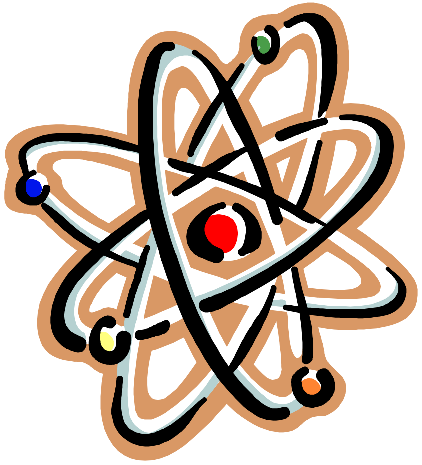
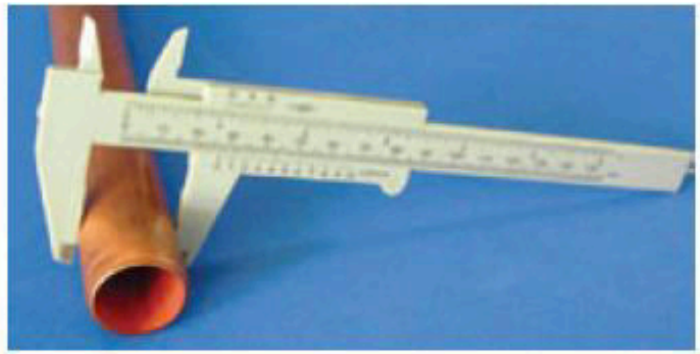
J.C. Physics



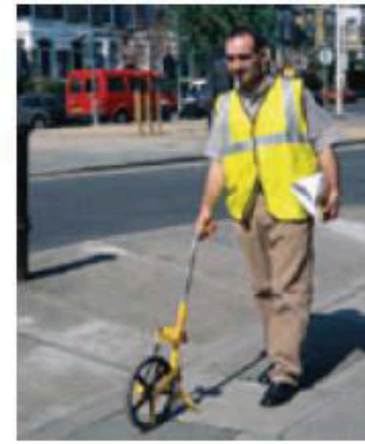
Measurements & Units

- **Length** is measured using a **metre stick** (straight lines), an **opisometer** (short curved lines), a **trundle wheel** (long, curved lengths) or a **Vernier calipers** (diameters or widths of solid objects)

Opisometer



Vernier callipers



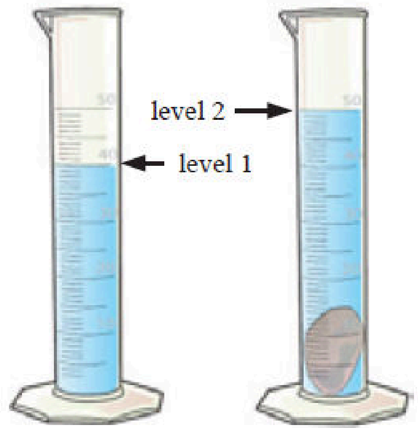
Trundle wheel

- The **area** of an object is a measure of the **amount of surface** it has.
- **Area** is measured in **cm^2**, **m^2** or **km^2**.
- The **area of a rectangle** is the **length** multiplied by the **breadth**.
- The **area of an irregularly-shaped object** (e.g. your hand or a leaf) is found by counting the number of squares it covers on **graph paper**.

- The **volume** of an object is the **amount of space** it takes up. **Volume** is measured in **cm^3**, **m^3**, or **L**.
- The **volume** of a **box** is the **length** multiplied by the **breadth** multiplied by the **height**.
- The **volume** of an **irregularly-shaped object** (e.g. a stone) is found by using a **graduated cylinder** or an **overflow can** and a **graduated cylinder**.

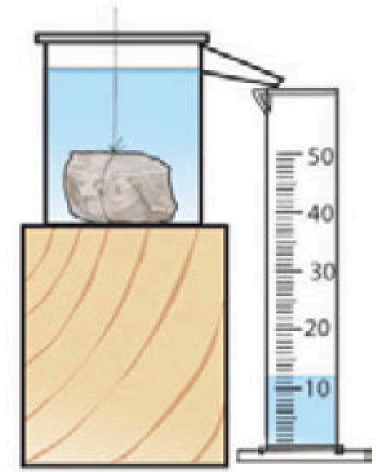
Finding the volume of a stone

using a graduated cylinder.



Finding the volume of a stone

using an overflow can and graduated cylinder.



EXPERIMENTS:

36.1 To Measure the Length of Straight Lines Using a Ruler

36.2 To Measure the Length of Curved Lines Using an Opisometer

36.3 To Measure Lengths Using a Vernier Callipers

36.4 To Find the Area of Regularly-Shaped Objects (Rectangles)

36.5 To Find the Area of an Irregularly-Shaped Object (Your Hand)

36.6 To Measure the Volume of a Liquid

36.7 To Measure the Volume of an Irregularly-Shaped Object (a Stone)

36.8 To Measure the Volume of an Irregularly-Shaped Object (a Stone), Using an Overflow Can

Energy

- **Energy** is the **ability** to do **work**.
- **Energy** is measured in **joules** (J).
- Different **forms** of **energy** include: **potential**, **kinetic**, **heat**, **light**, **sound**, **electrical**, **chemical** and **nuclear**.
- **Kinetic energy** is the energy that **moving** things have.
- **Potential energy** is **stored energy** (e.g. a coiled spring or a brick at a height).
- Energy cannot be **created** or **destroyed**, but can **only change** from one form to another.
- An **energy converter** (e.g. a toaster, radio, torch, battery, leaf, light bulb **changes energy** from **one form to another**.
- A **good insulator** (e.g. a lagging jacket) keeps heat energy in.
- **Non-renewable sources** of energy cannot be replaced when they are used up. They are the **fossil fuels**, coal, oil, gas and turf.
- **Renewable sources** of energy are constantly being **replaced by Nature**. They include **solar**, **hydro-electric**, **wind**, **wave**, **biomass** and **geothermal**.
- The **sun** provides almost all of our energy - it is our **primary source** of energy.
- **Nuclear energy** is the energy stored in the **nuclei** of **atoms**.

EXPERIMENTS:

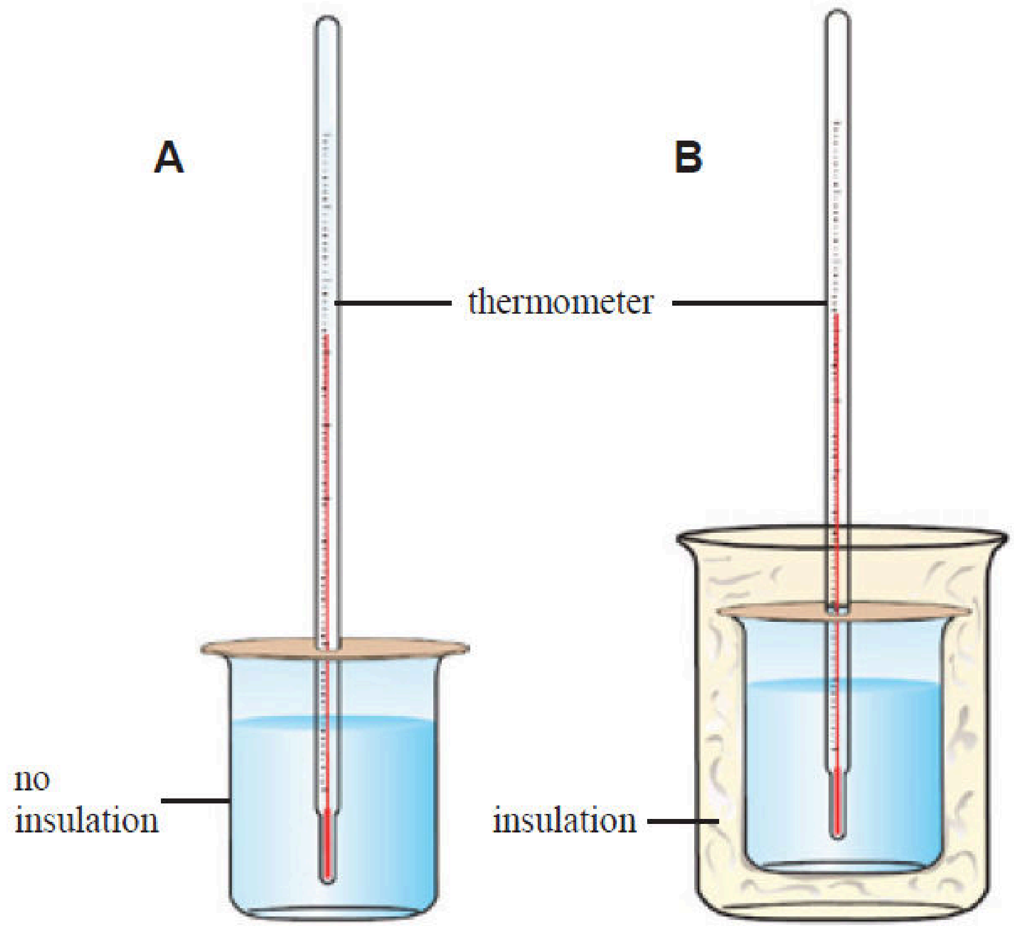
37.1 To Compare the Insulating Ability of Different Materials

Beaker **B** is **insulated** with various insulating materials.
Beaker **A** is left with **no insulation** - it acts as the **control**.
Boiling water is added equally to both beakers and the **temperature** taken using a **thermometer**.

After **10 minutes**, there is seen to be a **greater heat loss** from the beaker with **no insulation** than from the insulated beaker.

The amount of heat loss depends on how good the insulator used is.

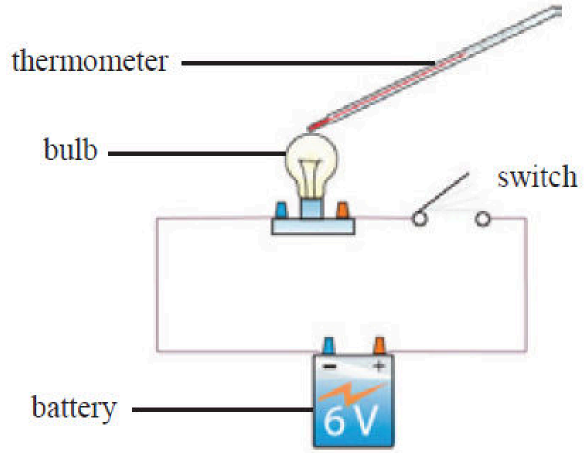
Insulation reduces heat loss.



37.2 To Convert Chemical Energy to Electrical Energy to Heat Energy

The **battery** converts **chemical energy** into **electrical energy** in the wires.

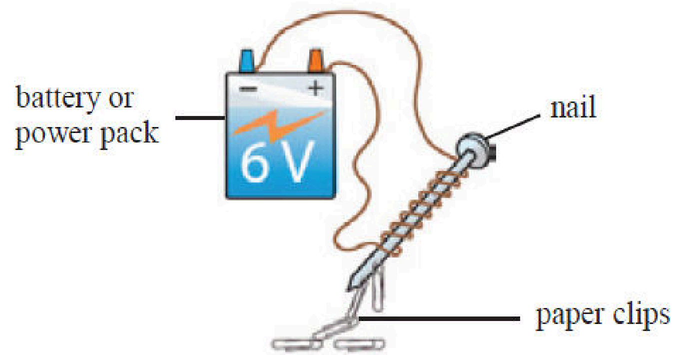
The **electrical energy** is converted into light and **heat energy** in the bulb.
The heat energy is detected using a **thermometer**.



37.3 To Convert Electrical Energy to Magnetic Energy to Kinetic Energy

The **electrical energy** from the battery is converted to **magnetic energy** in the nail.

The **magnetic energy** is then converted into **kinetic energy** in the paper clips, as they are lifted and move.

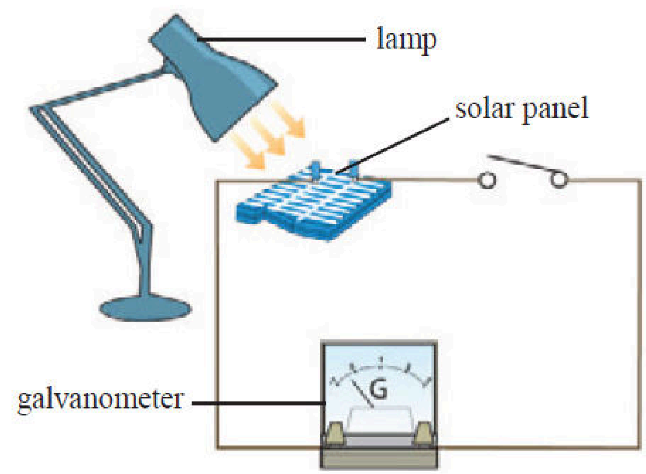


37.4 To Convert Light Energy to Electrical Energy to Kinetic Energy

Light energy from the lamp is converted into **electrical energy** in the solar panel.

