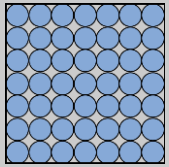
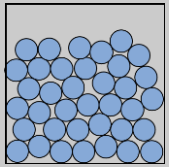
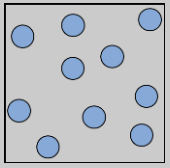
Year 7

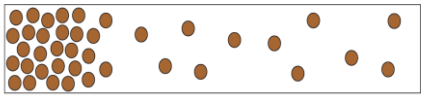
Particles, substances and mixtures

The particle model of matter

Diagram			
Arrangement	ordered and all touching	random and all touching	random and not touching
Movement	vibrate in fixed positions	move and slide over each other	move around quickly in random directions
Attraction between particles	strong	weak	very weak

Diffusion

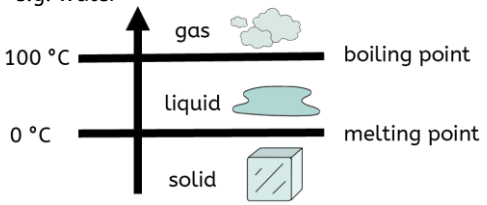
Diffusion is the random movement of particles from an area of high concentration to an area of low concentration. Particles of substances in the liquid and gas states can diffuse because their particles can move freely.



Melting and boiling points

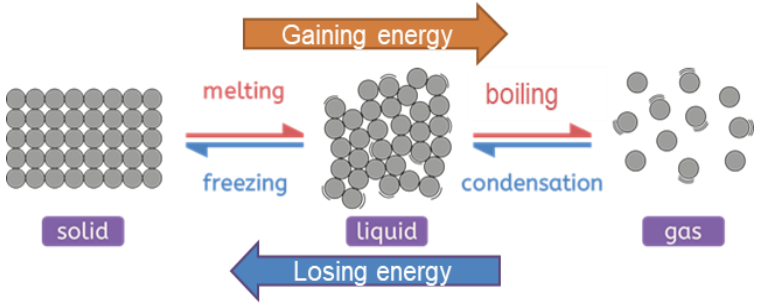
melting point: the temperature at which a substance changes from a solid to a liquid

boiling point: the temperature at which a substance changes from a liquid to a gas, e.g. water



Change of state

A change of state is a physical change because no new substances are made, and the change is reversible. Only the amount of energy the particles have changes, which affects the arrangement and movement of the particles. Temperature stays constant during a change of state.



Explaining the properties of solids

Property	Reason
Fixed shape and cannot flow	Strong forces of attraction between the particles keep them in fixed positions.
Cannot be compressed (squashed)	Particles are all touching and have no space to move into.

Explaining the properties of liquids

Property	Reason
Takes shape of container and can flow	Weak forces of attraction between the particles, so they can move around each other.
Cannot be compressed (squashed)	Particles are all touching and have no space to move into.

Explaining the properties of gases

Property	Reason
Takes shape of container and can flow	Very weak forces of attraction between the particles, allowing them to move and spread out.
Can be compressed (squashed)	Particles are not touching and have space to move into.

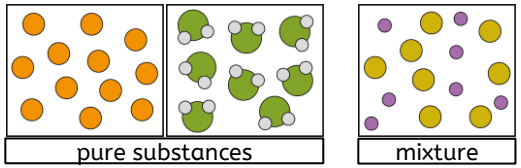
Gas pressure

When gas particles collide with the walls of their container, this creates a constant force on the walls of the container.
This causes pressure. The faster the particles move, the higher the gas pressure. The gas pressure inside containers can be increased by adding more particles or increasing the temperature. The more frequent the collisions, the higher the gas pressure.

Particles, substances and mixtures

Pure substances and mixtures

A **pure substance** is one that contains only one substance, e.g. pure iron contains only iron particles. A **mixture** contains two or more substances that are not joined together and can be physically separated.

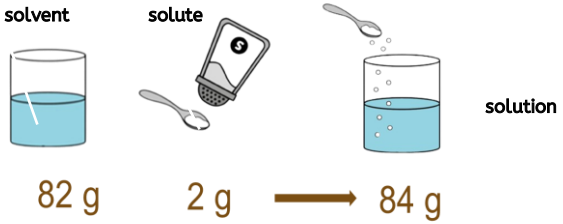


Solutions and solubility

A **solute** can be dissolved in a **solvent**. The mixture created is called a **solution**. When no more solute can dissolve in the solution, it is a **saturated** solution. If a solid dissolves in a solvent, it is **soluble**. If it does not dissolve in a solvent, it is **insoluble**. **Solubility** is a measure of how much solute can dissolve in a solvent. The higher the temperature of the solvent, the greater the mass of the solute that can be dissolved.

Solubility is different for different solutes. The solubility of a solute will change depending on the solvent used.

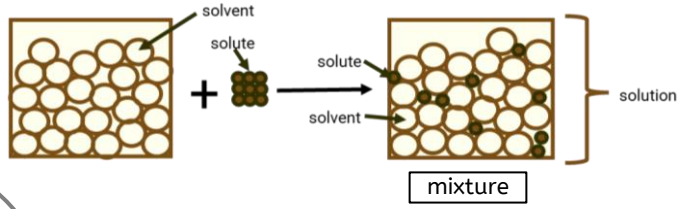
During **dissolving**, the solute particles are separated and fit between the solvent particles to make a solution.



Conservation of mass

When a solution is formed, **the mass of the solvent + the mass of the solute = the mass of the solution.**

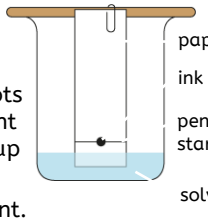
Mass remains constant because the number of particles is the same before dissolving as it is after.

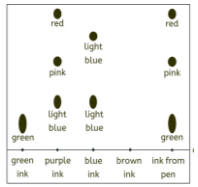


Separating mixtures

We can separate mixtures in different ways depending on their properties:

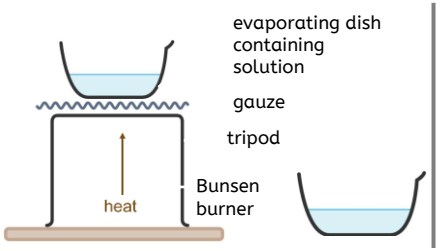
Chromatography is a separation technique that separates mixtures containing more than one solute based on their solubilities in a solvent. It works because some of the coloured substances dissolve better than others, so they travel further up the paper. A pencil line is drawn, and spots of ink or dye are placed on it. There is a container of solvent (e.g. water or ethanol). As the solvent continues to travel up the paper, the different coloured substances spread apart.

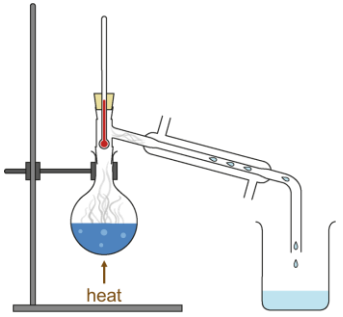




A **chromatogram**, the results of chromatography experiment.

Evaporation and **crystallisation** can be used to separate a soluble solid from a solution. For example, copper sulphate is soluble in water – its crystals dissolve in water to form a copper sulphate solution. During evaporation, the water evaporates away, leaving solid copper sulphate crystals behind. Crystallisation produces larger solid crystals.

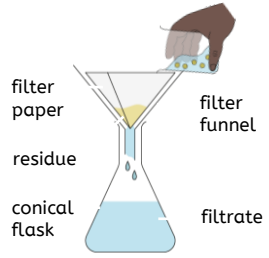




Distillation is a separation technique used to separate a mixture of liquids. The basis for separation in distillation is the difference in the boiling points of the components. For example, water can be separated from an ink and water solution because water has a much lower boiling point than ink. When the solution is heated, water evaporates. It is then cooled and condensed into a separate container. The ink does not evaporate, so it stays behind.

Filtration can be used to separate a liquid from an insoluble solid. The filter paper used in filtration is 'selectively permeable', meaning that it has holes in it that allow the movement of only some substances through whilst preventing the movement of others. The insoluble solid is unable to pass through the small holes of the filter paper. When a mixture of sand and water is filtered:

- The sand stays behind in the filter paper (it becomes the **residue**).
- The water passes through the filter paper (it becomes the **filtrate**).



