive sources protect themselves using lead glass.

Contamination is when the source is inside you
Exposure is when the source is outside you