The **electrical energy** is then converted into **kinetic energy** in the needle of the galvanometer, which moves.

If the current is large enough, a **small motor**, in place of the galvanometer could be used to show the kinetic energy.



Speed, Velocity & Acceleration

		Measured in:
• **Speed**:	The **speed** of an object is the **distance** it travels per **unit time**. **Speed** = $\frac{\text{Distance (m/s)}}{\text{Time taken (s)}}$	m/s or ms^{-1}
• **Velocity**:	The **velocity** of an object is the distance it travels per unit time, in a **given direction**.	m/s or ms^{-1}
• **Acceleration**:	**Acceleration** is the **change** in **velocity** per second. **Acceleration** = $\frac{\text{Change in velocity (m/s)}}{\text{Time taken (s)}}$	m/s/s, or ms^{-2}, or m/s^2

Mass, Density & Flotation

- The **mass** of an object is the **amount of matter** in it.
  Mass is measured in **kilograms** (kg) or **grams** (g).

- The **density** of a substance is the **mass** of **1 cm^3** of it.
  Density is measured in **grams per cubic centimetre**. (g/cm^3).

- **Density** = $\frac{\text{Mass (g)}}{\text{Volume } (cm^3)}$

- To find the density of any substance, first find its **mass** on an **electronic balance**, and then find its **volume**, using an **overflow can** and **graduated cylinder**.
  Then **divide** the **mass** by the **volume** to find the density. (answer in g/cm^3).

- The **density** of **water** is 1 g/cm^3.

- An object **sinks** if its **density** is **greater** than the density of the liquid it is in.

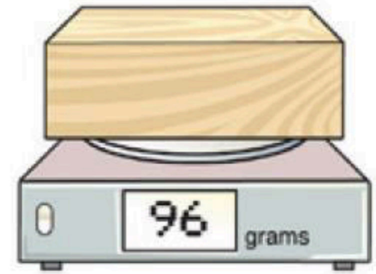
- An object **floats** if its **density** is **less** than the density of the liquid it is in.

- **Ice floats** in **water** because its **density** (0.9 g/cm^3) is **less** than the density of water.

EXPERIMENTS:

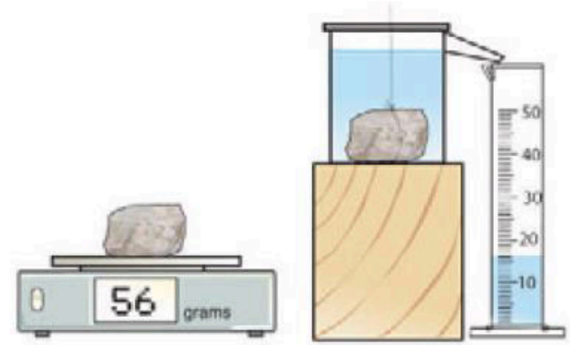
39.1 To Find the Density of a Regularly Shaped Solid (e.g. a Block of Wood)

The **mass** is found on an **electronic balance**.
The **volume** is length x breadth x height.
The **mass divided by the volume** gives **density**.



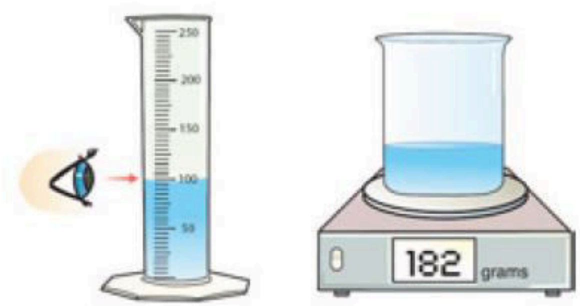
39.2 To Find the Density of an Irregularly Shaped Solid (e.g. a Stone)

The **volume** is found using an **overflow can**.
Mass divided by volume gives **density**.



39.3 To Find the Density of a Liquid

Volume is found using a **graduated cylinder**.
Mass divided by volume gives **density**.



39.4 To Study Flotation

Various substances are placed in **water**.
Those with a density less than that of water **float**.

39.5 To Show the Expansion of Water on Freezing

A bottle filled with **water** and left in a **freezer** bursts as the **ice expands**.

Force, Work & Power

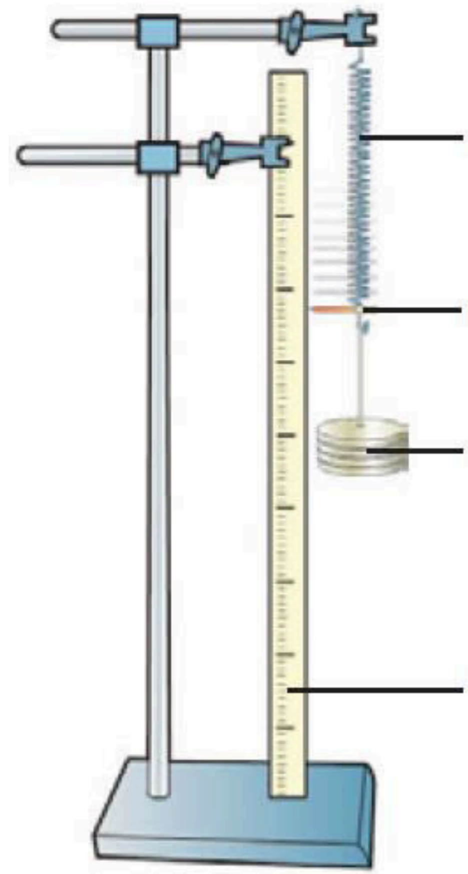
	Measured in:
• A **force** is anything which causes an object to **move** or **change** its **velocity**.	**newtons** (N)
• **Push**, **pull**, **weight** and **friction** are all examples of **forces**.	
• **Forces** are measured using a **spring balance**.	
• **Friction** is a force which **prevents easy movement** between two objects in contact.	**newtons** (N)
• The **weight** of an object is the **force of gravity** acting on it.	**newtons** (N)
• **Hooke's Law** states that the **extension** of a spring depends on the size of the **weight** (force) attached to it.	
• A **graph** of **spring extension** against the **weight** (force) attached to it, gives a **straight line** through the **origin** (0,0)	
• **Energy** is the **ability** to do **work**.	**joules** (J)
• **Work** is done when a **force** moves an **object**. **Work** (J) = **Force** (N) x **Distance** (m)	**joules** (J)
• **Power** is the **rate** at which **work** is done. **Power** is the amount of **work** done in **1 second**.	**watts** (W)
• **Power** = $\frac{\text{Work done (J)}}{\text{Time taken (s)}}$	

EXPERIMENTS:

40.1 To Investigate the Law of the Spiral Spring (Hooke's Law)

The **spring** and **metre stick** are held in the retort stand as shown.
The position of the **pin** is **noted** as each **weight** is added to the spring.
The **extension** of the spring for each **total weight** is noted.

The **bigger** the **weight**, the **greater** the **extension** of the spring. They are in **direct proportion**, and so would give a **straight line graph** through (0,0).



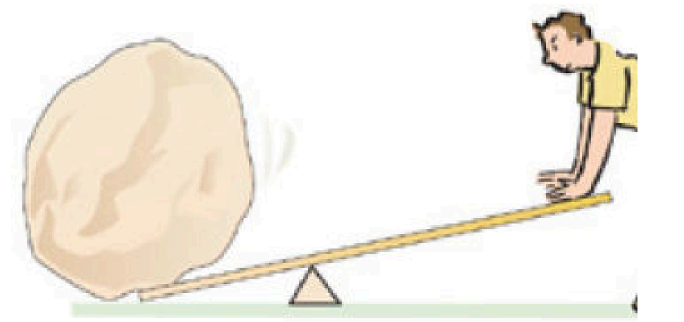
Weight

- The **weight** of an object is the **force of gravity** acting on it.
- **Weight** is a **force** and is measured in **newtons** (N).
- The **force of gravity on Earth** is 10 N on every 1 kg of mass.
- **Weight** (N) = **Mass** (kg) x **10** N/kg (earth's gravity).
- To **find the weight** on Earth, **multiply** the **mass** (in kg's) by **10**.
- The weight of something in **outer space** is the mass multiplied by **0**. It is **weightless**.

DIFFERENCES BETWEEN MASS AND WEIGHT

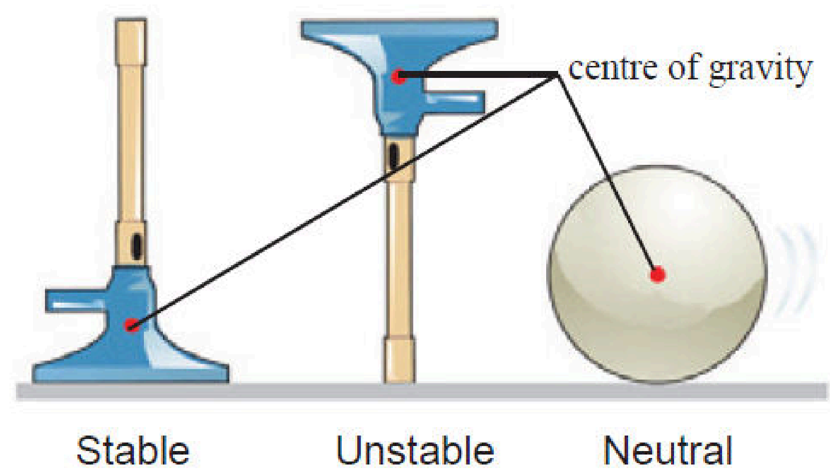
MASS	WEIGHT
1. Measured in **kilograms** (kg)	1. Measured in **newtons** (N)
2. Is **fixed**, never changes.	2. **Varies**, depends on where you are.
3. Is a **fixed feature** of all things - like length or volume.	3. Is a **force** or pull on something.

Turning Forces, Centre of Gravity



- The **moment** of a force is the **turning effect** of a force.
  Moment = (**Force**) x (**Distance from the fulcrum**).
- A **lever** is any **rigid body** which is free to turn about a a fixed point called the **fulcrum**.
- **Examples** of **levers** are: door, door handle, pliers, scissors, metre stick, screwdriver (used to open paint tin), etc.
- The **Law of the Lever** states that when a lever (e.g. a metre stick) is **balanced**, the total **clockwise moments equal** the total **anticlockwise moments**.
- The **centre of gravity** of an object is the point through which all the weight of the object appears to act. (i.e. the centre of its weight).

- **Stable equilibrium** is present if when an object is **slightly tilted**, its **centre of gravity** is **raised**, and it goes back to the original position on release.
- Objects in **stable equilibrium** will have a **wide base** and a **low** centre of gravity.
- **Unstable equilibrium** is present if when an object is **slightly tilted**, its **centre of gravity** is **lowered**, and it takes a new position when released (i.e. it falls over on its side).
- **Neutral equilibrium** is present if when an object is moved, its **centre of gravity** is **neither raised** nor **lowered**. The object never becomes unstable - it does not fall over and just takes up a new position where it is still in neutral equilibrium.

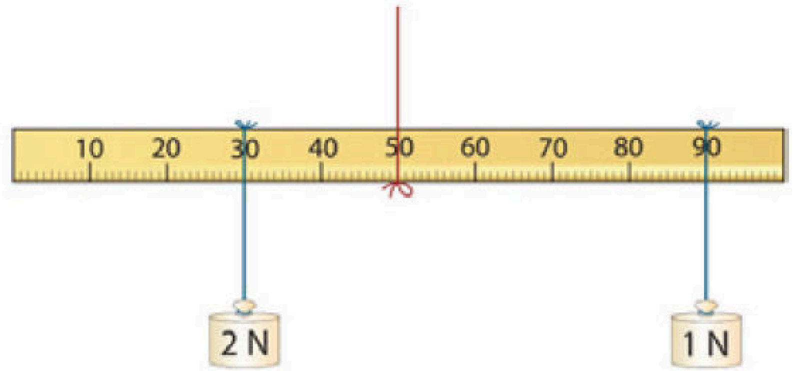


The three states of Equilibrium

EXPERIMENTS:

42.1 To Prove the Law of the Lever

The metre stick is hung from the **50 cm mark** and **weights** are hung from each side, **balancing the metre stick** each time.