Particles, substances and mixtures

Glossary

- **aqueous solution:** (noun) a solution in which water is the solvent, e.g. sugar and water solution
- **boiling point:** (noun phrase) the temperature at which a substance changes from a liquid to a gas
- **boiling:** (verb) when matter changes from a liquid state to a gas state, throughout the liquid
- **chromatogram:** (noun) the pattern that forms on chromatography paper after chromatography
- **chromatography:** (noun) a method of separating a mixture containing more than one solute
- **collide:** (verb) to hit or come into contact with something forcefully
- **compress:** (verb) to squash into a smaller space
- **concentration:** (noun) the number of particles present in a certain space
- **condense:** (verb) when gases cool enough to turn back into a liquid
- **condensing:** (verb) when matter changes from a gas state to a liquid state
- **conservation of mass:** (noun phrase) the scientific principle that states mass cannot be created or destroyed in a physical change or chemical reaction
- **crystallisation:** (noun) a method of separating soluble particles from a solution using evaporation
- **diffusion:** (noun) the random spreading out of particles from an area of high concentration to an area of low concentration
- **dissolving:** (verb) the process of solute particles separating and being held between solvent particles to form a solution
- **distillation:** (noun) a method of separation involving boiling followed by condensing
- **evaporate:** (verb) when particles gain enough energy to change from a liquid state to a gas state, at the surface of the liquid
- **filtering:** (verb) a method of separating insoluble particles from a liquid
- **forces of attraction:** (noun phrase) the ability to hold between the particles
- **freezing:** (verb) when matter changes from a liquid state to a solid state
- **gas pressure:** (noun phrase) the force exerted by gas particles when they collide with the walls of a container

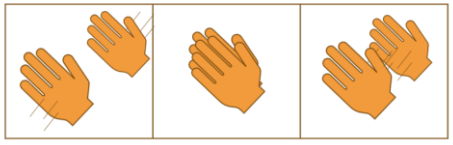
- **insoluble:** (adjective) when a substance cannot dissolve in a solvent
- **mass:** (noun) a measure of how much matter something contains; it is measured in grams or kilograms
- **melting point:** (noun phrase) the temperature at which a substance changes from a solid to a liquid
- **melting:** (verb) when matter changes from a solid state to a liquid state
- **mixture:** (noun) a material that contains two or more different substances that are not joined together and can be separated
- **mobile phase:** (noun phrase) the term given to the solvent because it moves up the chromatography paper
- **molten:** (adjective) the scientific term for a substance that normally exists as a solid at room temperature but has changed state to become a liquid because of heating, e.g. molten iron
- **observation:** (noun) the act of noticing facts about things happening or existing in the world
- **overcome:** (verb) to win against or defeat
- **physical:** (adjective) a property that can be measured without making a permanent change to the substance (e.g. melting point, hardness)
- **properties:** (noun) characteristics that describe what something can do or how it behaves
- **pure substance:** (noun phrase) a material that is made up of only one type of substance; it has only one type of particle
- **purify:** (verb) the act of making a substance pure
- **saturated:** (adjective) when no more solute will dissolve in a solution
- **selectively permeable:** (adjective phrase) something that has holes in it to allow the movement of only some substances through whilst preventing the movement of others
- **solubility:** (noun) a measure of how much solute can dissolve in a solvent
- **soluble:** (adjective) when a substance can dissolve in a solvent
- **solute:** (noun) a substance that has dissolved into a solvent
- **solution:** (noun) when a solvent and solute combine
- **solvent:** (noun) the liquid into which a solute dissolves.
- **stationary phase:** (noun phrase) the term given to the chromatography paper because it does not move
- **temperature:** (noun) a measure of how hot or cold something is; it can be measured using a thermometer; its unit is degrees Celsius, °C
- **volume:** (noun) the amount of space occupied by a substance; it is usually measured in cubic centimetres (cm^3) or millilitres (ml)

7.02: Fundamentals in physics

Forces and their interactions

Interaction:

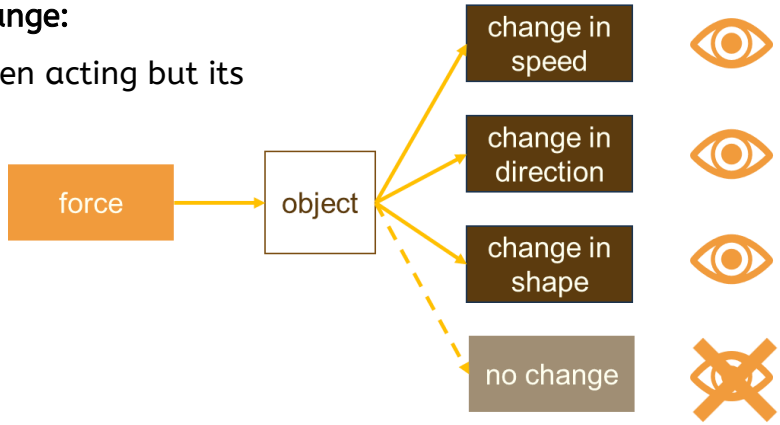
When two objects influence each other and cause a pair of forces to arise.



one force on each object — equal in size — opposite in direction

Forces can cause change:

A force cannot be seen acting but its effects often can.



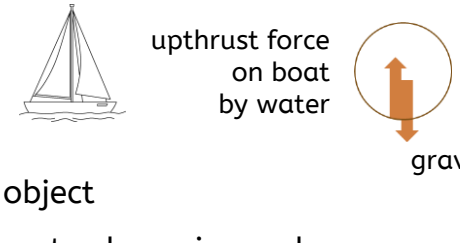
Forces can be contact or non-contact:

Contact forces arise between two touching objects.

Non-contact forces can act between two objects at a distance.

contact	thrust, friction, air resistance, water resistance, normal contact, upthrust
non-contact	gravity force, magnetic force

Free-body force diagrams



One object

Arrows to show size and direction of forces

Labelled forces:

- What kind of force is acting?
- What is the force acting on?
- What exerts the force?

Deforming forces

Two pushing forces cause compression: the object contracts.

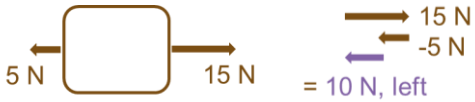
Two pulling forces cause tension: the object extends.

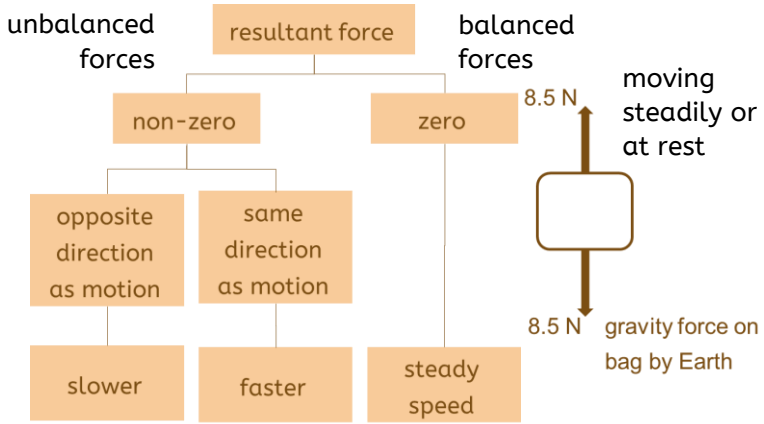
.02: Fundamentals in physics

Combining forces

More than one force acting:

- Their effects are combined
- As if a single force is acting: the resultant force

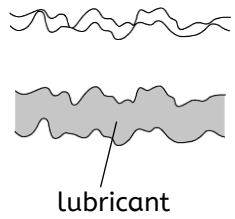




Friction force

- **What?** One of three frictional forces. They act to resist motion.
- **Where?** Acts between solid surfaces, along the surfaces.
- **When?** An object is sliding or trying to. When starting to slide, the applied force must be larger than the limiting friction: so, an unbalanced force acts.
- **How?** Opposite direction to the motion, or the applied force.
- **Why?** Surfaces are uneven, so the 'catching' between them must be overcome.

	Useful	Nuisance
Walking	✓	
Machines		✓
Driving	✓	
Wear and tear		✓



catching;

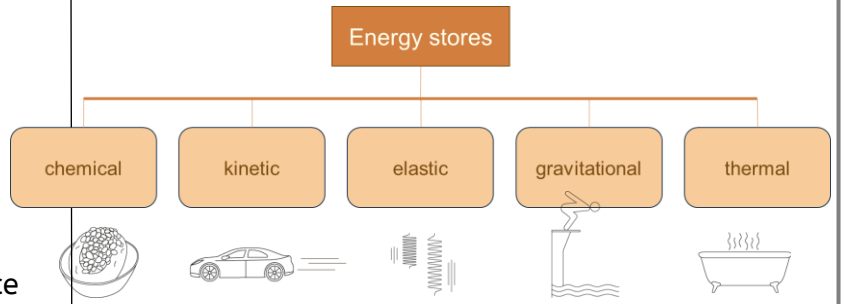
surfaces parted: no catching

Energy stores and pathways

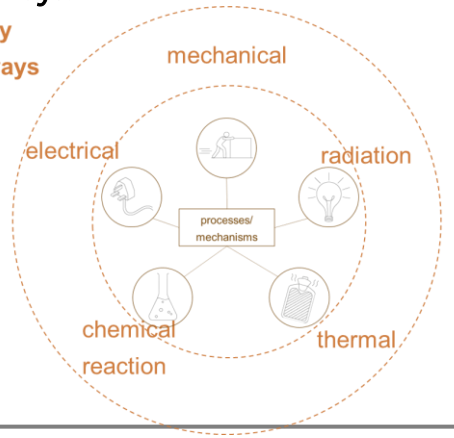
What energy does:

- Flows between objects in a system
- Stays the same when it transfers
- Cannot be used up

Energy is transferred between stores:



Energy is transferred because of processes, by pathways:

