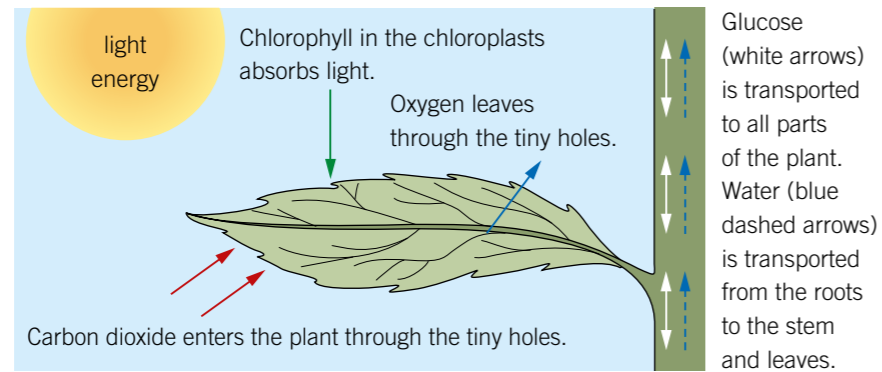


### Photosynthesis

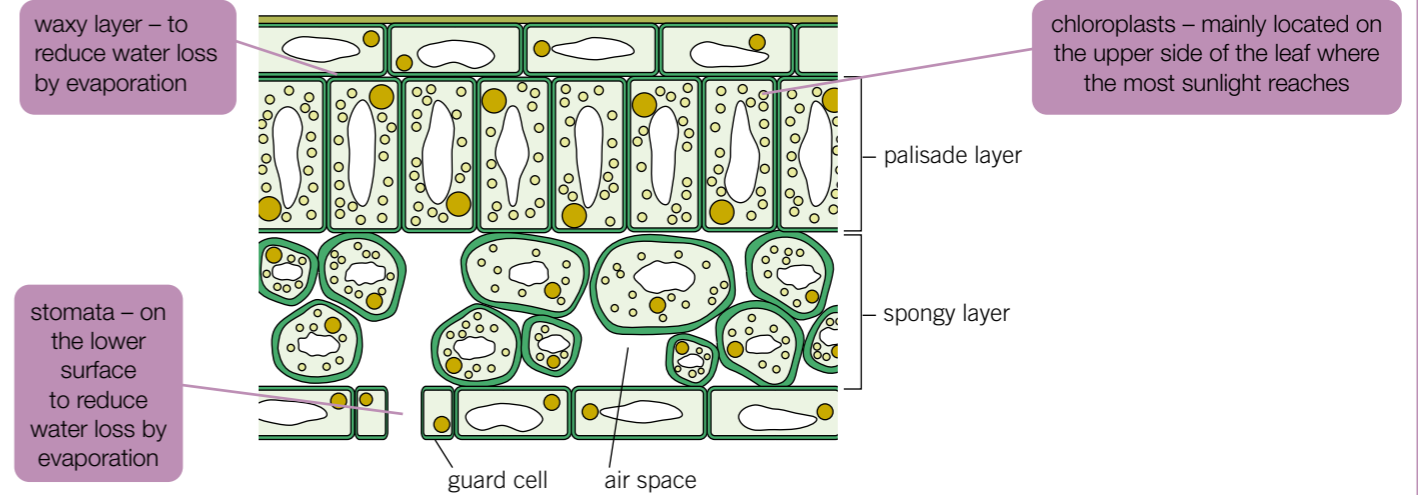
**Photosynthesis** is a chemical reaction that takes place in the **chloroplasts** to produce **glucose**.



The minerals plants need are:

- 1 **nitrates** for growth
- 2 **phosphates** for healthy roots
- 3 potassium for healthy leaves and flowers
- 4 magnesium for making chlorophyll

If a plant does not have enough of a mineral, it may suffer from a mineral **deficiency**. Farmers can use **fertilisers** to add missing minerals to the soil.