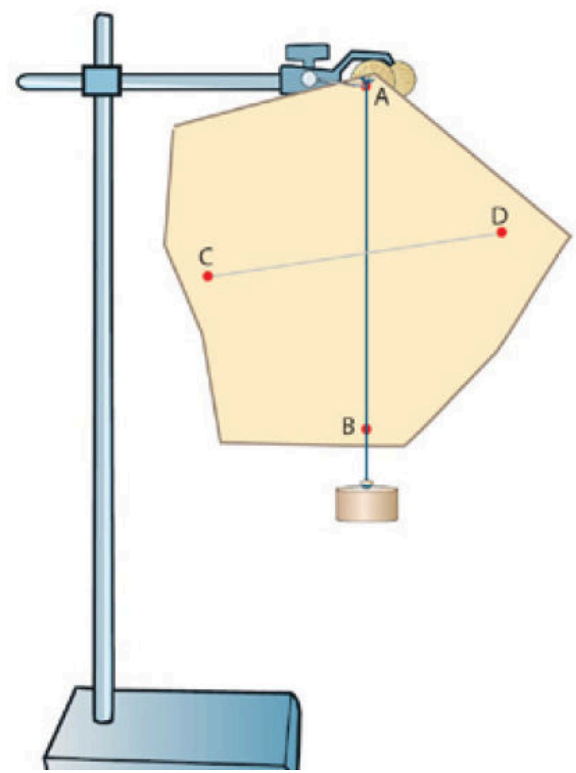


The **moments** are calculated on each side by **multiplying** the **weight** by the **distance** to the **fulcrum**.
When the **clockwise moments** equal the **anticlockwise moments**, the metre stick is balanced.

This proves the **Law of the Lever**.

42.3 To Find the Centre of Gravity of an Irregularly Shaped Cardboard

The **cardboard** and a **plumbline** are hung from a **pin**, stuck in a **cork** and held as shown in a **retort stand**.



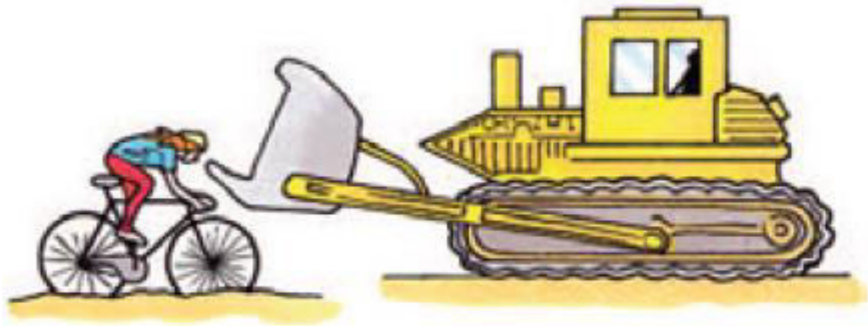
Using the plumbline as a guide, the line **AB** is drawn on the **cardboard**.
The cardboard is then hung from a different point (e.g. **C**), and, again, the plumbline is used to draw the line **CD**.

This is repeated twice more from **other points** at the edge of the cardboard, and vertical lines drawn, as before.

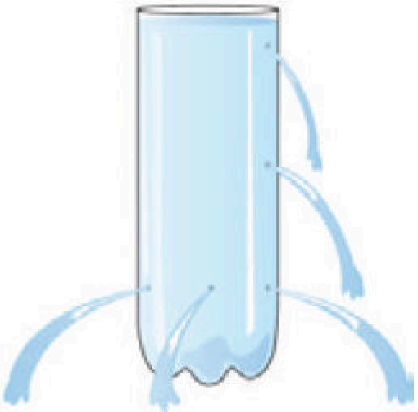
Where all the lines **meet** is the **centre of gravity** of the cardboard.

Pressure

- **Pressure** is the **force** per **unit area**.
- **Pressure** $= \dfrac{\text{Force (N)}}{\text{Area (m}^2\text{)}}$



- **Pressure** is measured in **newtons per square metre** (N/m^2), or **pascals** (Pa). $1\ N/m^2 = 1\ Pa$.
- The **smaller the area**, the **greater the pressure**.
- **Pressure** in a **liquid increases** with **depth**.
- The **pressure** in a **liquid** acts **equally** in all directions.
- **Atmospheric pressure** is caused by the **weight** of the **atmosphere**.
- **Atmospheric pressure decreases** the **higher** you go above sea-level.

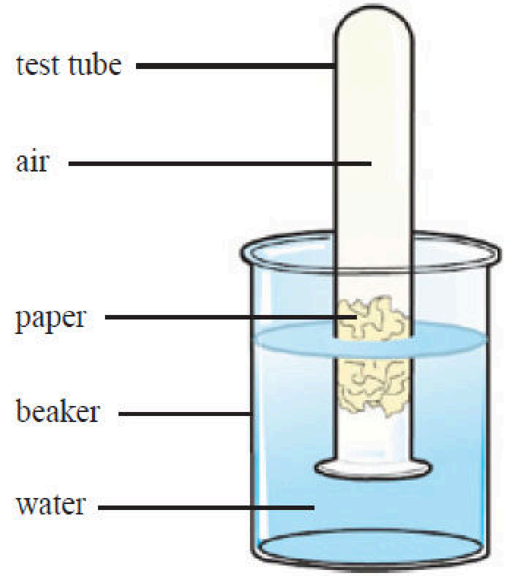


- A **barometer** is used to measure atmospheric pressure.
- **Normal atmospheric pressure** can hold up **76 cm of mercury** in a mercury barometer.
- Normal atmospheric pressure is **76 cm of mercury** or **1013 hectopascals**.
- An **altimeter** is a **barometer** used to measure **height**.
- **High atmospheric pressure** gives **good**, settled **weather**.
- **Low atmospheric pressure** gives **bad**, unsettled **weather**.

43.2 To Show that Air Occupies Space

The **dry paper** in the test tube remains dry when removed from the beaker.

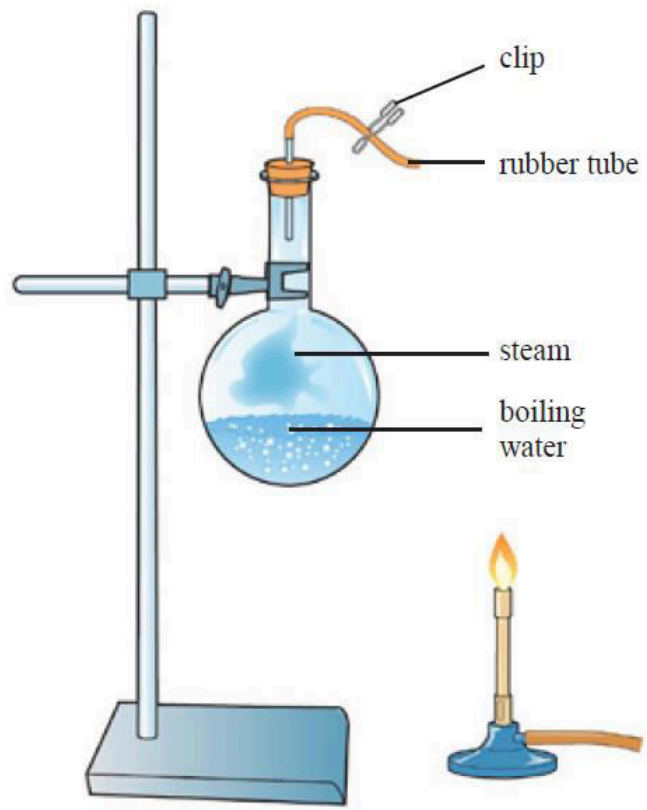
The **water** did **not enter** the test tube because **air** was **taking up space** in the test tube.



43.3 To Show that Air has Mass

With the **clip open**, **water** is **boiled** in the flask.
The steam **drives** all the **air** out of the flask.
The **Bunsen burner** is then removed and the **clip closed** so no more air can get in.
As the steam cools, it **condenses** back into water, leaving **no air** in the **flask** above the water.

An **electronic balance** is then used to find the **mass** of the flask **without air**.
The clip is then opened, **allowing air back** into the **flask**.
The **mass** of the **flask with air** is then found.
By **subtracting** the two masses, the **mass of air in the flask** is found.

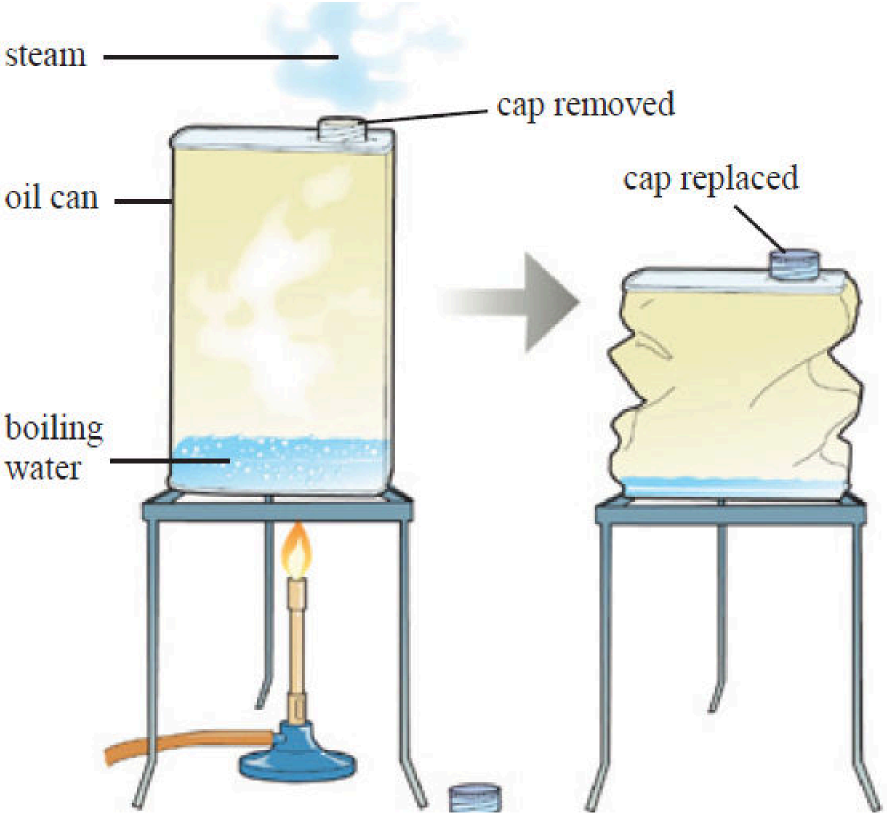


43.4 To Demonstrate Atmospheric Pressure

A small amount of **water** is **boiled** for five minutes in the can, with the **cap removed**. The **steam** drives all the air out of the can. The Bunsen burner is then removed and the cap replaced so **no more air** can get in.

As the steam cools, it **condenses** back into **water**, leaving **no air in the can** above the water.

With no air inside the can, **atmospheric pressure** outside the can crushes it.

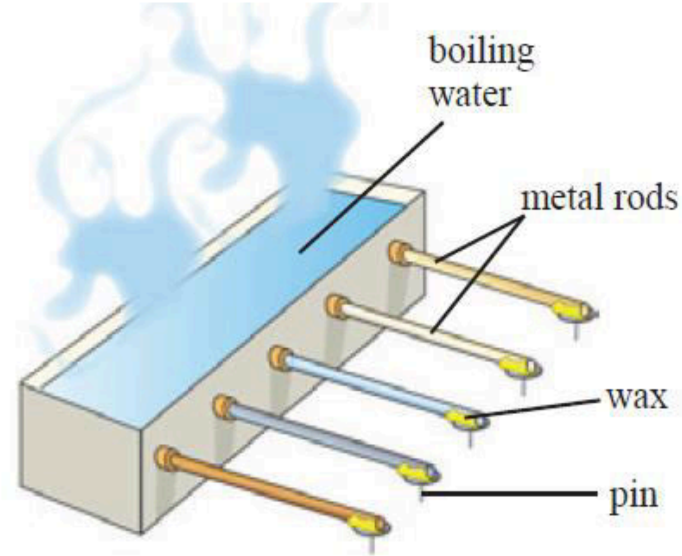


Heat

- **Heat** is a form of **energy**; it is measured in **joules** (J).
- **Heat** always moves from a **hot area** to a **cold area**.
- **Conduction** is the transfer of heat through a substance **without** the particles in the substance **moving out of position**.
- **Metals** are very **good conductors** of heat.
- An **insulator** is a substance that does **not allow heat** to pass through it easily. Insulators are very poor conductors.
- **Convection** is the transfer of heat through a **liquid** or **gas** when **molecules** of the liquid or gas **move upwards** and carry the heat.
- **Radiation** is the transfer of heat, in **rays**, from a hot object, **without** needing a **medium** to pass through.
- A **dull, black surface radiates** heat out better than a **bright shiny surface**.
- A **dull, black surface absorbs** heat better than a **bright, shiny surface**.
- **Solids, liquids and gases** all **expand** when **heated** and **contract** on **cooling**.
- When **water** is cooled **below 4°C**, it begins to **expand**.
- **Ice is less dense than liquid water** and so **floats** on water - this is important for fish to survive.