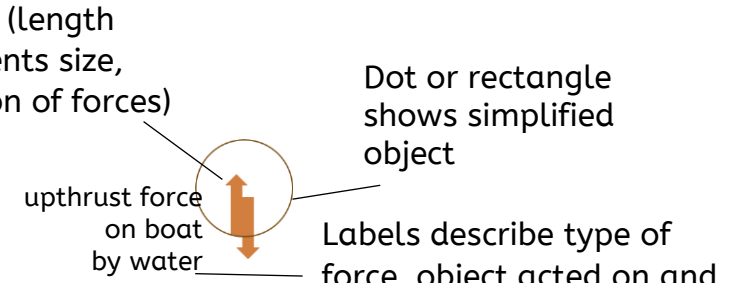


7.02: Fundamentals in physics

Modelling forces

Forces are modelled because:

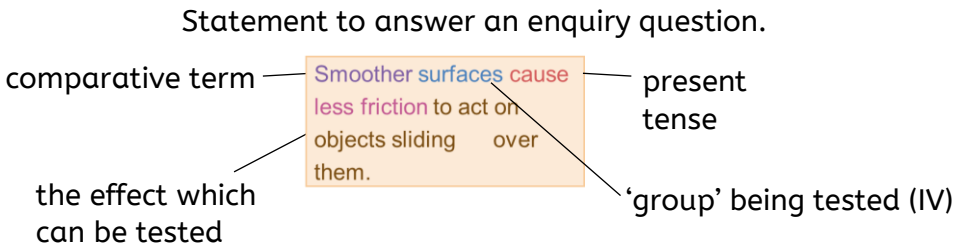
- forces cannot be seen acting
- there are many forces acting at a time
- their size and direction have important effects on situations, so need to be shown.



Investigating forces

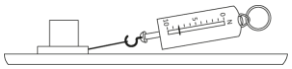
Scientific methods:

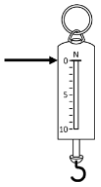
- With or without hypothesis
- Manipulating variables or not



Planning to collect high-quality data:

- Measuring with skill
- Preparing the data table
- Repeatable data





Check force-meter is on zero with no force.

headings describe variable

IV

Surface	Force to start sliding (N)		
	1	2	3
Glass	1.4	1.5	1.7
Metal	1.5	1.6	1.7
Polished wood	2.0	2.3	2.2
Plastic	2.9	3.0	2.9
Paper	4.5	3.8	4.0

DV in columns

repeated

Peer review: ★★★

Peers (people of a similar level of knowledge) test the results for quality.

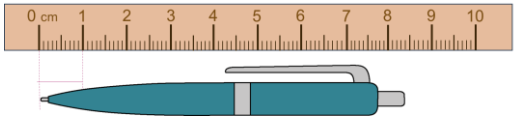
Repeatability:
Same group, same results

Reproducibility:
Different group, same results

Observing by measurement

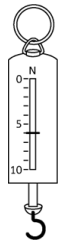
Using a scale

- set of lines at equal increments
- Labelled with numbers and units



Measuring instruments

- Include rulers, balances, clocks and thermometers.
- Force is measured using a force-meter.



Quantities: and their units

Base quantities: length (m), mass (kg), time (s) and temperature (K).

Derived quantities include force (N).

Fundamentals in physics

Glossary

- **air resistance:** (noun phrase) a contact force arising from an interaction between air and a moving object
- **analogy:** (noun) a similarity between two things that can be used as a comparison
- **balanced forces**: (noun phrase) when forces acting on an object have equal size and act in opposite directions
- **chemical reaction pathway:** (noun phrase) the energy pathway that transfers energy during a chemical reaction
- **chemical store:** (noun phrase) the energy store an object has if it possesses chemicals that can react
- **compression:** (noun) the process of forces pushing towards each other on an object
- **conclusion:** (noun) a summary and explanation of what has been found during an investigation
- **conservation of energy:** (noun phrase) a scientific law stating that energy cannot be created or destroyed
- **contact force:** (noun phrase) force that is caused to act on an object because it is touching a surface
- **contract:** (verb) to make smaller or shorter
- **control measure:** (noun phrase) a safety precaution that is put in place to reduce the likelihood of harm
- **deformation:** (noun) a change in shape or size as a result of applied forces
- **dissipate:** (verb) scatter or break up
- **elastic store:** (noun phrase) the energy store that stretched or squashed objects have
- **electrical pathway:** (noun phrase) the energy pathway that transfers energy when an electrical current flows
- **end-point analysis:** (noun phrase) a comparison of the amount of energy in energy stores at the start of an event and the end
- **energy diagram:** (noun phrase) diagram to show energy transfers between objects during an event (bar, box and arrow, Sankey)
- **energy store:** (noun phrase) a representation of where energy is ‘kept’ in an object
- **energy pathway:** (noun phrase) a description of the path by which energy is transferred
- **energy transfer:** (noun phrase) the relocation of energy from one place to another
- **explanation:** (noun) a statement that gives reasons for an observation to have occurred

- **extend:** (verb) to make longer or bigger
- **force:** (noun) an action that pushes or pulls on an object
- **force arrow:** (noun phrase) an arrow drawn to represent the force acting on an object, whose length and direction equate to that of the force
- **force-meter:** (noun) device used to measure force
- **free-body force diagram**: (noun phrase) drawing to show all forces acting on an object
- **friction force:** (noun phrase) force acting at points of contact between an object and a surface which resists the sliding motion
- **gravitational store:** (noun phrase) the energy store possessed by an object that is high up
- **gravity force:** (noun phrase) a non-contact force arising from an interaction between two objects
- **hazard:** (noun) something that is potentially harmful
- **heating pathway:** (noun phrase) the energy pathway that transfers energy when there is a temperature difference between places
- **hypothesis:** (noun) a statement about a research question, that suggests the result of the investigation
- **interaction:** (noun) when tow objects affect each other at the same time
- **interaction pair:** (noun phrase) the two forces that arise due to an interaction
- **kinetic store:** (noun phrase) the energy store that moving objects have
- **lift force:** (noun phrase) a contact force arising from an interaction between air moving and a curved object
- **limiting friction:** (noun phrase) the maximum friction that can occur between a surface and an object before it starts to slide
- **lubricant:** (noun) substance that helps to reduce friction forces acting between an object and a surface
- **magnetic force:** (noun phrase) a non-contact force arising from an interaction between magnets or a magnet and a magnetic material
- **mass:** (noun) a measure of how much matter something contains; it is measured in grams or kilograms
- **measurement result:** (noun phrase) a value attributed to the quantity being measured, reported at the end of the measurement process
- **mechanical pathway:** (noun phrase) the energy pathway that transfers energy when a force is exerted over a distance
- **newton:** (noun) name of the unit for the quantity 'force'
- **non-contact force:** (noun phrase) force that can act at a distance between two objects
- **normal contact force:** (noun phrase) force arising from an interaction between two objects in contact and acting perpendicular to the surface
- **observation:** (noun) the act of noticing facts about things happening or existing in the world

- **opposing forces:** (noun phrase) forces that act in opposite directions
- **peer review:** (noun phrase) process where scientific research is checked for quality so that it can be trusted
- **quantity**: (noun) any property that can be given a size by counting or measuring
- **radiation pathway:** (noun phrase) for example, the energy pathway that transfers energy by lighting up an area
- **repeatability**: (noun) a measure of the closeness of experimental results by the same person using the same method
- **reproducibility:** (noun) a measure of the closeness of experimental results by different people or using different methods
- **resultant force:** (noun phrase) the single force that could replace all the forces acting on an object and have the same effect
- **risk:** (noun) likelihood anyone will come to harm if a planned action is carried out, and to what extent
- **stand, clamp and boss:** (noun phrase) apparatus used for support and stability when holding equipment at a desired height and position
- **scientific method:** (noun phrase) the application of an objective approach to collect high-quality data and use the data to explain phenomena
- **scientific model:** (noun phrase) a representation of reality that can be used to explain observations
- **system:** (noun) an object or a group of objects
- **systematic:** (adjective) organised, leaving no gaps, logical
- **temperature:** (noun) a measure of how hot or cold something is; it can be measured using a thermometer; its units are degrees Celsius, °C
- **tension:** (noun) the process of forces pulling away from each other on an object
- **thermal store:** (noun phrase) the energy store that objects that are hot have
- **thrust force:** (noun phrase) a contact force arising from an interaction between two objects which are free to move apart
- **unbalanced forces**: (noun phrase) when one force acting on an object is greater in size than another force and acts in the opposite direction
- **unit:** (noun) standard used to compare measurements
- **upthrust:** (noun) a contact force arising from an interaction between an object and a fluid in which it is or could be immersed
- **value:** (noun) an expression of the size of a quantity; may be a number or a number and a unit
- **variable:** (noun) a quantity or characteristic that can change
- **water resistance:** (noun phrase) a contact force arising from an interaction between a fluid and an object moving through it
- **weight:** (noun) the gravity force acting on an object exerted by a large body