Leaves are specially adapted for photosynthesis:

- have lots of green **chlorophyll** – absorb sunlight for photosynthesis
- are thin – allow gases to diffuse in and out of the leaf
- have a large surface area – absorb as much light as possible
- have veins – xylem transports water and phloem transports glucose

### Respiration

with oxygen

#### Aerobic respiration



- Respiration occurs in the **mitochondria** of cells to produce energy.
- Glucose is absorbed from the small intestine into the blood **plasma**. It is transported to the cells where it diffuses in.
- Oxygen is breathed in and diffuses into the bloodstream. Oxygen is then carried by haemoglobin to the cells where it diffuses in.
- Carbon dioxide diffuses out of the cells into the blood plasma. It is transported to the lungs where it diffuses into the air sacs and is exhaled.

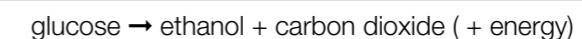
without oxygen

#### Anaerobic respiration (in animals)



- This occurs when there is not enough oxygen for aerobic respiration, such as during strenuous exercise.
- It transfers less energy than aerobic respiration.
- The lactic acid produced can cause muscle cramps. This causes increased inhalation to break down lactic acid – the oxygen needed is called the **oxygen debt**.

#### Fermentation (in microorganisms)



- Yeast respire anaerobically – this fermentation is important in food production (e.g., bread, beer, and wine).

### Key words

Make sure you can write definitions for these key terms.

aerobic   anaerobic   chlorophyll   community   consumer   deficiency   fermentation   fertiliser   producer   mitochondria   nitrate   oxygen debt   plasma  
phosphate   photosynthesis   stomata



### Competition

Animals compete for:

- 1 food
- 2 water
- 3 space – to hunt and for shelter
- 4 mates – to reproduce.

Plants compete for:

- 1 light
- 2 water
- 3 space
- 4 minerals – plants do not compete for food, as they produce their own through photosynthesis.

### Predators and prey

When a predator feeds on just one type of prey, there is an interdependence between the predator population and the prey population. This means that changes in the population of one animal directly affect the population of the other.

### Populations and ecosystems

The number of organisms that live in the same area is called a **population**. Populations of organisms are constantly changing – this affects other populations in a food web.

**Interdependence** is when living organisms depend on each other to survive, grow, and reproduce.

**Ecosystem:** all the organisms found in a particular location, and the area they live in.

**Community:** the organisms in an ecosystem.

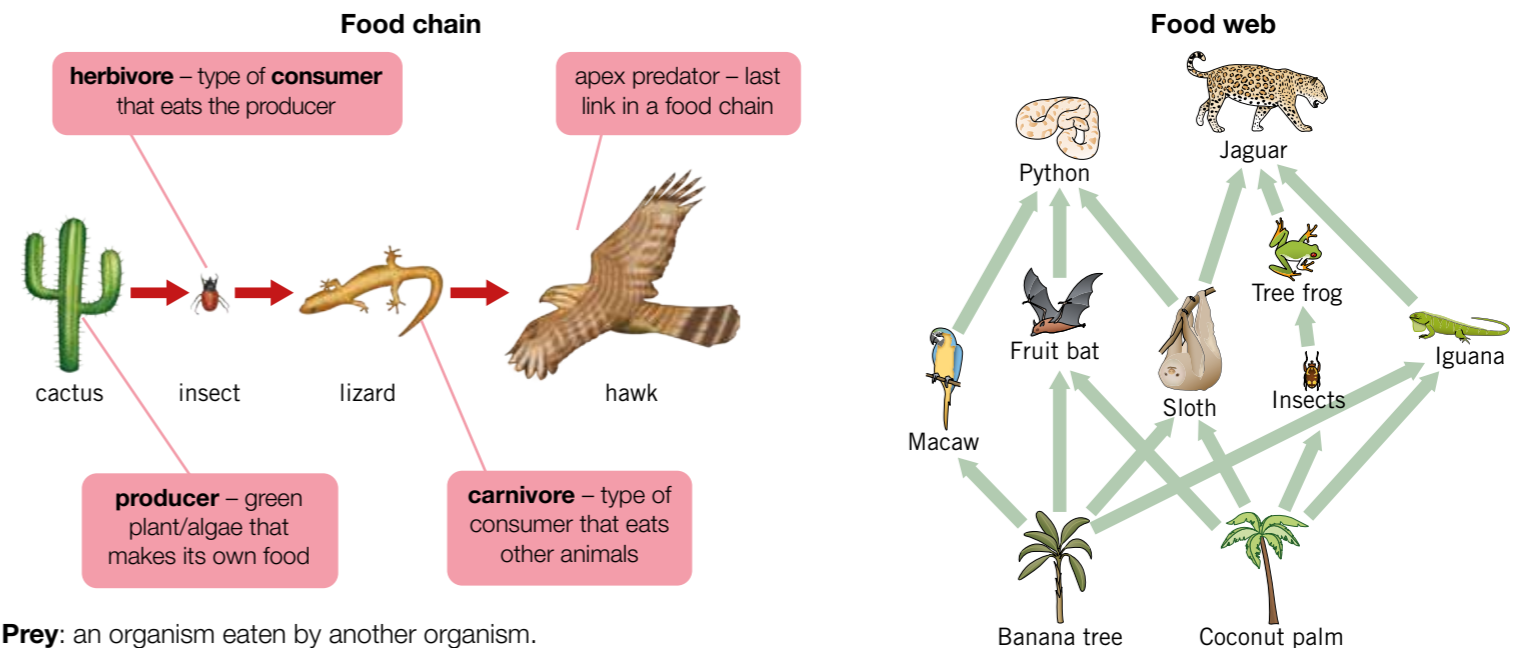
**Habitat:** the area a community lives in.