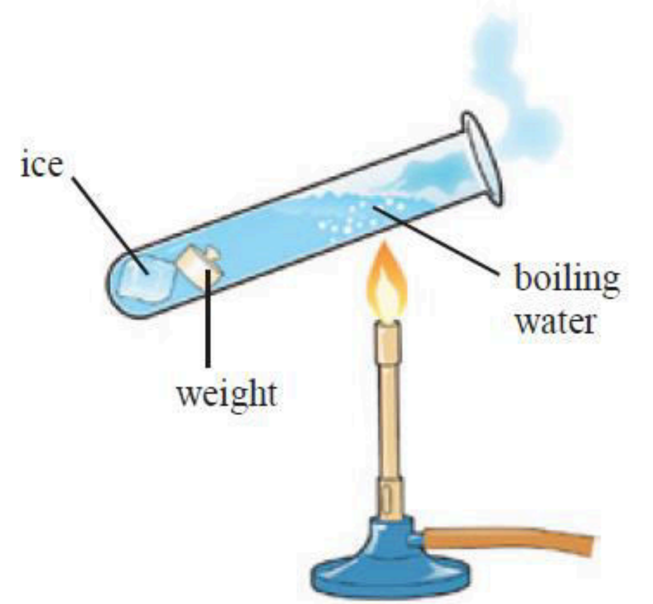
EXPERIMENTS:

44.1 To Compare the Conductivity of Various Metals



Heat travels by **conduction** through the **metal rods**. The **wax melts** and the **pin drops** off the metal that is the **best conductor** of heat first.

44.2 To Show that Water is a Poor Conductor of Heat



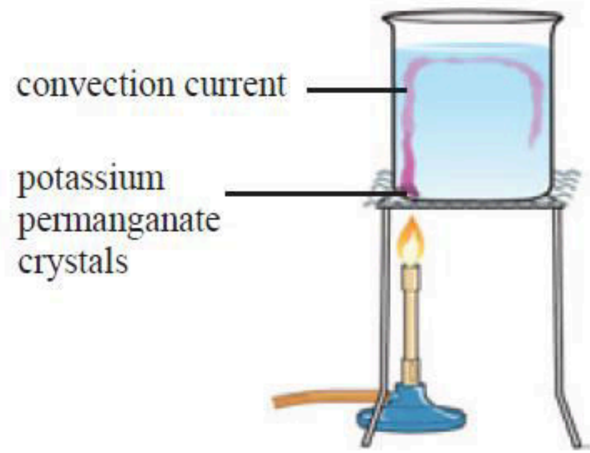
The **ice** at the bottom of the test tube does **not melt**, even though the **water** at the **top** is **boiling**.

As heat cannot reach the ice by convection (where molecules move upwards to carry heat), the **water** above the ice must be a **very bad conductor** of heat.

44.3 To Show Convection Currents in Water

Some potassium permanganate **crystals** are placed at the bottom of the beaker, to **colour the water**.

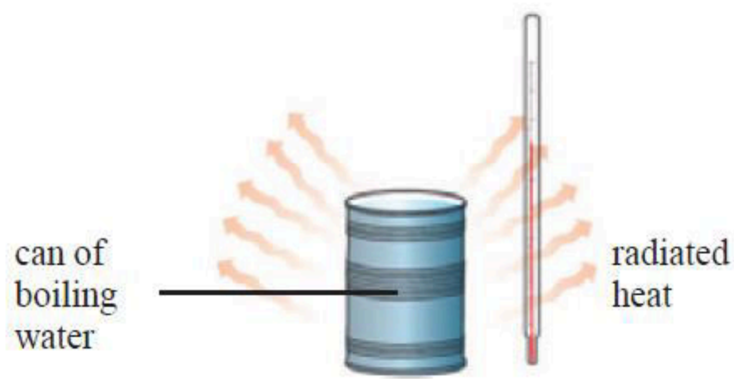
The **movement** of the **coloured water**, shows a **convection current** in the water, as **heated water** moves **upwards** and is **replaced** by **colder water** moving **downwards**.



44.4 To Show Heat Transfer by Radiation

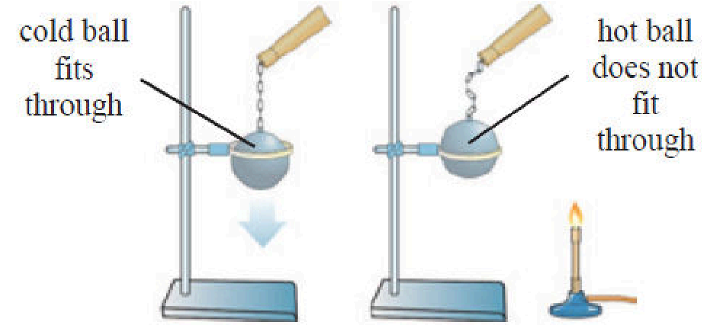
The **tin can** is filled with **boiling water** and the **thermometer bulb** is placed **beside** it as shown.

Heat transfer from the hot can, by **radiation**, **raises** the **temperature** on the thermometer.



44.5 To Show that Solids Expand when Heated and Contract when Cooled

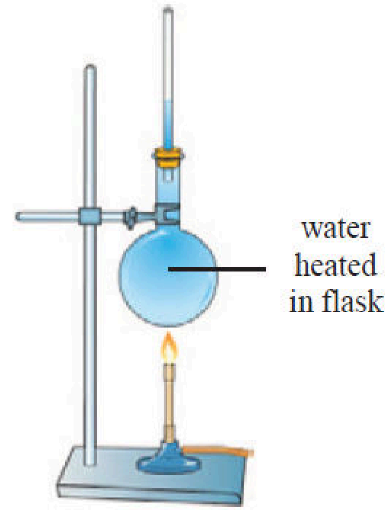
The **metal ball can fit** through the **ring** when the ball is **cold**.
When the ball is **heated**, it **expands** and can **no longer fit** through the ring.
On **cooling**, the ball **contracts** and can fit through the ring again.



44.6 To Show that Liquids Expand when Heated and Contract when Cooled

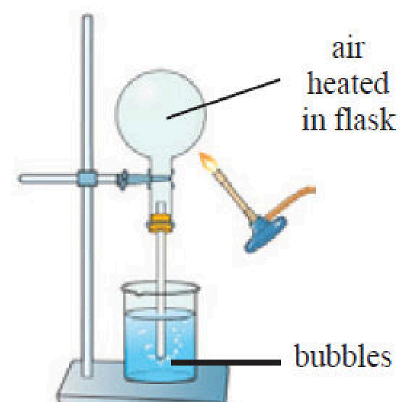
When the **water** in the flask is **heated** it **expands** and **rises up** the glass tube.
On **cooling**, the water **contracts** and moves back **down** the tube.

The **expansion** of a **liquid** on **heating** and its **contraction** on **cooling** explains how a **thermometer** works.



44.5 To Show that Gases Expand when Heated and Contract when Cooled

When **heated**, the **air in the flask expands** and some escapes causing **bubbles** in the water in the beaker.
On **cooling**, the **air contracts** and **water** from the **beaker** gets **sucked up** the tube.

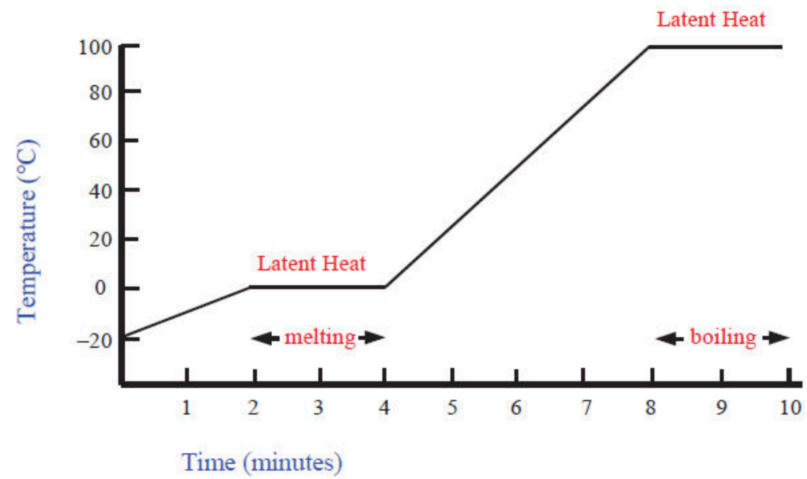


Temperature

- **Temperature** is a measure of **how hot** an object is.
- A **mercury** or **alcohol thermometer** is used to **measure** temperature accurately.
- **Thermometers** work because **liquids expand** when **heated** and **contract** when **cooled**.
- **Temperature** is measured in **degrees Celsius** (°C).
- **Water freezes** at **0°C**, and **boils** at **100°C** at normal atmospheric pressure.
- The **amount of heat** in a substance **depends** on its **temperature**, its **mass**, and **what the substance is**.
- **200 ml** of **water** at **60°C** contains **twice** as much heat as **100 ml** of **water** at **60°C**.
- **200 ml** of **water** at **60°C** contains **more heat** than **200 ml** of **oil** at **60°C**.

- **Latent heat** is the heat used by a substance to **change its state** - it does **not** raise the temperatu

- Latent heat:

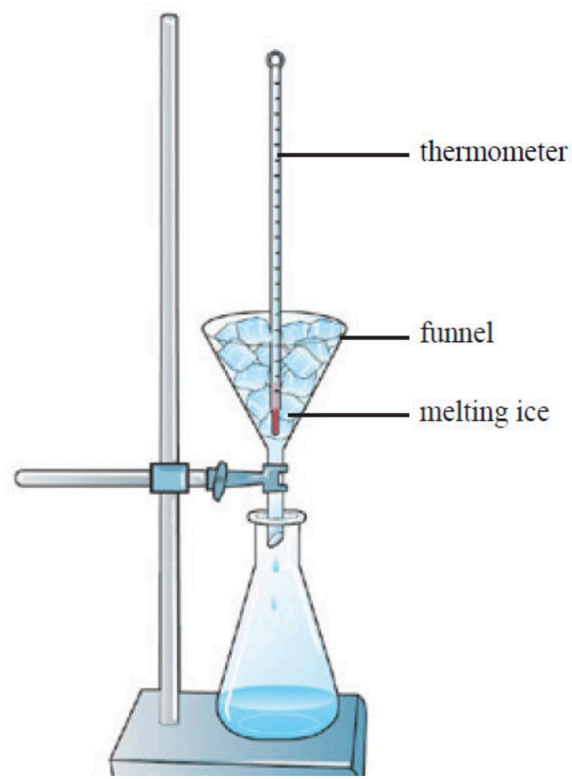


EXPERIMENTS:

45.1 To Determine the Melting Point of Ice

A **thermometer** is placed in a **funnel** of **melting ice**, as shown.

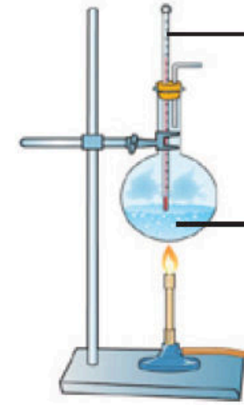
The temperature remains **steady** at **0°C** as the **ice melts** - this is the **melting point** of ice.



45.2 To Determine the Boiling Point of Water

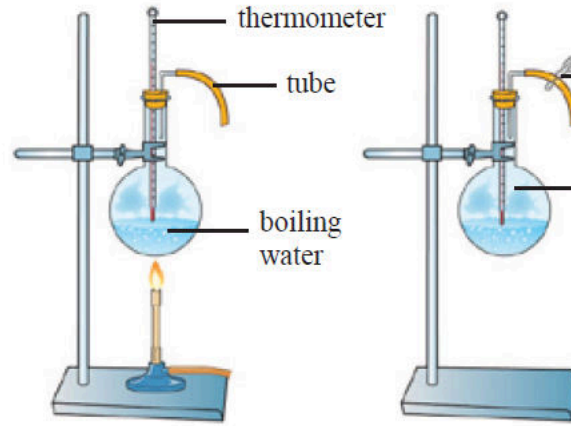
A **thermometer** is placed just **above** the **surface** of **boiling water** in a flask, as shown.