Cells and organisation

The seven common processes of living organisms

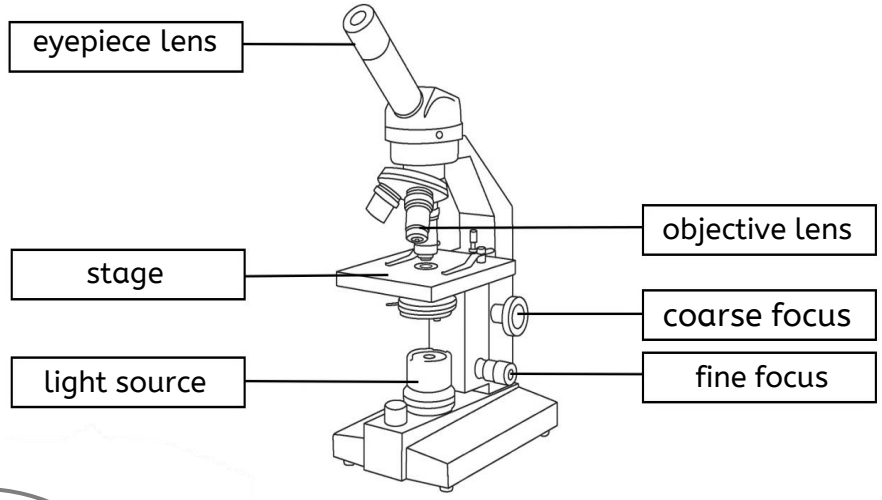
Process	Definition
movement	moving itself or its parts to change position or location
reproduction	producing offspring of the same kind
sensitivity	sensing and responding to changes in their surroundings
growth	increasing in size and repairing parts that are damaged
respiration	using oxygen and glucose (a sugar) to provide energy
excretion	removal of waste substances that are no longer needed
nutrition	using food or other nutrients like water to stay alive

Levels of organisation

cell → tissue → organ → organ system

cell	the smallest living building block of organisms
tissue	a group of similar cells that work together to perform a specific function
organ	a structure made up of different types of tissues that work together to carry out a specific function
organ system	a group of organs that work together to perform a common function

The parts of the microscope



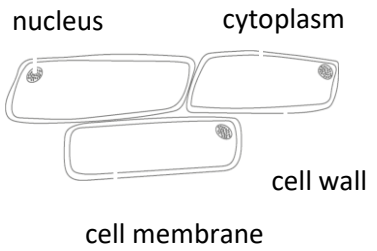
total magnification = eyepiece x objective

Using a microscope

1. Turn the **objective lens** to the **lowest magnification**.
2. Secure the slide on the **stage** using the clips.
3. Move the **stage** up to the **objective lens** by turning the **coarse focus**.
4. Look down the **eyepiece lens,** and move the stage away by turning the **coarse focus**.
5. To make the image sharper and clearer, turn the **fine focus.**
6. Rotate the **objective lens** to get a higher magnification.

Rules for scientific drawings of cells

Drawing of onion cells



10 x 40 = x400

- smooth continuous lines
- large, with the same proportions
- stippling
- a few cells
- title and label
- total magnification

Cells and organisation

Cell organelles and their functions

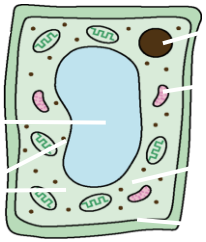
nucleus	contains the genome that controls the cell's activities
cytoplasm	where the chemical reactions of the cell take place
mitochondria	where energy is released in respiration
cell membrane	controls which substances enter or leave the cell
vacuole	stores a watery sap
cell wall	strengthen and support the cell
chloroplasts	where light is trapped for photosynthesis to happen

plant cell

cell wall

vacuole

cell wall



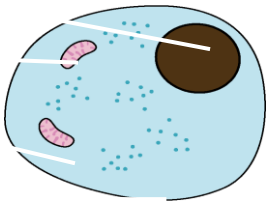
animal cell

nucleus

mitochondria

cytoplasm

cell membrane



Cells are three dimensional (3D).

The rate of diffusion

The rate of diffusion means how fast diffusion happens. Three factors that can affect the rate of diffusion are **temperature**, the **concertation** of particles and **surface area**.

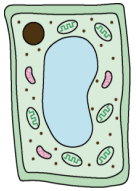
- The higher the temperature, the faster the rate of diffusion.
- The bigger the difference in the concentration of particles, the faster the rate of diffusion.
- The larger the surface area, the faster the rate of diffusion.

Needs of plants and animals for survival

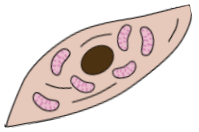
- Plants need, oxygen, water, light, carbon dioxide, minerals, a suitable temperature and space to grow.
- Animals, including humans, need water, oxygen, nutrients and the right temperature to survive.
- Plants and animals need these to keep all the cells that make them up alive and functioning properly.

Oxygen and **glucose** (a sugar) are needed for **respiration** to take place in cells, to provide energy to keep cells alive. These useful substances enter the cell by **diffusion.** Waste products of respiration are carbon dioxide and water. Waste products leave the cell by diffusion and need to be removed from cells to keep them alive.

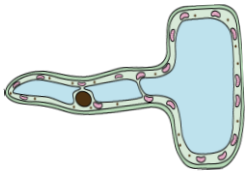
Specialised cells are adapted to carry out a specific function



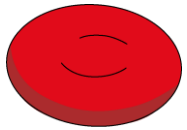
A **palisade cell** has **lots of chloroplasts** that absorb light for photosynthesis and a **column shape** to pack more in the leaf.



A **muscle cell** has **lots of mitochondria** to release energy for contraction.



A **root hair cell** has a **long cell membrane** that provides a large surface area to absorb more water and minerals.



A **red blood cell** has **no nucleus** for extra space to carry more oxygen.

Cells and organisation

Glossary

- **carbon dioxide:** (noun phrase) a gas present in the air, produced during respiration and essential for plant life
- **cell membrane:** (noun phrase) the part of the cell that controls which substances enter or leave the cell
- **cell wall:** (noun) made of fibres to strengthen and support the cell
- **cell:** (noun) the smallest living building block of organisms
- **chloroplasts:** (noun) the part of the cell where light is trapped for the plant to make food by photosynthesis
- **coarse focus:** (noun phrase) the larger focusing wheel on the microscope that moves the stage up and down to bring the object into general focus
- **concentration:** (noun) the number of particles present in a certain volume (space)
- **cytoplasm:** (noun) the part of the cell where the chemical reactions of the cell take place
- **diffusion:** (noun) the random spreading out of particles from an area of high concentration to an area of low concentration
- **excretion:** (noun) a process of living organisms – removal of waste substances that are no longer needed by the organism
- **eyepiece lens:** (noun) the lens at the top of the microscope that we look through for magnification
- **field of view:** (noun phrase) the area of a specimen that is visible through the eyepiece lens of a microscope at any given moment
- **fine focus:** (noun phrase) the smaller focusing wheel on the microscope (used after the coarse focus) to bring the object into sharp focus and clarity and remove any blurriness
- **function:** (noun) a special activity, purpose or job of a person or thing
- **genome:** (noun) a cell's set of instructions for growth, development and life processes. The genome stores genetic information that was inherited from parents
- **glucose:** (noun) a sugar that cells use with oxygen to provide energy through respiration
- **growth:** (noun) a process of living organisms – when an organism increases in size and repairs parts that are damaged

- **hierarchy:** (noun) a system that organises or ranks things in order
- **lens:** (noun) a curved glass that bends light to change the size of an image
- **light source**: (noun phrase) the part that emits light to allow you to see the object being viewed
- **magnify:** (verb) to make something appear larger
- **microscope:** (noun) an instrument used to magnify small objects, usually objects that cannot be seen with the naked eye
- **minerals:** (noun) nutrients from the soil that plants need for survival and growth
- **mitochondria:** (noun) the part of the cell where respiration takes place, providing energy for the cell's activities
- **movement:** (noun) a process of living organisms – when an organism moves itself or its parts to change position or location
- **muscle cells:** (noun phrase) specialised cells in animals that are adapted for contracting to create movement (usually movement of body parts)
- **muscle contraction**: (noun phrase) shortening of muscle cells to generate a pulling force
- **nucleus:** (noun) the part of the cell that contains the genome, which controls activities in the cell
- **nutrition:** (noun) a process of living organisms – when an organism uses food or other nutrients like water to stay alive
- **objective lens:** (noun) the lens located on a rotating wheel, just above the stage, that is used for magnification – there are usually three of them
- **observation:** (noun) the act of noticing facts about things happening or existing in the world
- **organ:** (noun) a structure made up of different types of tissues that work together to carry out a specific function
- **organ system:** (noun phrase) a group of organs that work together to perform a common function
- **organelle:** (noun) cell structures that have specific functions to perform in the cell
- **organism:** (noun) something that is living or used to be alive
- **oxygen:** (noun) a gas that is found in the air and is essential for the survival of most living organisms as it is used in the process of respiration
- **palisade cells:** (noun phrase) specialised cells in plant leaves that are adapted for photosynthesis, which allows the plant to make food
- **photosynthesis**: (noun) the chemical reaction in which plants use carbon dioxide and water to make glucose and oxygen using energy transferred by light
- **qualitative data:** (noun phrase) non-numerical information, such as detailed descriptions