**Niche:** the particular place or role that an organism has within an ecosystem. This reduces competition for resources.

### Food chains and webs

**Food chains** show the transfer of energy between organisms – the arrows represent the direction of energy transfer.

**Food webs** show how lots of food chains are connected in an ecosystem.



**Prey:** an organism eaten by another organism.

**Predator:** an organism that eats another organism.

**Bioaccumulation** is the build up of chemicals, like insecticides, passed along a food chain.

### Adaption and change

#### Adaptation

- Adaptations are characteristics that help an organism to survive and reproduce.

*For example, the cheetah is the fastest land animal. This speed makes it a very successful predator.*

#### Environmental changes

- Plants and animals adapt to changes in their environments.
- Habitats can change through fire, climate change, or disease causing reduced food supplies.

*For example, deciduous trees look different in each season, and bears hibernate somewhere warm in the winter.*

#### Interdependence

- Predator and prey species are **interdependent**.

- This occurs when a change in the population of one animal directly affects the population of the other.

For example, Canadian lynx and the snowshoe hare are interdependent:

- When the prey (hare) population increases, the predators (lynx) have more to eat, the lynx survive longer and reproduce more, so the number of predators increases.
- The increase in predators means that more prey are eaten, so the prey population decreases.
- The predators then do not have enough food, so their numbers decrease, and the prey population increases again.

### Key words

Make sure you can write definitions for these key terms.

adaptation bioaccumulation carnivore chemosynthesis competition continuous characteristic discontinuous ecosystem environmental variation evolution extinct food chain food web fossil record habitat herbivore inherited variation interdependence interdependent natural selection niche population predator prey species variation



### Metals and acids

- If a metal reacts with an acid, it produces a **salt** and hydrogen gas.
- All acid compounds have hydrogen in them.
- When the hydrogen is replaced by a metal, the compound is called a salt.

For example, sulfuric acid has the formula  $\text{H}_2\text{SO}_4$ . Copper sulfate has the formula  $\text{CuSO}_4$  – it is a salt because the copper has taken the place of the hydrogen in sulfuric acid.

The three main acids are hydrochloric acid, sulfuric acid, and nitric acid. Metals can react with all of these acids to produce a salt and hydrogen gas.

*copper + hydrochloric acid → copper chloride + hydrogen*

*iron + sulfuric acid → iron sulfate + hydrogen*

*magnesium + nitric acid → magnesium nitrate + hydrogen*

### Metals and water/steam

- Very reactive metals like sodium will react with cold water to produce a metal hydroxide and hydrogen gas.