Note the **steady temperature** of **100 °C** in the steam - this is the **boiling point** of water.



45.3 To Show the Effect of Pressure on the Boiling Point of Water

With the **tube open**, the **water** in the flask is **boiled** for **three minutes**.
The **steam** drives all the **air out** of the flask.
The **Bunsen burner** is then **removed** and the **tube clamped**.
The **steam** then **condenses** leaving a **partial vacuum** (with very **low pressure**) above the water in the flask.
At this **low pressure**, the water is seen to boil again at temperatures of as **low as 60°C**.

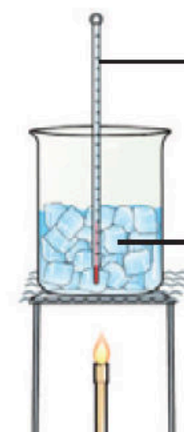


45.4 To Demonstrate Latent Heat

A **thermometer** is placed in ice taken **directly** from the **freezer**. This ice should show a temperature of **less than 0°C**, and, as it **melts**, the temperature **rises** to **0°C**.

The **ice** and **water** will **remain at 0°C** until **all** the ice has **melted**. The heat being supplied is **latent heat** - it is being used to **change the state**, and does **not raise** the **temperature**.

The **temperature** will then **increase** steadily to **100°C** when the water begins to **boil**. The **temperature** will **not rise above 100°C**, as, once again, the heat supplied is being used to **change the state** (**latent heat**).



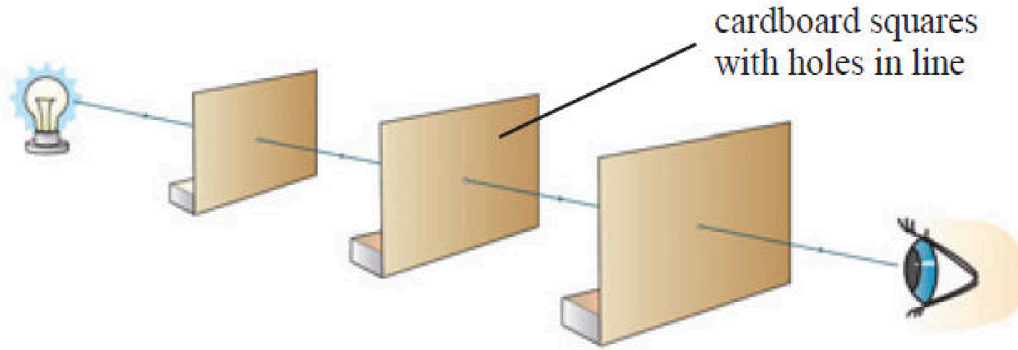
Light

- **Light** is a form of **energy** - it can make things move.
- The **Crooke's radiometer** and the **solar-powered calculator** show that light is a form of **energy**.
- **Luminous objects** give out light, e.g. the **Sun**, a **light bulb**, a **candle**.
- **Light travels** in **straight lines** - this gives rise to **shadows**.
- A **solar eclipse** occurs when the **Moon** passes between **Sun** and **Earth**.
- **Reflection** occurs when light **bounces** back off a surface.
- Light is **reflected** in a **regular manner** off a **shiny surface** e.g. a mirror.
- **Refraction** is the **bending of light** as it goes from one medium to another.
- Light **rays** are always **refracted towards** the **denser medium**.
- A **convex** or **converging lens** brings light **rays together**.
- A **concave** or **diverging lens** spreads light **rays apart**.
- **White light** is a mixture of the **7 colours** of the **spectrum**.
- **Dispersion** is the **breaking up** of **white light** into its 7 colours.

EXPERIMENTS:

46.1 To Show that Light Travels in Straight Lines

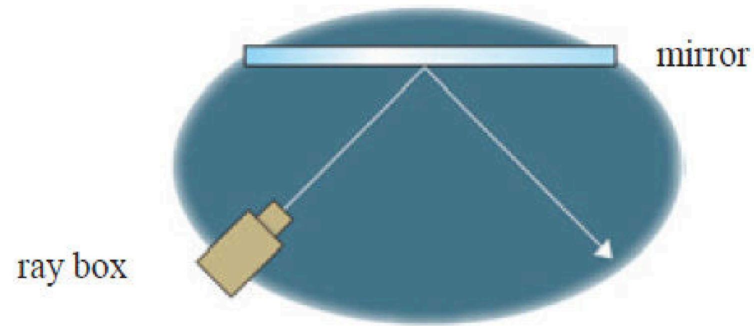
The bulb can only be seen when the three holes in the cardboard squares are in a straight line.



46.2 To Show the Reflection of Light

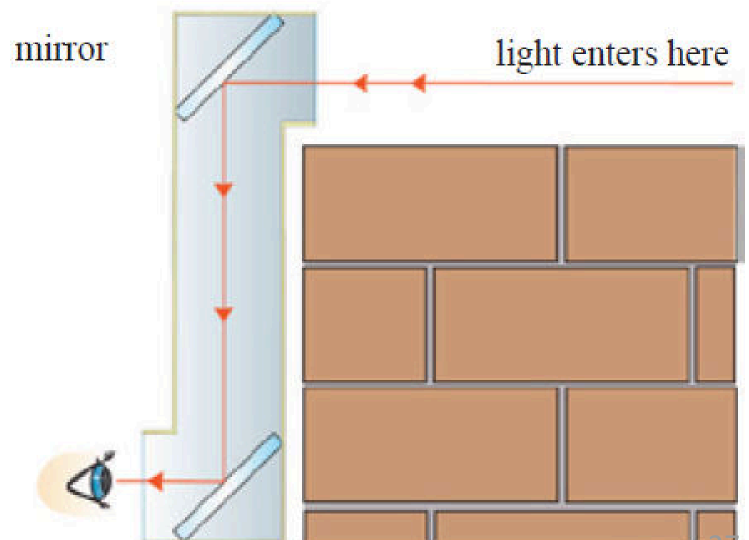
The **light ray** from the **ray box** strikes the **mirror** and gets **reflected** back.

The ray gets **reflected** back at the **same angle** as it strikes the mirror with.



Light from an **object** enters the **periscope** and strikes the **top mirror**.
It is then **reflected down** to the **bottom mirror** which reflects it **into the eye**.

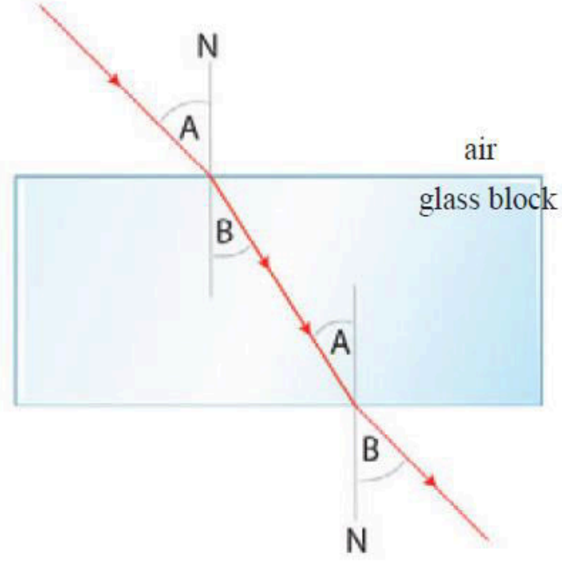
Both mirrors must be at an angle of **45°** for the periscope to work.



46.3 To Show the Refraction of Light

A **light ray** from a **ray box** is seen to **change direction** (bend) as it goes from **air** into the **glass block**.

The **angle B** is **less** than the **angle A** as the light ray gets pulled in **towards** the **denser medium** (the glass).



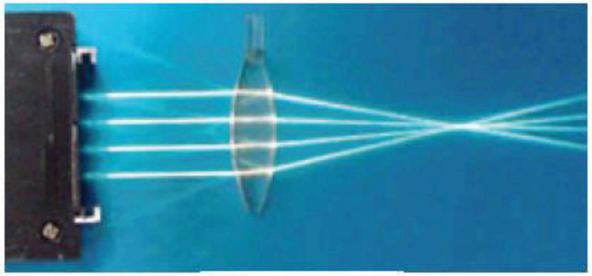
46.4 To Show the Effect of Convex and Concave Lenses

Light rays from a **ray box** are passed through a **convex** and a **concave** lens.

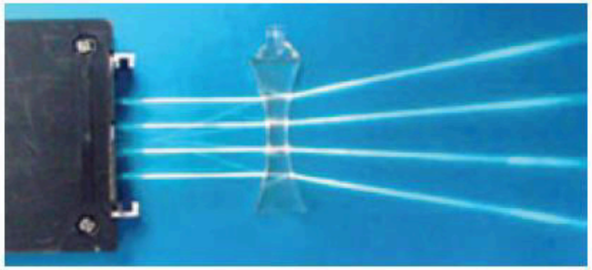
Light rays striking a glass with a **curved surface** get **refracted** at different angles.

A **convex** (**converging**) lens refracts the light rays entering it so that they all **meet at a point**.

A **concave** (**diverging**) lens refracts the light rays entering it so that they **spread out** as they leave the lens.



convex lens

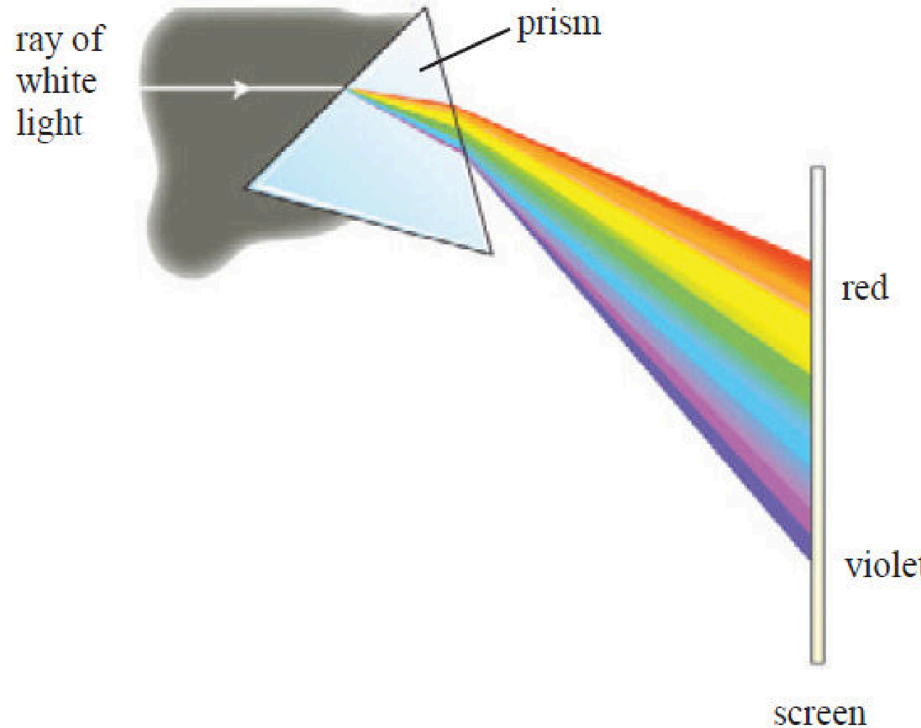


concave lens

46.5 To Show the Dispersion of White Light

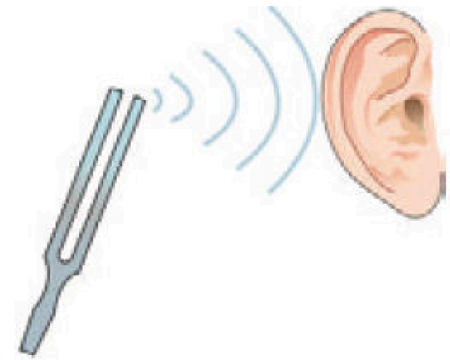
A **ray** of **white light** is passed through a glass **prism**.
The prism **disperses** (breaks up) the light into its **7 different colours**.

Each colour is **refracted differently** through the prism **- red light** is **refracted** the **least**, and **violet**, the **most**.
This causes the colours to **spread out** as seen on a **screen**.



Sound

- **Sound** is a form of **energy** caused by **vibrating objects**.
- **Sound**, unlike light, **needs a medium** to pass through.
- **Sound** is **reflected** off hard surfaces, resulting in echoes.
- **Ultrasound** has **frequencies** too **high** for humans to **hear**.
- **Sound travels** at **340 m/s -** much **slower** than **light** (300,000,000 m/s).
- **Thunder** and **lightning** show that **light travels faster** than sound.
- The **loudness** of sound is measured in units called **decibels**.