- **quantitative data:** (noun phrase) information that is numerical
- **red blood cells:** (noun phrase) specialised cells in animals that are adapted for transporting oxygen throughout the body
- **reproduction:** (noun) a process of living organisms. when an organism produces offspring of the same kind
- **respiration:** (noun) a process of living organisms – a chemical reaction that takes place in all living cells that releases energy
- **root hair cells:** (noun phrase) specialised cells in plant roots that are adapted for absorbing water and minerals from the soil
- **selectively permeable:** (adjective phrase) something that has holes in it to allow the movement of only some substances through while preventing the movement of others
- **sensitivity:** (noun) a process of living organisms – when an organism senses and responds to changes in its surroundings
- **specialised:** (adjective) adapted to suit a specific purpose; when cells or tissues become adapted to carry out their specific function
- **specimen:** (noun) a sample of an object or organism used for scientific examination or study
- **stage:** (noun) the part of the microscope where we place the object or sample that we want to observe under the microscope
- **surface area:** (noun phrase) the entire outer area of an object or shape
- **temperature:** (noun) a measure of how hot or cold something is; can be measured using a thermometer – its unit is degrees Celsius (°C)
- **tissue:** (noun) a group of similar cells that work together to perform a specific function
- **vacuole:** (noun) where the cell sap is found in plant cells. Sap is a fluid containing water, sugars and other substances

Year 8

Plants and photosynthesis

Photosynthesis
- Plants make their own food (for energy) in a process called **photosynthesis**.
- Photosynthesis helps keep:
  - levels of oxygen high;
  - levels of carbon dioxide low.

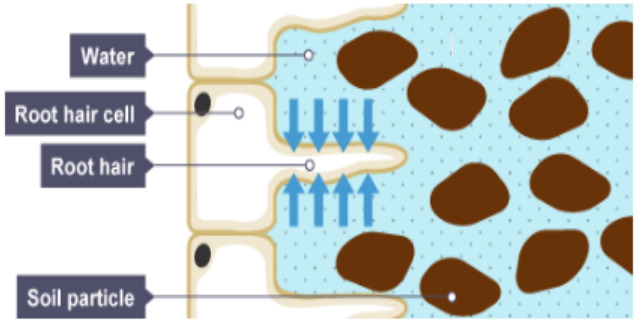
- Photosynthesis takes place in the **chloroplasts.**
- Chloroplasts contain **chlorophyll** which absorbs the energy transferred by light waves for photosynthesis

The equation for photosynthesis is:

carbon dioxide + water → glucose + oxygen

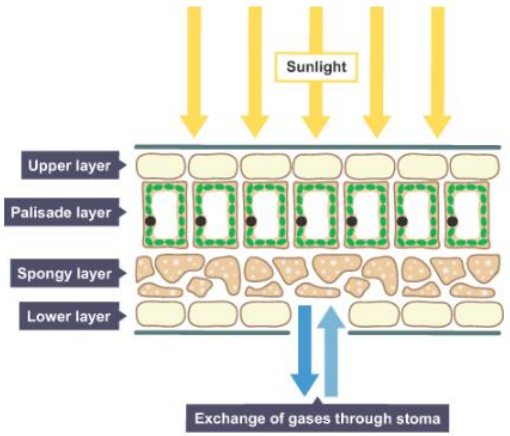
These are the things that plants need for photosynthesis:
- **carbon dioxide** – absorbed through their leaves;
- **Water** - from the ground through their roots;
- **light** (a source of energy) - from the Sun.

These are the things that plants make by photosynthesis:
- **Oxygen** - released into the air from the leaves;
- **Glucose**:
  - turned into **starch** and plant oils, used as an energy store;
  - This energy is released by **respiration**;
  - Used to make **cellulose** for cell walls.



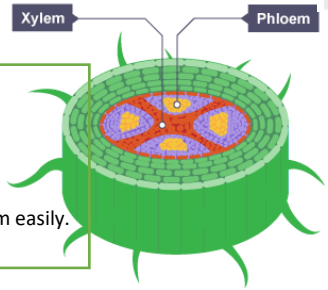
Water is absorbed into the roots by a process called **osmosis**, which does not use energy.
Minerals are absorbed into the roots by a process called **active transport,** which uses energy.

Feature of plant leaf	Function
Thin	Short distance for carbon dioxide to diffuse into the leaf
Waxy Layer	Prevents water loss by **evaporation**
Palisade cells	Contain a lot of **chloroplasts** to absorb light
Chloroplasts contain chlorophyll	Absorbs light
Stomata	Allows carbon dioxide to diffuse into the leaf (and oxygen to diffuse out)
Guard cells	Open/close stomata depending on conditions
Network of tubes (xylem & phloem)	Transports water (xylem) and food (phloem)



A cross-section through a leaf showing its main parts

Water
- Water is absorbed through the roots, by **osmosis**;
- It is transported through tubes (**xylem**) to the leaf;
- The roots contain cells called a **root hair cells:**
  - They increase the **surface area**
  - They have **thin walls to** let water pass into them easily.
  - They **do not** contain chloroplasts.



Respiration v photosynthesis
Photosynthesis:
carbon dioxide + water → glucose + oxygen
Aerobic respiration is:
glucose + oxygen → carbon dioxide + water
The equation for photosynthesis is the **opposite** of the equation for aerobic respiration.
- **Photosynthesis**:
  - **produces** glucose and oxygen;
  - **uses** carbon dioxide and water;
- **Respiration**:
  - **produces** carbon dioxide and water;
  - **uses** glucose and oxygen;

Food security and pollination
- **Pollination** is the transfer of pollen from one plant to another;
- Pollen can be transferred by **insects** or by **wind**;
- Insects that pollinate plants help us produce our food.
- Our food supply depends on plants:
  - Our food made of, and from plants;
  - The animals we eat feed on plants.

Carbon dioxide
- Enters leaf by **diffusion** through the **stomata**.
- **Guard cells** control the size of the stomata
- Stomata closes in **hot**, **windy** or **dry** conditions.
- Spongy layer has gaps between cells;
  - Allows carbon dioxide to **diffuse** to other cells in the leaf;
  - Allows oxygen produced in photosynthesis diffuse out of the leaf.

The 7 nutrients

Nutrient	Use in the body	Good sources
Carbohydrate	To provide energy	Cereals, bread, pasta, rice and potatoes
Protein	For growth and repair	Fish, meat, eggs, beans, pulses and dairy products
Lipids (fats and oils)	To provide energy. Also to store energy in the body and insulate it against the cold.	Butter, oil and nuts
Minerals	Needed in small amounts to maintain health	Salt, milk (for calcium) and liver (for iron)
Vitamins	Needed in small amounts to maintain health	Fruit, vegetables, dairy foods
Fibre	To provide roughage to help to keep the food moving through the gut	Vegetables, bran
Water	Needed for cells and body fluids	Water, fruit juice, milk

Chemical food tests

Nutrient	Chemical test	Positive result
Starch	Iodine solution	Iodine solution turns from orange/brown→ blue black
Sugar	Benedict's solution & heat	Benedict's solution turns from: blue → green /yellow/brick red
Fat	Ethanol & shake, then water & shake	Ethanol turns cloudy white
Protein	Biuret reagent	Biuret reagent changes from blue to purple

Respiration

A chemical reaction that takes place in all living cells to release the energy in food:

Sugar + oxygen → carbon dioxide + water

Energy released from food is used for things like:
- muscle contraction
- keeping warm
- making new cells

Each person needs a different amount of energy depending on factors such as:
- gender (male or female)
- age
- amount of daily activity

Energy in food is measured in **kilojoules**, kJ.

Digestion and Nutrition

A **balanced diet** contains the right energy intake **and** the correct amounts of necessary nutrients.
An **imbalanced diet** contains too much or too little of a particular nutrient and/or energy.

Nutrient deficiency diseases:
Mineral deficiency diseases are caused when your diet is lacking in a particular mineral:
- iron deficiency causes anaemia, where there are too few red blood cells;
- iodine deficiency can cause a swelling in the neck called goitre.

Vitamin deficiency diseases are caused when you diet is lacking in a particular vitamin:
- vitamin A deficiency can cause blindness;
- vitamin C deficiency causes scurvy, which makes the gums bleed;
- vitamin D deficiency causes rickets, which makes the legs bow outwards in growing children.

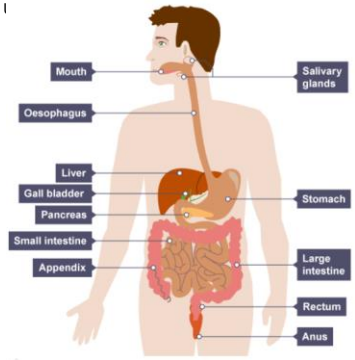
Energy imbalances in diets
If the amount of energy you get from your food is different from the amount of energy you use, your diet will be imbalanced:

- too little food/ energy can make you underweight
- too much food/ energy can make you overweight

Imbalanced energy intake diseases:
Starvation happens if you eat so little food that your body becomes very underweight. This can eventually cause death.

Obesity happens when you eat so much food that your body becomes very overweight. Diseases linked with obesity include heart disease, diabetes, arthritis and stroke.