*sodium + water → sodium hydroxide + hydrogen*

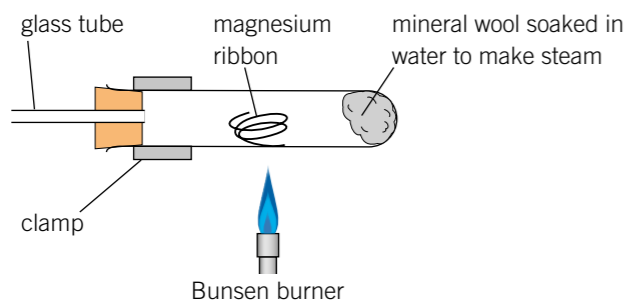


- Other metals like magnesium only react with steam, and produce a metal oxide and hydrogen.

*magnesium + steam → magnesium oxide + hydrogen*



Magnesium can be reacted with steam using the following experimental set-up.



### Testing for hydrogen gas

The gas produced when reacting a metal and a salt can be collected in an upturned test tube, and a test performed to check that the gas is hydrogen.

Insert a lit splint into the upturned test tube – if the gas is hydrogen, there will be a 'pop' sound.

### Metals and oxygen

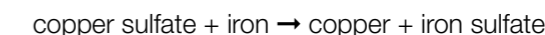
- Many metals will react with oxygen from the air to produce a metal oxide.
- Often, they will need to be heated before they can react.

Metal	Reaction with oxygen
magnesium	burns vigorously
zinc	burns less vigorously
iron	burns
lead	do not burn; when heated, form layer of oxide on surface
copper	do not burn; when heated, form layer of oxide on surface
gold	no reaction

### Metal displacement reactions

- A **displacement reaction** occurs when a more reactive element takes the place of a less reactive element in a compound. In metals, this means that the more reactive metal will become a compound, and the less reactive one an element.

For example, iron is more reactive than copper so:



The iron has displaced the copper from its compound. The solution changes from blue to pale green and the metal changes from grey to rose coloured, indicating that a chemical reaction has happened.

### The reactivity series

most reactive
potassium
sodium
lithium
calcium
magnesium
aluminium
zinc
iron
lead
copper
silver
gold
least reactive

↑ Increasing reactivity

### State symbols

- Symbol equations have letters in brackets after each substance.
- These tell you the state of matter of each substance, and are called **state symbols**:

(s) = solid, (l) = liquid, (g) = gas, (aq) = dissolved in water

For example,  $\text{H}_2\text{O(s)}$  is ice,  $\text{H}_2\text{O(l)}$  is water,  $\text{H}_2\text{O(g)}$  is steam, and  $\text{NaCl(aq)}$  is sodium chloride (table salt) dissolved in water.

### Materials

A **ceramic** is a hard, brittle material that is made by firing a material, such as clay, at a high temperature. Ceramics also have similar chemical properties to each other. They do not react with water, acids, or alkalis.

A **polymer** is a substance with very long molecules. There are many polymers. Different polymers have different properties. Their properties make them suitable for their uses. Natural polymers include wool and rubber. Synthetic polymers include polyester and nylon.

A **composite** is a mixture of materials. Each material has different properties. The composite has properties that are a combination of the properties of the materials that are in it.

### Metal extraction

Only very unreactive metals like gold and platinum are found as their metals themselves in nature. Most metals are found in compounds called minerals. Chemical reactions can be used to extract the metal element from its compound. Minerals that have enough metal in them to make it financially worthwhile to extract the metal are called ores.

### Key words

Make sure you can write definitions for these key terms.

acid ceramic composite displacement reaction hydrogen material metal polymer reaction reactivity reactivity series salt state symbol



# P1 Chapter 3: Light Knowledge organiser

## How does light travel?

**Luminous** objects are sources of light, e.g., the Sun.

**Non-luminous** objects do not produce their own light, e.g., the Moon.

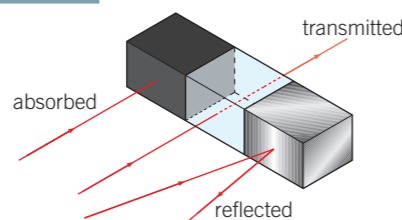
When light hits an object it can be **absorbed**, **reflected**, or **transmitted**.