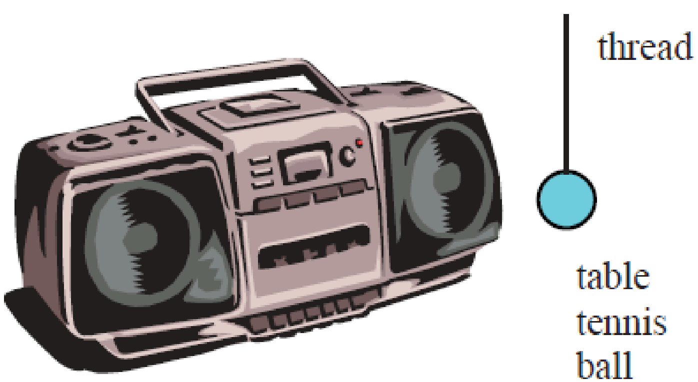


EXPERIMENTS:

47.1 To Show that Sound is a Form of Energy

Sound from the **speaker** travels through the air and causes the **table tennis ball** to **move**.

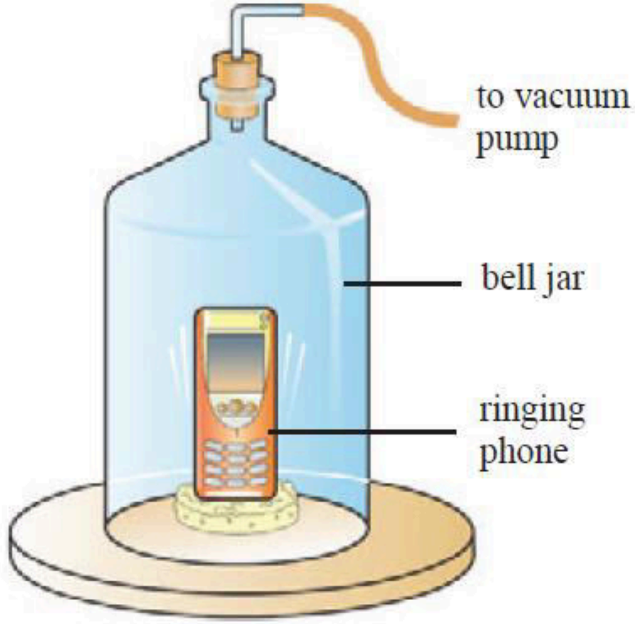
This shows that **sound** is a form of **energy** and can be **converted** into other forms.



47.2 To Show that Sound Cannot Travel in a Vacuum

A **vacuum pump** is used to **remove** the **air** from inside the bell jar.
The **phone** can be heard **ringing** when there **is air** in the bell jar - the **sound** can **travel** through **air**.

When the **air** is **removed**, even though the phone is still ringing, **no sound** is **heard**.
Sound cannot travel through a **vacuum**.

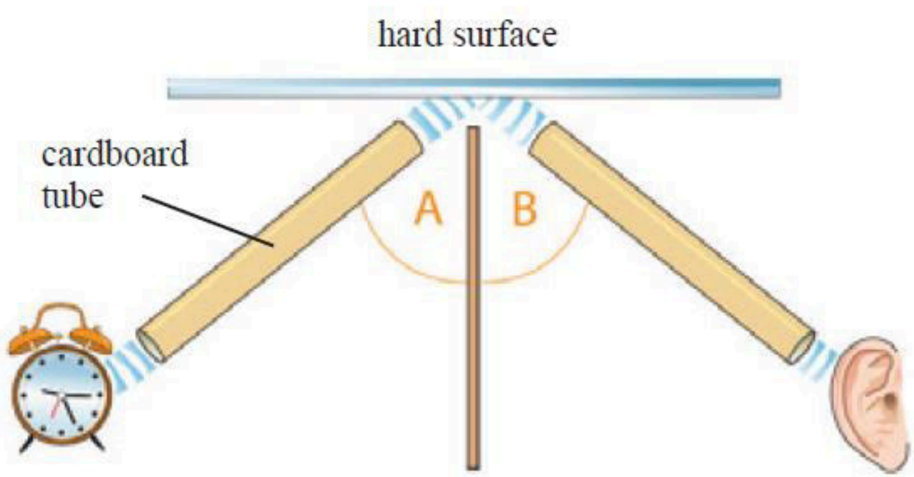


47.3 To Demonstrate the Reflection of Sound

Sound from the ticking clock is directed through the **cardboard tube**, to a **hard surface**.

The **reflected sound** is then heard through the **second tube**.
The reflected sound is heard the **loudest** when the **angle A equals** the **angle B**.

This shows that sound, like light, reflects off a surface at the **same angle** it enters.



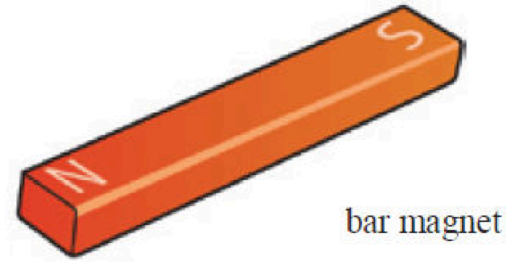
Magnetism

- **Iron**, **nickel**, **cobalt** or their **alloys** can be **magnetised**.
- The **magnetic effect** of a magnet is strongest at the **two ends** - called the **north pole** and the **south pole**.
- The north pole of a freely suspended magnet always points North.
- **Like poles repel** each other, **unlike poles attract**.
- A **magnetic compass** contains a small **magnet balanced** on a **thin spindle** which is free to move. Its **north pole** points **North**.
- A **magnetic field** is the **space** around a magnet where a **magnetic force** can be see
- **Magnetic fields** can be shown using **iron filings** or **plotting compasses**.
- **Magnetic field lines** go from the **north pole** to the **south pole** of a magnet.
- The **Earth** has a **magnetic field** as if it had a huge **bar magnet** at its **centre**, with the **magnet's south pole** in the **northern hemisphere**.
- Magnets are used in **electric motors**, **telephones**, **loudspeakers**, **compasses**, press and **fridge doors**, **dynamos** etc.

EXPERIMENTS:

48.1 To Test a Variety of Materials for Magnetism

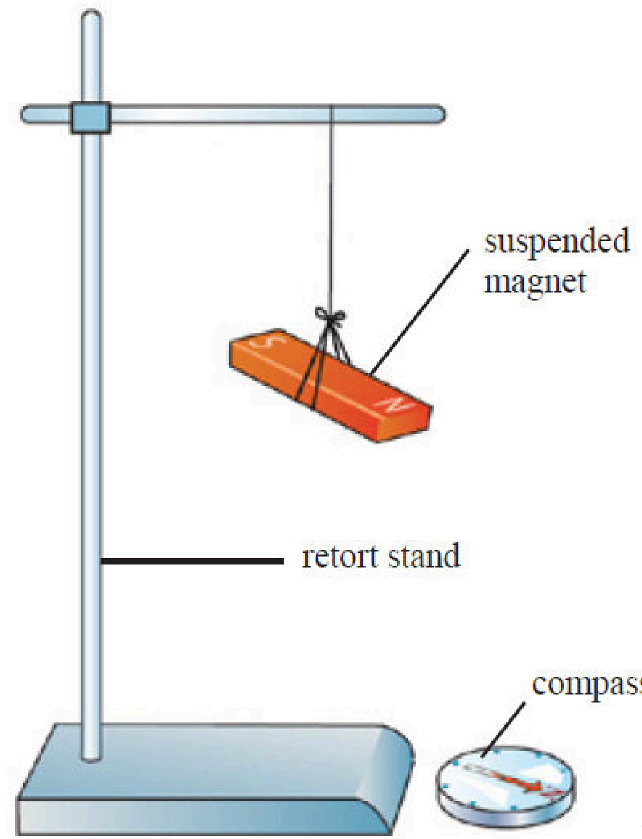
Bring a **bar magnet** close to a variety of materials to see if they are **attracted** to the **magnet**. Materials that contain the elements **iron**, **nickel** or **cobalt** will have magnetic properties.



48.2 To Find the North Pole of a Magnet

One end of a **suspended magnet** points **North**.

A **compass** is used to determine which end of the suspended magnet is pointing **North**.



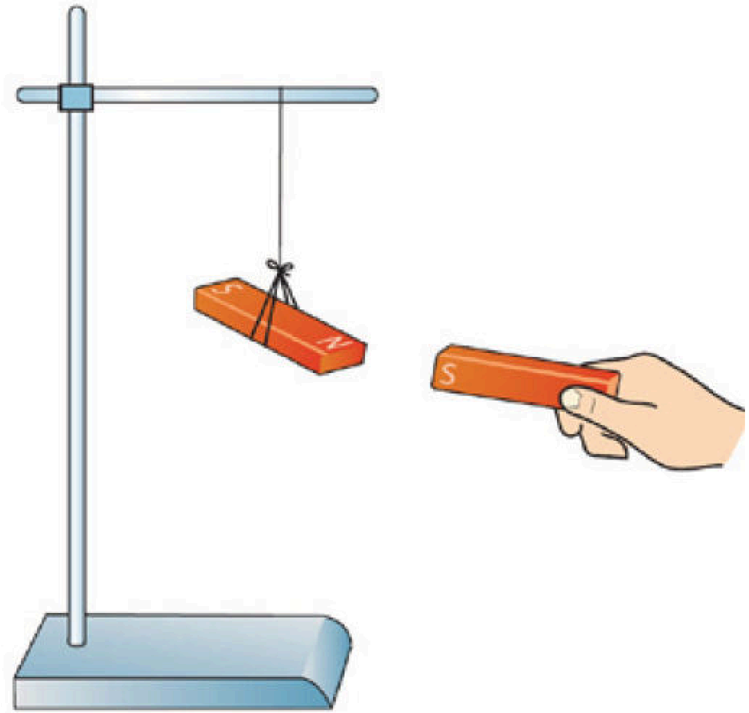
48.3 To Demonstrate the Attraction and Repulsion of Magnets

When the **south pole** of a bar magnet is brought **towards** the **north pole** of a suspended magnet, the **magnets attract** each other.

Unlike poles attract.

When the **north pole** of a bar magnet is brought **towards** the **north pole** of a suspended magnet, the **magnets repel** each other.

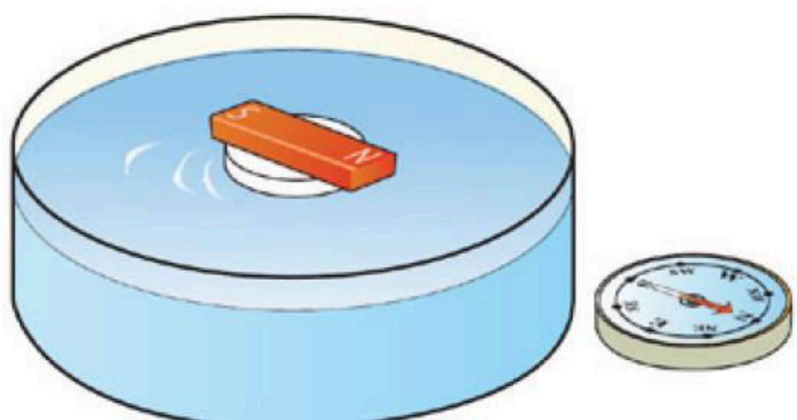
Like poles repel.



48.4 To Make a Floating Compass and Demonstrate the Earth's Magnetic Field

A **bar magnet**, **floating** on a piece of **polystyrene** in a **bowl** of **water**, will have its **north pole** pointing **North**.

The magnet is free to move so it behaves just like the **magnetised pointer** of a **compass**.
Its **north pole** is **attracted** to the **Earth's magnetic south pole** (which is in the **northern hemisphere** of the Earth).