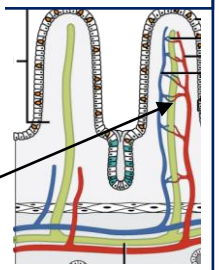
Stages of digestion
- Digestion starts in the **mouth**, where teeth **mechanically digest** food during chewing. **Chemical digestion** begins here when the food mixes with saliva.
- Food is swallowed as passes down the **oesophagus.**
- When food reached the **stomach**, the food continues to be **mechanically digested** when the stomach muscles contract to churn food. **Chemical digestion** also continues when the food mixes with acid and enzymes inside the stomach.
- Most **digestion** happens inside the **small intestine** when the food mixes with **enzymes** and **bile (chemical digestion),** and is moved along the canal by **muscle contractions (mechanical digestion)**
- Digested food is **absorbed** into the bloodstream, by diffusion from the small intestine. Water is reabsorbed into the body in the small intestine
-



The role of liver and pancreas
- The liver produces **bile**, which helps the digestion of lipids (fats and oil).
- The pancreas produces biological **catalysts** called digestive **enzymes** which speed up the digestive reactions.

Absorption by diffusion across a surface happens efficiently if:
- the surface is thin;
- its area is large.

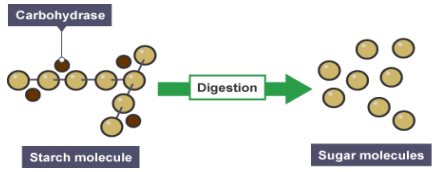
The inner wall of the small intestine is adapted. It has:
- a thin wall, just one cell thick;
- many tiny **villi** to give a really big **surface area.** The villi contain many **capillaries** to carry away the absorbed food molecules.



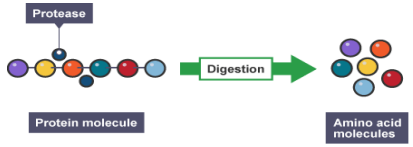
Digestion is when large **insoluble** food particles are broken down into small **soluble** particles so that they can be absorbed into our bloodstream.

This is carried out by **enzymes** - special proteins that can break large molecules into small molecules.

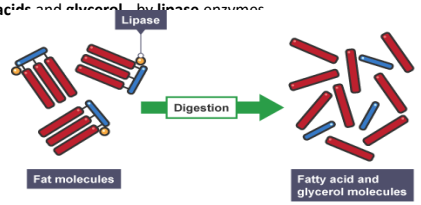
Different enzymes can break down different nutrients:
- **Carbohydrates** (eg starch) are broken down into **sugar -** by **carbohydrase** enzymes



- **Proteins** are broken down into **amino acids -** by **protease** enzymes;



- **Lipids** (ie fats and oils) are broken down into **fatty acids** and **glycerol** by **lipase** enzymes



At very high temperatures, these enzymes will be **denatured.**

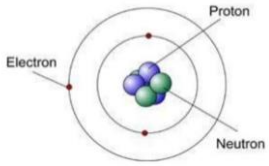
Digestive enzymes cannot break down dietary fibre, which is why the body cannot absorb it.
Minerals, vitamins and water are not digested, as they are already small enough to be absorbed.

The digestive system contains some good **bacteria** which are important because they:
- can digest certain substances humans cannot digest;
- reduce chance of harmful bacteria multiplying, causing disease;
- produce vitamins that humans need eg vitamins B & K.

Atoms are tiny particles that everything is made of.

They are made of smaller particles called:

- **Protons** (+ positive)
- **Neutrons** (neutral)
- **Electrons** (- negative)



Metals have properties in common. They are:

- **shiny**, especially when they are freshly cut
- **good conductors** of heat and electricity
- **malleable** (they can be bent and shaped without breaking)

Elements
There are over a hundred different elements.

Atoms have the same number of protons as each other.

Atoms of differing elements have a different number of protons.

The atoms of some elements do not join together, but instead they stay as separate atoms, eg Helium.

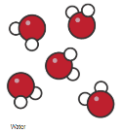
The atoms of other elements join together to make **molecules**, eg oxygen and hydrogen**.**

Most metals also have other properties in common. They are:

- **solid** at room temperature, except mercury;
- **hard** and **strong;**
- they have a **high density;**

Compounds
A compound is contains atoms of **two or more different elements**, and these atoms are **chemically joined together.**

For example, water is a compound of hydrogen and oxygen.



Each of its molecules contains two hydrogen atoms and one oxygen atom.

The elements are arranged in a chart called the periodic table. A Russian scientist, Mendeleev, produced the first periodic table in the 19th century.

The modern periodic table is based closely on the ideas he used:

- the elements are arranged in order of increasing atomic number (number of protons);
- the **horizontal** rows are called **periods;**
- the **vertical** columns are called **groups;**
- elements in the same group have the same number of electrons in their outside shell

Chemical formulae
Remember that we use chemical symbols to stand for the elements.
For example, **C stands for carbon**, **S stands for sulfur** and **Na stands for sodium.**

For a molecule, we use the chemical symbols of all the atoms it contains to write down its formula. For example, the formula for **carbon monoxide is CO.**

It tells you that each molecule of carbon monoxide is made of one carbon atom joined to one oxygen atom.

Be careful about when to use capital letters. For example, CO means a molecule of carbon monoxide but **Co is the symbol for cobalt** (an element).

Each element is given its own chemical symbol, like **H for hydrogen** or **O for oxygen.**

Chemical symbols are usually one or two letters.

Every chemical symbol **starts with a capital letter, with the second letter written in lower case**.For example, Mg is the correct symbol for magnesium, but mg, mG and MG are wrong.

Mg	mg	mG	MG
✓	✗	✗	✗

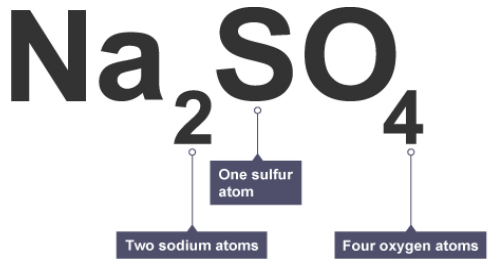
Numbers in formulae
We use numbers to show when a molecule contains more than one atom of an element.

The numbers are written **below** the element symbol. For example, CO_2 is the formula for carbon dioxide.

It tells you that each molecule has **one carbon atom** and **two oxygen atoms**.

The **small numbers go at the bottom**. For example:

- CO_2 is correct;
- CO^2 and CO2 are wrong.



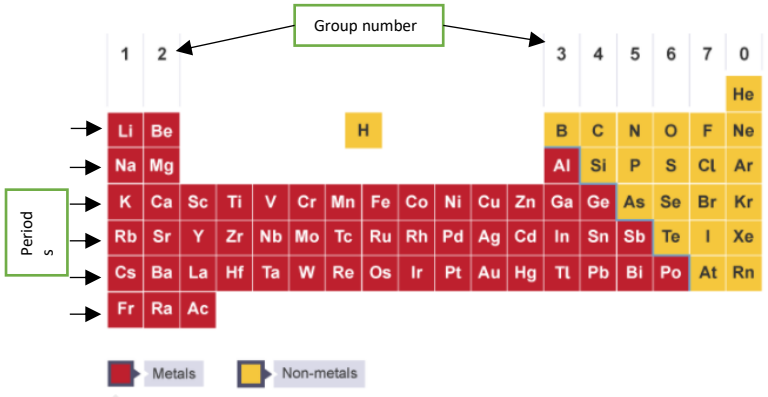
Some formulae are more complicated. For example, the formula for sodium sulfate is Na_2SO_4. It tells you that sodium sulfate contains two sodium atoms (Na x 2), one sulfur atom (S) and four oxygen atoms (O x 4).

We can use the periodic table to predict the properties of elements in the same group.

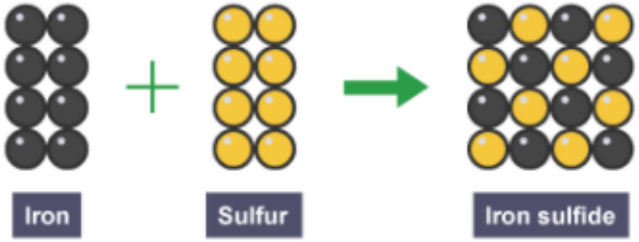
Group 7	Melting point	Density	Reactivity
Fluorine	Increases down the group ↓	Increases down the group ↓	Decreases down the group ↓
Chlorine			
Bromine			
Iodine			

Group 1	Melting point	Density	Reactivity
Lithium	Decreases down the group ↓	Increases down the group ↓	Increases down the group ↓
Sodium			
Potassium			
Rubidium			

Periodic Table



Chemical reactions
When chemicals react, the atoms are rearranged. For example, iron reacts with sulfur to make iron sulfide



Iron sulfide, the compound formed in this reaction, has different properties to the elements it is made from.

	Iron	Sulfur	Iron sulfide
Type of substance	Element	Element	Compound
Colour	Silvery grey	Yellow	Black
Is it attracted to a magnet?	Yes	No	No
Reaction with hydrochloric acid	Hydrogen formed	No reaction	Hydrogen sulfide formed, which smells of rotten eggs

- The atoms in a compound are joined together by forces called **bonds**.
- The properties of a compound are different from the elements it contains;
- You can only separate its elements using another chemical reaction;
- Separation methods like filtration and distillation will not do this.