If an object is:

**transparent** – most light is transmitted

**translucent** – light is scattered

**opaque** – no light is transmitted so a shadow is produced.



Light can travel through gases, some solids and liquids, and completely empty space (a vacuum).

The speed of light in a **vacuum** is about 300 000 km/s.

Distances in space are measured in **light-time**. Remember that light-time is a distance (not a measure of time).

A light-minute is the distance light travels in one minute.

A light-year is the distance light travels in one year.

## Colours of light

A **prism** refracts different colours of light by different amounts. This disperses light into a continuous **spectrum** of colours.

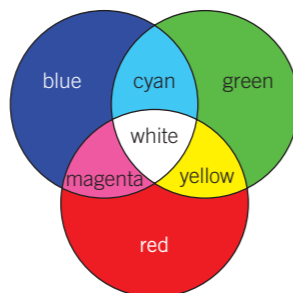
The **primary colours** of light are **red**, **green**, and **blue**.

**Secondary colours** are produced when any two primary colours are mixed.

**Filters** subtract colours from white light, so that only one colour of light is transmitted.

Objects appear to be different colours because they reflect some colours of light and absorb others.

Black objects absorb all colours and white objects reflect all colours.

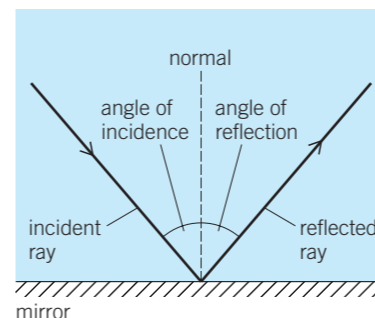


## Reflection and refraction of light

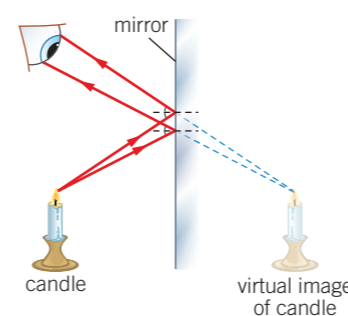
The **law of reflection** states that:

The **angle of incidence** is equal to the **angle of reflection**.

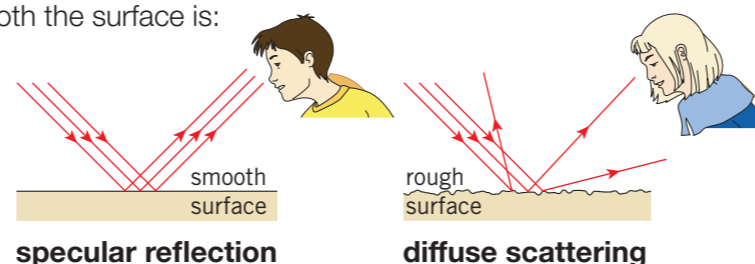
The **normal** is an imaginary line at 90° to the mirror.



Images in mirrors are **virtual** – they look like they are behind the mirror.



Whether or not you can see a clear reflected image depends on how smooth the surface is:

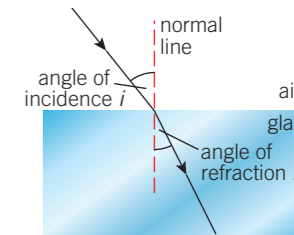


**Refraction** is when light changes direction when it travels from one **medium** (material, such as air or water) to another.

Refraction happens because light travels at different speeds in different materials.

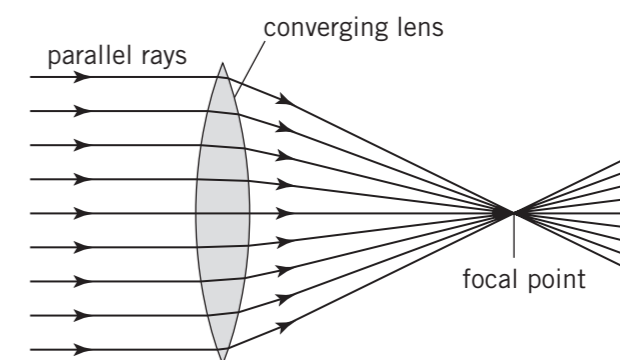
Rays of light will be refracted:

- towards the normal if they slow down, such as going from air to glass
- away from the normal if they speed up, such as going from water to air.