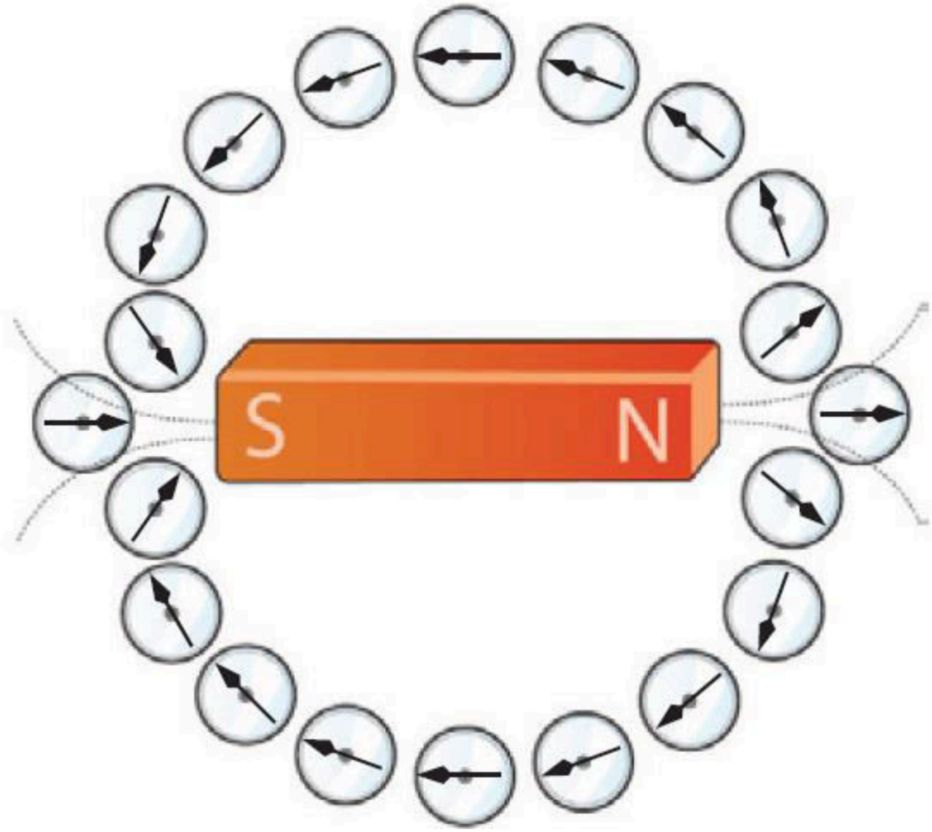


48.5 To Plot the Magnetic Field Around a Bar Magnet Using Plotting Compasses

Plotting compasses are placed around a **bar magnet** as shown.

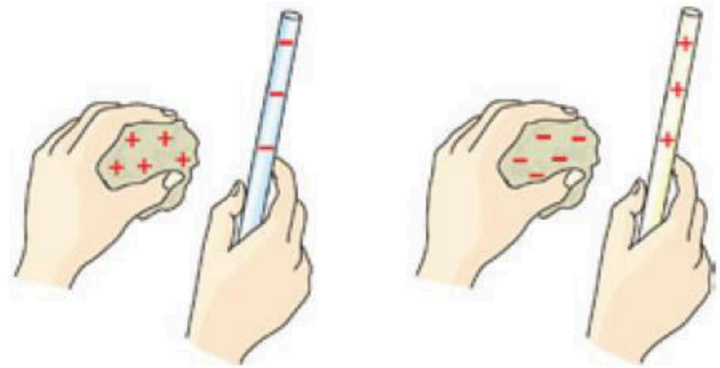
The pointers of the **compasses point** from the **north pole** of the magnet to the **south pole** of the magnet.

This shows that the **magnetic field lines** of a magnet point from **north pole** to **south pole**.

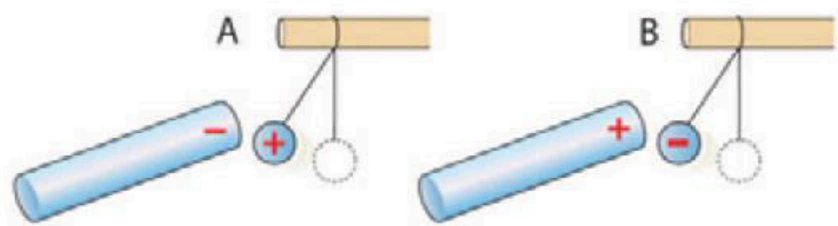


Static Electricity

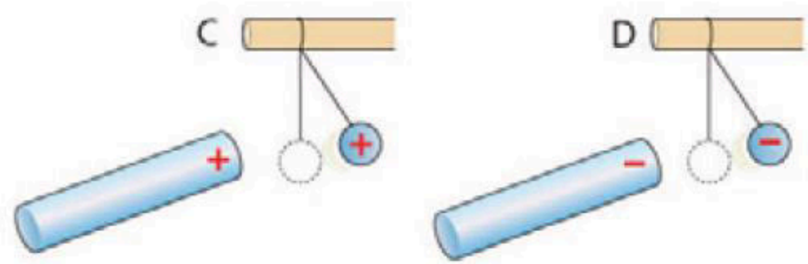
- When two objects are **rubbed together**, **electrons** get **transfered** from one to the other.
- Some substances such as **polythene** and **perspex** (good **insulators**) do not allow these electrons to flow out so they build up an **electric charge** called **static electricity**.
- A **polythene rod gains electrons** from a woollen cloth when it is rubbed with the cloth - the rod **gains** a **negative charge**.
- A **perspex rod loses electrons** to a woollen cloth when it is rubbed with the cloth - the rod **gains** a **positive charge**.
- An object becomes **negatively charged** if it **gains electrons**;
  an object becomes **positively charged** if it **loses electrons**.
- **Unlike charges attract** each other;
  like charges repel each other.
- **Earthing** occurs when a charged object **loses** its **charge** to the **earth**.



Polythene rod gains electrons   Perspex rod loses electrons



Unlike charges attract



Like charges repel

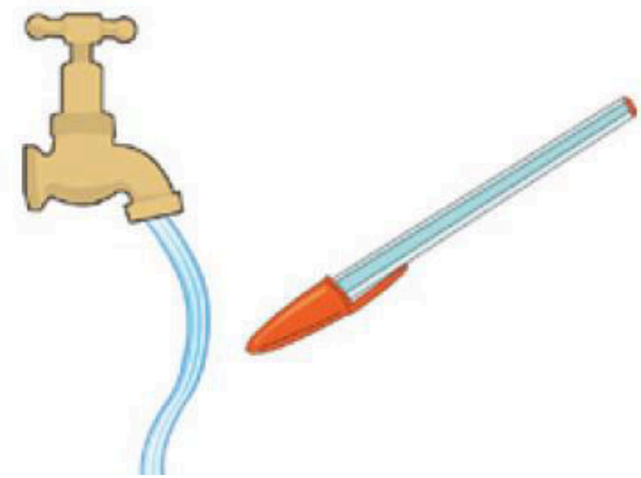
EXPERIMENTS:

49.1 To Show the Presence of Static Electricity

A **biro** or **polythene rod**, rubbed with a **woollen cloth** will gain a **static charge**.

This allows it to pick up small pieces of paper.

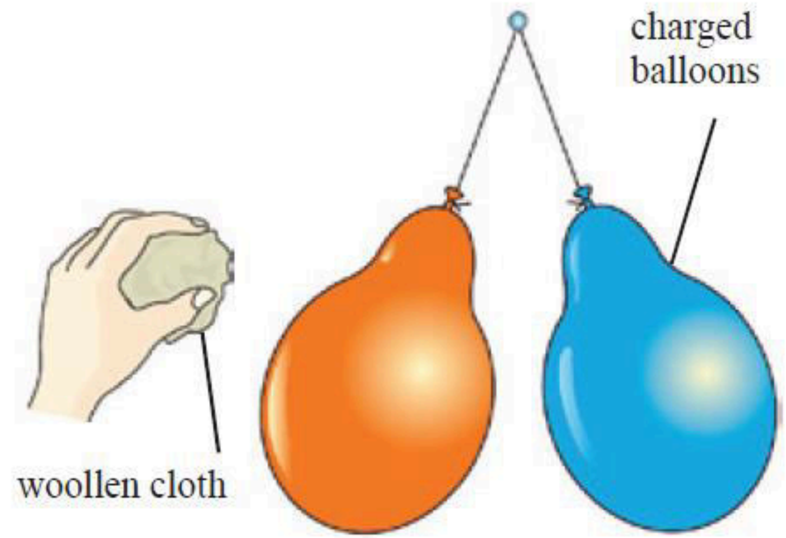
A **charged rod** or biro will **attract a stream of water** if it is brought close to it.



49.2 To Demonstrate the Force Between Charged Objects

Two **balloons** are **suspended** from a piece of **thread** as shown.
Each balloon is then **rubbed** with a **woollen cloth**, so that each **gains** the **same static charge**.

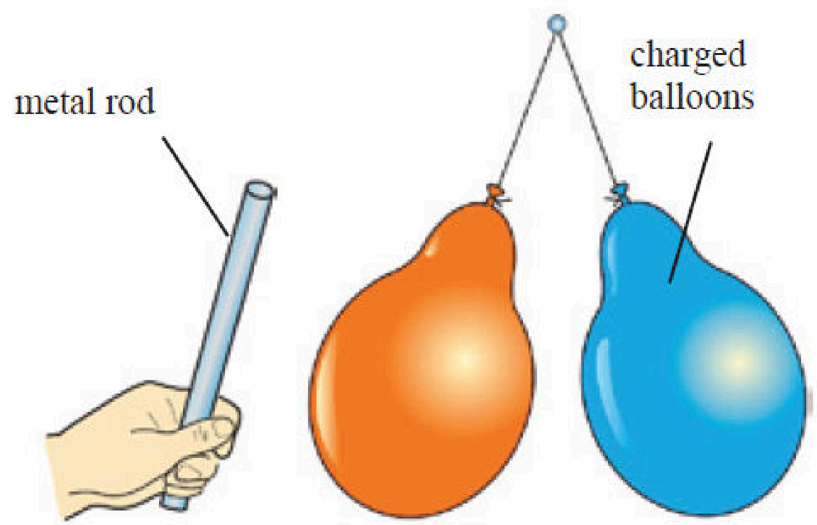
The balloons **move away** from each other as the **like charges** on them **repel**.



49.3 To Demonstrate the Effect of Earthing

A **metal rod** is touched to **each** of the **charged balloons** in turn.
The balloons **fall back together** and touch each other.

Charge has **left each balloon** and **run** to **Earth**, when it was touched with the metal rod (a **conductor**).
The charge on the balloons has been **earthed** - the balloons are no longer charged.



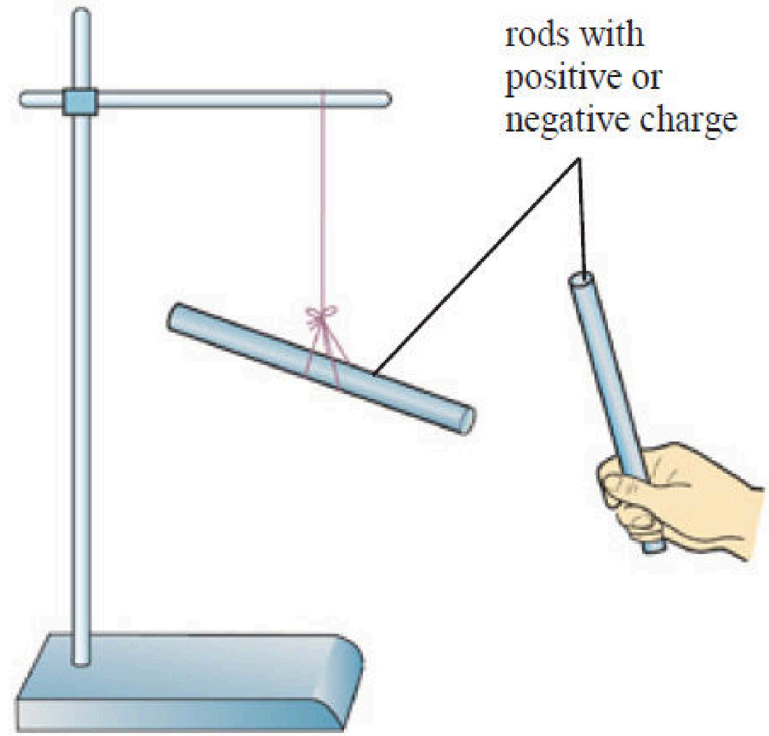
49.4 To Investigate the Forces Between Like and Unlike Charges

A suspended **polythene rod** is **charged** by rubbing it with a **woollen cloth -** it gains a **negative charge**.
When another charged **polythene rod** is brought close to it, the **like charges repel** and the suspended rod **moves away**.

Like charges repel.

When a **charged perspex rod** (**positive charge**) is brought close to the **negatively charged polythene rod**, the suspended rod **moves towards** it.

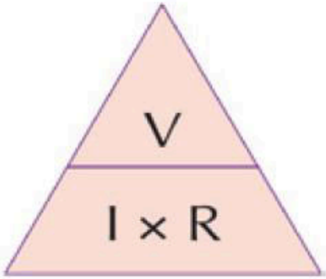
Unlike charges attract.