Chemical equations
We summarise chemical reactions using equations:

reactants → products

- **Reactants** are shown on the **left** of the arrow;
- **Products** are shown on the **right** of the arrow.

Do not write an equals sign instead of an arrow.

If there is more than one reactant or product, they are separated by a + sign. For example:

copper + oxygen → copper oxide

Reactants: copper and oxygen
Products: copper oxide

A **word equation** shows the names of each substance involved in a reaction, and **must not include any chemical symbols or formulae**

Periodic Table

Conservation of mass
When atoms are rearranged in a chemical reaction, they are not destroyed or created.

- **Reactants** - the substances that react together;
- **Products** - the substances that are formed in the reaction;
- **Mass is conserved** in a chemical reaction, this means…
- Total mass of the reactants = total mass of the products;

Symbol equations

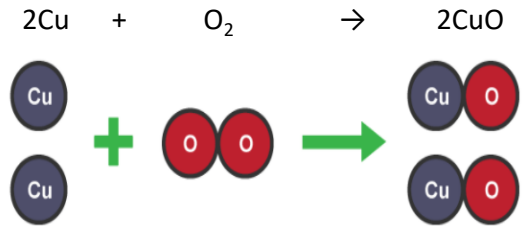
A balanced **symbol** equation includes the **symbols** and **formulae** of the substances involved. For example:

Word equation:
Copper + Oxygen → Copper Oxide

Symbol equation (unbalanced):
$Cu + O_2 \rightarrow CuO$

There is one copper atom on each side of the arrow, but two oxygen atoms on the left and only one on the right. This is **unbalanced.**

A **balanced** equation has the **same number of each type of atom on each side of the arrow.** Here is the balanced symbol equation:



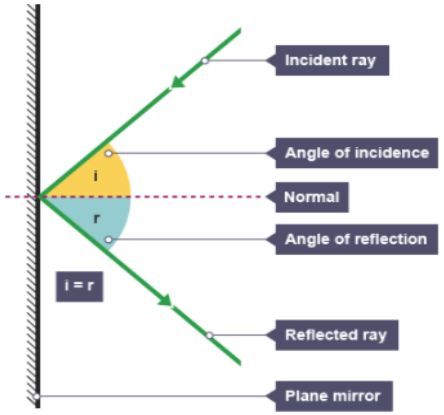
Some more examples of balanced symbol equations
- $C + O_2 \rightarrow CO_2$
- $2H_2 + O_2 \rightarrow 2H_2O$
- $2Mg + O_2 \rightarrow 2MgO$
- $CuCO_3 \rightarrow CuO + CO_2$
- $Mg + 2HCl \rightarrow MgCl_2 + H_2$

Take care when writing formula – e.g. for carbon dioxide:
CO_2 NOT CO^2 or Co_2

Reflection
A ray diagram shows how light travels, including what happens when it reaches a surface. In a ray diagram, you draw each ray as:
- a straight line;
- with an arrowhead pointing in the direction that the light travels;
- always use a ruler and a sharp pencil.

The law of reflection
When light reaches a mirror, it reflects off the surface of the mirror:
- **incident ray** is the light going **towards the mirror;**
- **reflected ray** is the light coming **away from the mirror.**

The law of reflection states:
- **the angle of incidence = the angle of reflection, i = r.**



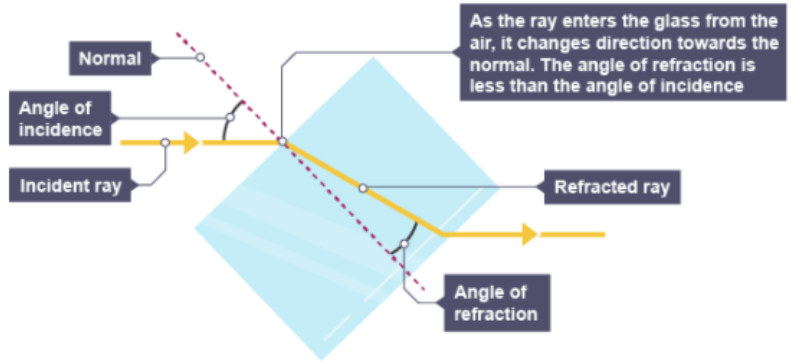
Diffuse scattering
- If light meets a rough surface, each ray obeys the law of reflection;
- Different parts of the rough surface point in different directions;
- So the light is not all reflected in the same direction;
- The light is reflected in all directions.
- This is called **diffuse scattering.**

Light and Sound

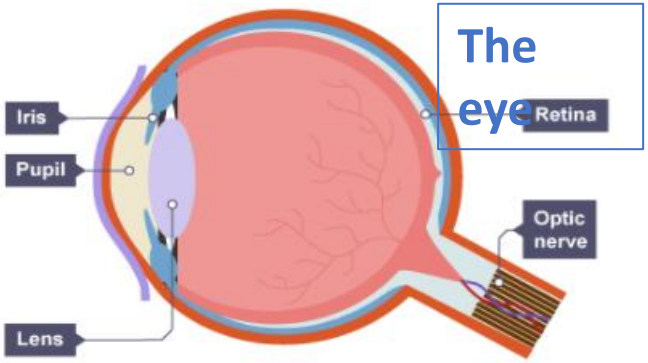
In the ray diagram:
- the hatched vertical line on the right represents the mirror;
- the dashed line is the normal, drawn 90° to the surface of the mirror;
- the angle of incidence, i, is the angle between the normal and incident ray;
- the angle of reflection, r, is the angle between the normal and reflected ray;
- The reflection of light from a flat surface such as a mirror is called **specular reflection** – light meeting the surface in one direction is all reflected in one direction.

Refraction
When light waves pass across a boundary between two substances with a different density, eg air and glass. They:
- change speed;
- causing them to change direction;
- This is called refraction.

At the boundary between two transparent substances:
- the light slows down going into a denser substance, and the ray bends towards the normal;
- the light speeds up going into a less dense substance, and the ray bends away from the normal.

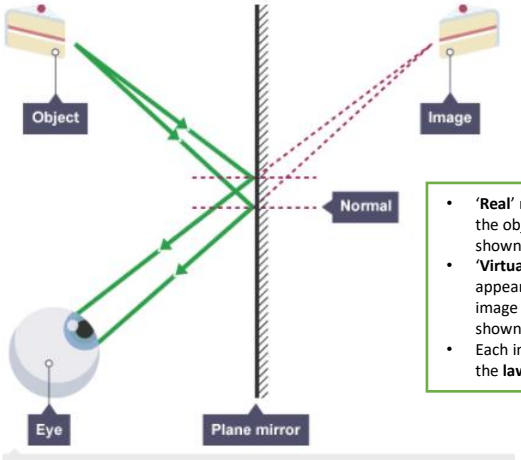


The eye



Imaging in mirrors
- A plane mirror is a flat mirror.
- When you look into a plane mirror, you see a reflected image of yourself. This image:
  - appears to be behind the mirror
  - is the right way up
  - is 'laterally inverted' (letters and words look as if they have been written backwards)

- 'Real' rays, the ones leaving the object and the mirror, are shown as solid lines.
- 'Virtual' rays, the ones that appear to come from the image behind the mirror, are shown as dashed lines.
- Each incident ray will obey the law of reflection.



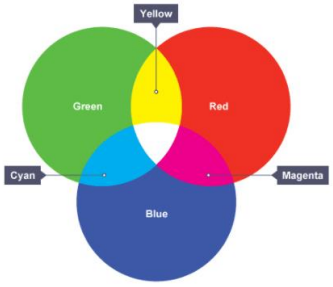
- '**Real' rays**, the ones leaving the object and the mirror, are shown as solid lines.
- '**Virtual' rays**, the ones that appear to come from the image behind the mirror, are shown as dashed lines.
- Each incident ray will obey the **law of reflection**.

Light and

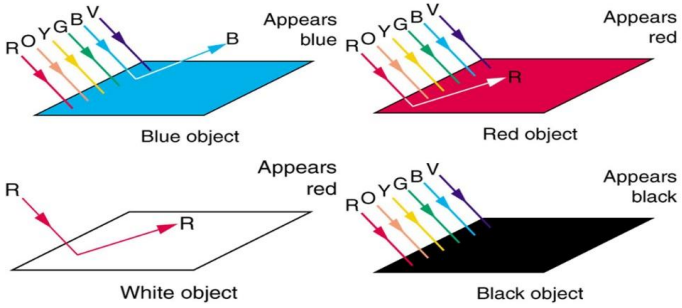
Colour
- White light is a mixture of many different colours;
- Each colour has a different frequency;
- White light can be split up into a **spectrum** using a prism, a triangular block of glass or Perspex;
- Light is refracted when it enters the prism;
- Each colour is refracted by a different amount;
- Light leaving the prism is spread out into different colours;
- This is called **dispersion**.