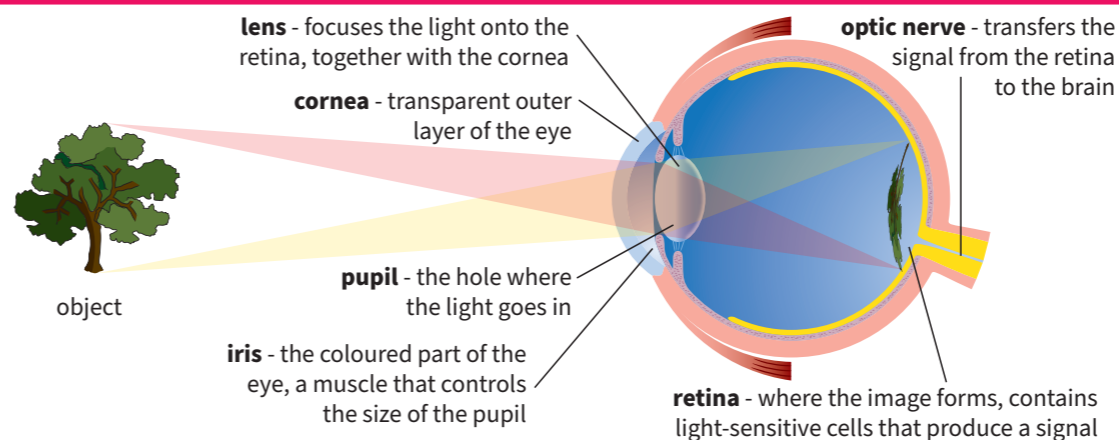
**Lenses** use refraction to spread out or **focus** light.

**Convex** (or **converging**) lenses (like the ones in your eyes) are shaped to focus the light to a point – called the **focal point**.



## How do eyes and cameras work?

Light entering your eye is refracted by the **lens**, focusing it on the **retina** and creating an inverted image. **Photoreceptors** detect the light hitting your retina and send an electrical impulse to your brain.



Cameras work in the same way as your eye – light passes through an opening and a **real image** is formed on a screen or film.

Digital cameras now have a **charge-coupled device (CCD)** instead of film – when light hits a **pixel** it produces an electrical charge.

## Key Words

Make sure you can write a definition for these key terms. **absorb** **angle of incidence** **angle of reflection** **aperture** **camera** **charge-coupled device** **continuous** **converging** **convex** **cornea** **diffuse scattering** **dispersion** **emit** **eye** **filter** **focal point** **focus** **image** **incident ray** **inverted** **iris** **law of reflection** **lens** **light-time** **luminous** **medium** **non-luminous** **normal** **opaque** **optic nerve** **photoreceptors** **pixel** **plane** **primary colour** **prism** **pupil** **ray** **real image** **reflect** **reflected ray** **refraction** **retina** **secondary colour** **source** **spectrum** **specular reflection** **translucent** **transmit** **transparent** **virtual image**



## Energy adds up

The **law of conservation of energy** states that energy cannot be created or destroyed, only transferred.

$$\text{total energy before} = \text{total energy after}$$

### Transferring energy

Light, sound, and electricity are ways of transferring energy between different stores.

## Energy and temperature

- **Thermometers** measure temperature in degrees **Celsius (°C)**.
- Temperature measures the *average* energy.
- **Thermal energy** measures the total energy.

A warm bath has more thermal energy than a heated kettle, even though the kettle has a higher temperature.

### Heating solids, liquids, and gases

- As we heat things the particles gain more **kinetic energy**, and vibrate more or faster.
- The energy needed to heat an object depends on the mass, material, and temperature rise.

### Equilibrium

**Equilibrium** is when objects have the same thermal energy.

## Energy resources

### Renewable resources

Renewable resources produce greenhouse gases when built, not when used, and will not run out.

For example, wind, tidal, wave, hydroelectric, geothermal, biomass, and solar powers.

The power rating tells you how much energy is transferred per second, or the rate of transfer of energy. Measured in **watts (W)**.

$$\text{Energy transferred (J)} = \text{power (W or J/s)} \times \text{time (s)}$$

The current generated is sent to our offices, factories, and homes down long cables.