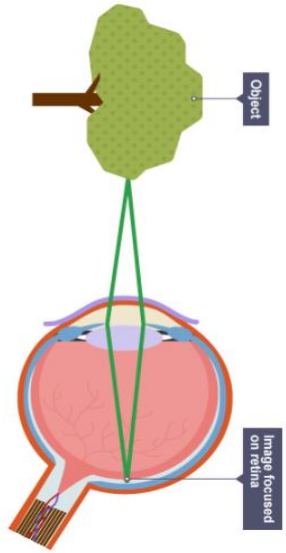
The spectrum
The seven colours of the spectrum listed in order of their frequency, from the lowest frequency (fewest waves per second) to the highest frequency (most waves per second):
- **R**ed
- **O**range
- yellow
- green
- blue
- indigo
- Violet

'**R**ichard **O**f **Y**ork **G**ave **B**attle **I**n **V**ain'.



Coloured light
- There are three primary colours in light: red, green and blue.
- Light in these colours can be added together to make the secondary colours magenta, cyan and yellow.
- All three primary colours add together make white light;
- When light hits a surface, some of it is absorbed and some of it is reflected.
- The colour of an object is the colour of light it reflects;
- All other colours are absorbed.

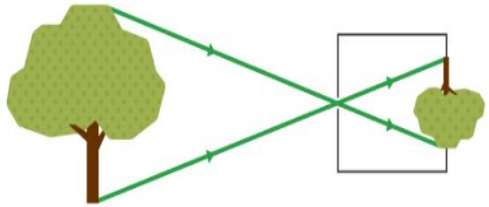


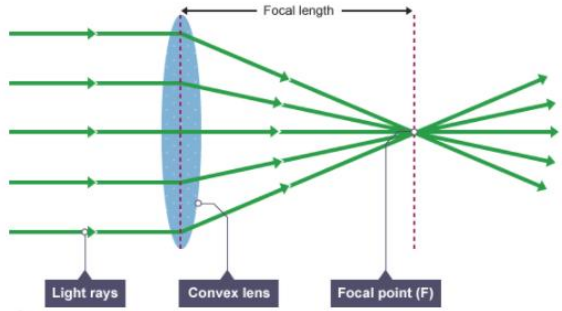


The eye
The eye is like the camera:
- The eye focuses light from an object;
- Onto the photo-sensitive **retina**;
- The retina contains cells sensitive to light;
- They produce electrical impulses when they absorb light;
- These impulses are passed along the **optic nerve** to the **brain**;
- Which interprets them as vision.

Focusing
- Light rays can be focused so that they meet at a single point;
- Focusing is important for getting clear images in our eye;
- Images that are not focused appear blurred.

The pinhole camera
A pinhole camera consists:
- of a box with a **translucent screen** at one end;
- a tiny hole (the pinhole) in the other end;
- light enters the box through the pinhole;
- It is focused by the pinhole onto the screen;
- The image is inverted (upside down) and smaller than the object





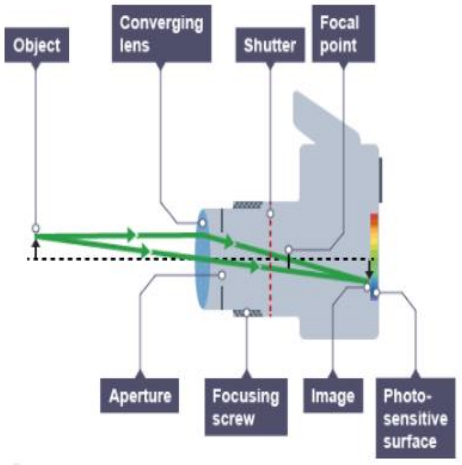
The convex lens
- A convex lens is made from a transparent material that bulges outwards in the middle on both sides.
- It can focus light so that appears to meet at a single point, called the focal point.
- Light is refracted as it passes into, then out of, the lens.
- Convex lenses are found in:
  - **magnifying glasses**;
  - **spectacles** for people with long-sight (who can see distant objects clearly but not nearby ones);
  - **telescopes**.

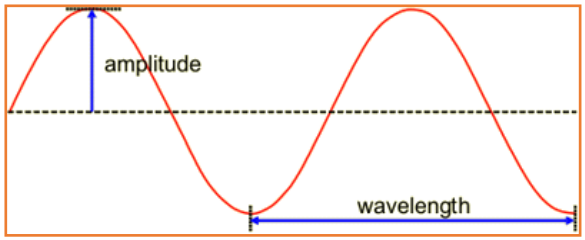
Detecting light
Cameras and eyes detect light. They both have:
- a material that is sensitive to light
- a change that happens when this material absorbs light

The camera
Cameras focus light onto a photo-sensitive material using a lens.

In old cameras, the photo-sensitive material was camera film;
- The film absorbs light;
- A chemical change produces an image, called the 'negative'.
- This was used to produce a photograph on photo-sensitive paper.

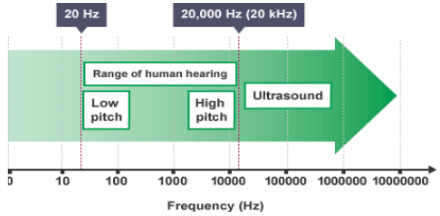
In a modern camera or the camera in a mobile phone:
- The photo-sensitive material produces electrical impulses;
- Which are used to produce an image file;
- This can be viewed on the screen.





- **Amplitude:** the maximum height of the wave from its resting position:
  - the greater the amplitude, the louder the sound
- **Wavelength:** the distance between two **crests** (tops) next to each other (or any other two identical point on waves next to each other)
- **Frequency:** the number of **waves per second** (**Hertz** - **Hz**): the higher the frequency, the closer together the waves are, the higher the pitch

Ultrasound
Human beings can generally hear sounds as low as 20 Hz and as high as 20,000 Hz (20 kHz**).**



Ultrasound is:
- any sound with a frequency of **more than 20,000 Hz.**
- Too high pitched for humans to hear
- Other animals (eg dogs, cats and bats) can hear it.
- Ultrasound can be used to check on the health of unborn babies, clean jewellery and in physiotherapy.

Types of waves
All waves transfer energy from place to place.
There are two types of wave: **longitudinal** and **transverse**:

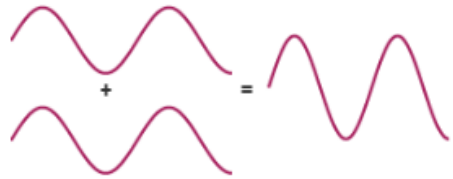
Longitudinal waves
Sound waves are **longitudinal waves.**
The vibrations are **parallel to the direction of travel.**

Transverse waves
Light waves (and water waves) are **transverse waves.**
The vibrations are **perpendicular to the direction of travel**.

Water waves
- Water waves move with a transverse motion
- The **undulations** (up and down movement) are at 90° to the direction of travel.
- Water waves, like all waves, can be **reflected**, **refracted** and **diffracted**.

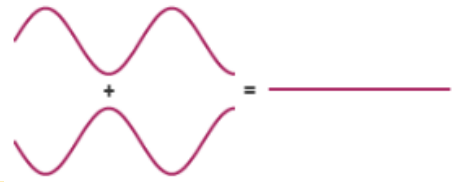
Superposition is where two waves meet and they affect each other: **adding** or **cancelling**.

Adding (constructive interference)

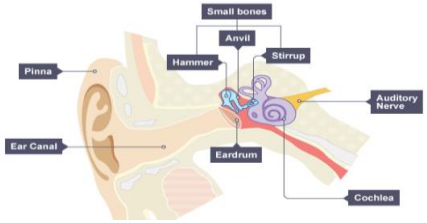


If two waves meet each other **in step**, they add together and reinforce each other. They produce a much higher wave, a wave with a greater **amplitude**.

Cancelling (destructive interference)
If two waves meet each other **out of step**, they cancel out.



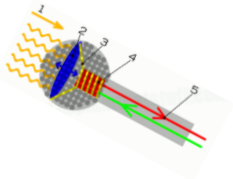
Ears
- An ear has an **eardrum**, connected to **three small bones**
- Vibrations in air make the eardrum vibrate
- which in turn vibrates the three small bones (called **ossicles**) to a spiral structure called the **cochlea**
- Signals are passed from the cochlea to the brain
- through the **auditory** nerve.



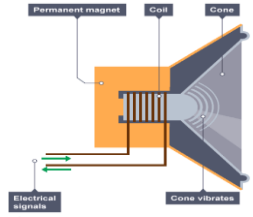
Light and Sound

Reflection
- Sound waves can reflect off surfaces
- These reflections as heard as **echoes**
- **Hard, smooth surfaces** are good at reflecting sound (more echoes)
- **Soft, rough surfaces** are good at absorbing sound (less echoes)

Microphones
- Microphones contain a **diaphragm**, which does a similar job to an eardrum
- The vibrations in air make the diaphragm vibrate. These vibrations are changed to electrical impulses.



Loudspeakers
- Loudspeakers work by converting electrical current into vibrations
- This moves the cone which creates the sound waves.



The speed of sound is **340 m/s**

Properties of sound waves
- When something vibrates, it produces sound
- These sound waves are carried by vibrating particles
- Sound can only travel through solids, liquids or gases
- They cannot travel through empty space (a **vacuum**).