Fossil fuels are burned to heat water, which produces steam.

Burning fossil fuels produces **greenhouse gases**, such as carbon dioxide.

The steam turns a turbine, which spins a generator.

### Non-renewable resources

Non-renewable resources include the **fossil fuels** coal, oil, and gas. These were formed millions of years ago from fossilised remains.

These are non-renewable because you cannot reuse them, and they will eventually run out.

Coal, oil, or gas are used to run **thermal power stations**.

## Food and fuels

- There is energy in the **chemical stores** associated with food and fuel.
- Energy is measured in **joules (J)**.
- You need different amounts of energy for different activities.

The energy in food varies.

For example:

- apple – 200kJ per 100g
- chips – 1000kJ per 100g

The energy used when we do things varies too.

For example:

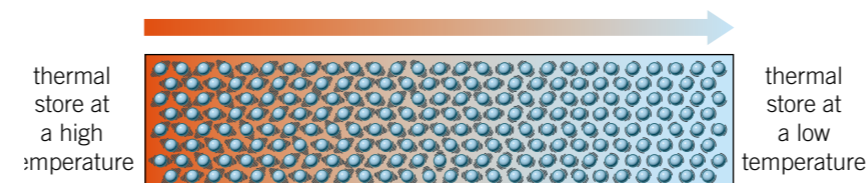
- sitting – 6kJ per minute
- running – 60kJ per minute

## Particles

Thermal energy can be **transferred** by **conduction**, **convection** or **radiation**.

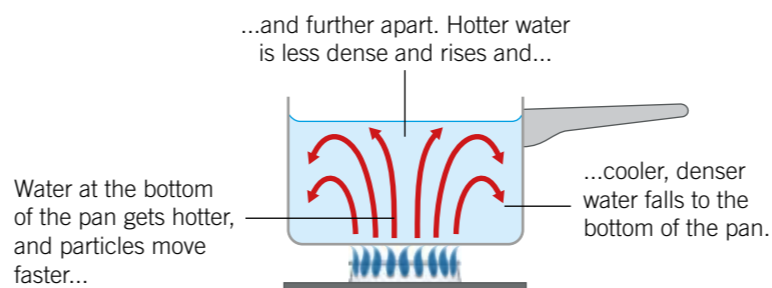
### Conduction

- Particles collide into others when they vibrate.
- Occurs in solids.



### Convection

- Occurs in liquids or gases.
- The part in contact with the heat source gets hotter. The particles move faster, causing them to become further apart, and a decrease in density.
- The hot part then rises, and cooler, denser parts fall and take its place at the bottom.
- They now heat, so the cycle continues. We call this a **convection current**.



## Energy and power

**Power** is the rate of energy transfer – how much energy is transferred each second.

### Energy bills

- Energy use is measured in kilowatt hours (kWh).  
For example, a 2kW device used for 1 hour uses 2kWh; if used for 2 hours, it uses 4kWh.
- An energy bill covers the cost of the fuel used at the power station, the power station, staff, and infrastructure.
- To convert kWh to joules, convert the time to seconds (there are 3600 seconds in an hour).  
For example, 2kWh = 2000J/s × 3600s = 7 200 000J

### Reducing bills

- Use fewer appliances or more efficient ones.
- Insulated houses lose less thermal energy so don't need to use as much power.

## Work

You can transfer energy by using a force, which is doing **work**.

$$\text{Work done (J)} = \text{force (N)} \times \text{distance (m)}$$

Simple machines like **levers** and **gears** can make it easier to do work but you still get the energy out that you put in.

## Radiation

- **Infrared radiation** transfers energy without particles – it is a wave.
- All objects emit radiation.
- The amount depends on their temperature and the surface (colour and rough/smooth).
- Radiation can be **absorbed** or **reflected**.



## Key words

Make sure you can write definitions for these key terms.

absorb chemical store conduction convection convection current energy store fossil fuel gear greenhouse gas infrared radiation insulator joule kilowatt law of conservation of energy lever non-renewable power station radiation renewable reflect thermal energy thermometer work