Current Electricity

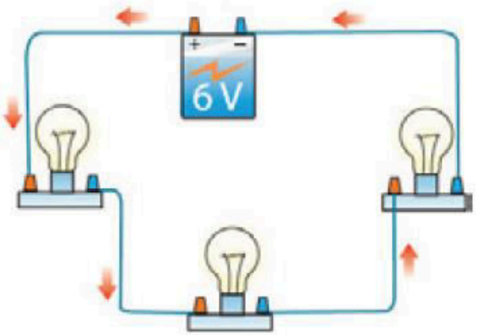
- An **electric current** is a **flow** of **electric charge**.
- **Conductors** are substances which **allow** electric **current** to **flow** through them freely (e.g. all metals).
- **Insulators** are substances which do **not allow current** to pass through them.
- A **battery** or **power pack** is an '**electrical pump**' that **pumps electrons** around a circuit.
- **Electrons** are pumped from a region of **high electrical pressure** (the **negative terminal**) to a region of **low electrical pressure** (the **positive terminal**).
- The **difference** in electrical pressure between the **negative** and **positive terminals** is called the **potential difference** or **voltage**.
  It is measured in **volts** (V) using a **voltmeter**.
- **Current** is the **flow** of **electrical charge**. It is measured in **amps** (A) using an **ammeter**.
  The symbol for **current** in amps is (**I**).

- **Resistance** is the ability a substance has to **resist the flow** of **current** in a circuit. It is measured in **ohms** (**Ω**).

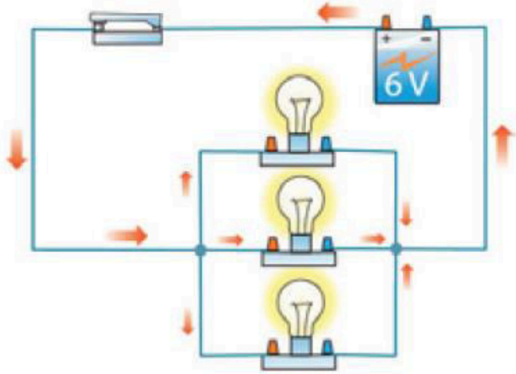


- The **larger** the **voltage**, the **larger** the **current** that can flow. The **larger** the **resistance**, the **smaller** the **current** in the circuit. The **relationship** between voltage (**V**), current (**I**) and resistance (**R**) can be shown using the **VIR triangle**.
- **Ohm's Law** states that at **constant temperature**, the **voltage** (V) is always **proportional** to the **current** (I) in a circuit.
- **Resistors** (e.g. bulbs) in a circuit can be **wired** either in **series** or **parallel**.

Resistors wired in series

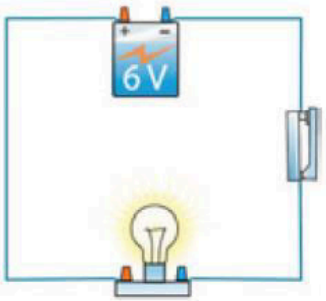


Resistors wired in parallel



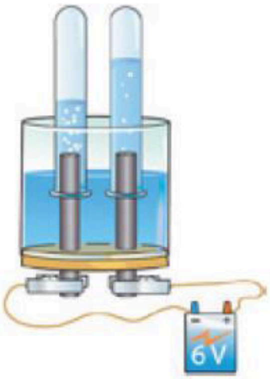
- For **resistors in series**, the **total resistance** is found by adding each of the individual resistances together. $\mathbf{R_{(Total)} = R_1 + R_2 + R_3}$.
- The **three effects** of an **electric current** are **heating**, **magnetic** and **chemical**.

Heating effect



Magnetic effect

Chemical effect

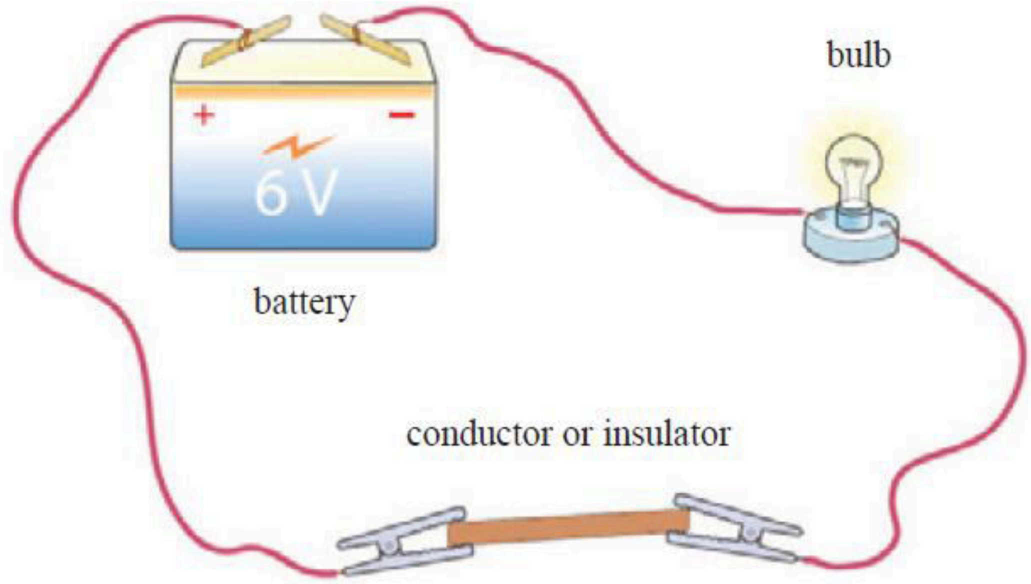


EXPERIMENTS:

50.1 To Distinguish Between Conductors and Insulators

Different materials are placed between the **crocodile clips** to see if they are **conductors** or **insulators** of electricity.

A **conductor allows** the **current** to **flow** in the circuit and the **bulb lights**.
An **insulator** does **not allow** the bulb to light.



50.2 To Verify Ohm's Law

A **circuit** with a **heating element** is set up as shown.
The **voltage** of the circuit may be **changed** using the **voltage dial** on the **power pack**.

The **voltage** is read from the **voltmeter**, which is wired in **parallel** with the **resistor**.

The **current** in the circuit is read from the **ammeter**, which is wired in **series** with the **resistor**.

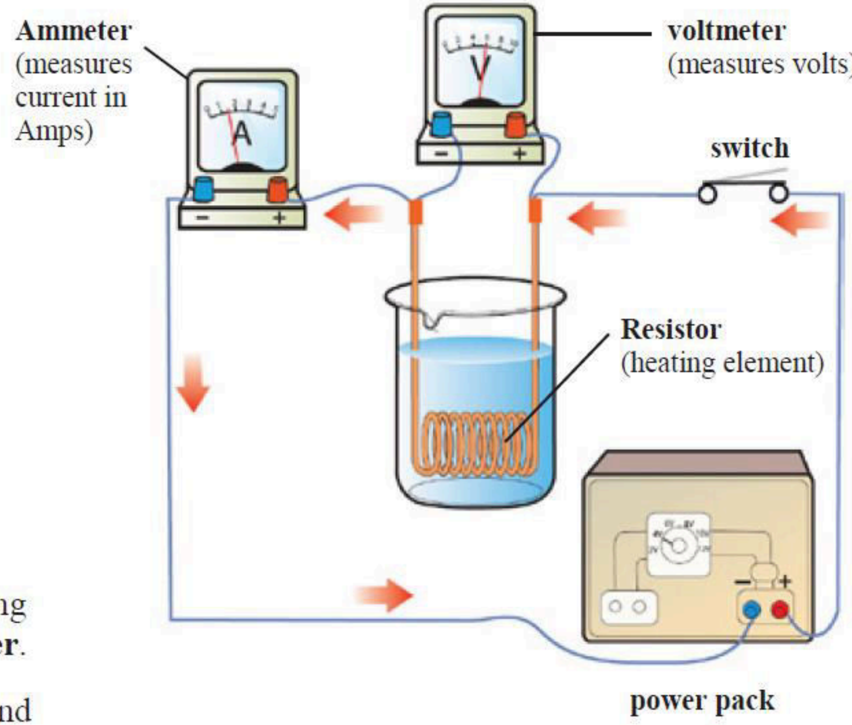
The **resistor** is prevented from heating up too much by immersing it in **water**.

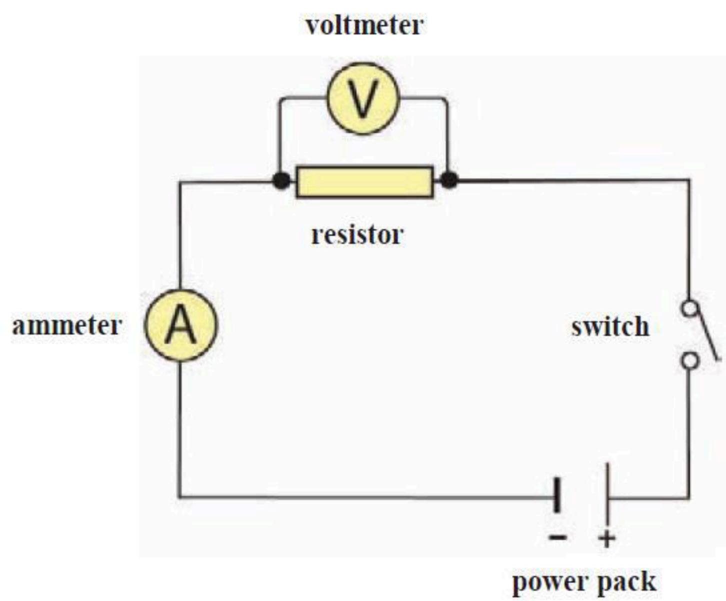
As the **voltage** is **increased**, it is found that the **current** also **increases**.

A **graph** plotted of **current against voltage** gives a **straight line** that passes through the **origin** (0,0).

This **verifies Ohm's Law** which states that, at **constant temperature**, the **current** in a circuit is always in **proportion** to the **voltage** of the circuit.

A **simpler drawing** of the apparatus used is shown on the right.





Electricity in the Home

- A **fuse** is a **safety device** which **cuts off** the **current** in a circuit if the **current goes above** a certain level. The **thin fuse wire** overheats and **melts** and so **breaks the circuit**. Fuses are now replaced by **circuit breakers**.

- When choosing the **correct fuse** for a circuit, its **amp rating** should be **slightly higher** than the **normal circuit** or appliance requires.

- The terminals of a plug are connected as follows: **Live** on the right (**Brown** wire); **Neutral** on the left (**Blue** wire); **Earth** in the middle (**Yellow/Green** wire). A **fuse** is inserted on the **Live wire**.

- The **power** of an appliance is a **measure** of how quickly it **converts** electrical energy into other forms of energy. **Electrical power** is measured in units called **watts** (W).

- The **ESB's unit of energy** is the **kilowatt hour** (kWh).
  A **kilowatt hour** is the electrical energy used (converted) by a **1 kW** appliance running for **1 hour**.

- The number of kilowatt hours (**units**) **used**: = (**number of kilowatts**) x (**number of hours**).

- **Cost** of electricity = (**number of kilowatt hours or units**) x (**cost per unit**).

- **Direct current** (d.c.) travels in **one** direction only.
  Alternating current (a.c.), supplied by the **ESB**, **changes direction** many times per second. a.c. can easily be converted to d.c. using a **rectifier**.

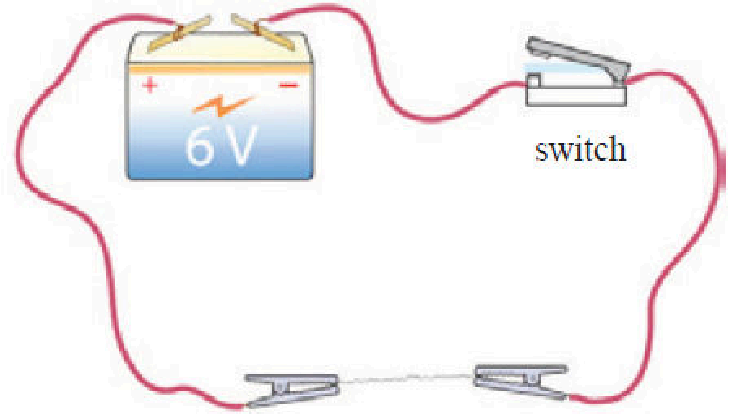
EXPERIMENTS:

51.1 To Show the Action of a Fuse

A **single strand** of fine **wire wool** is placed between the crocodile clips in the circuit.

When the **switch** is closed, the **heating effect** of the **current** heats and **breaks the strand**.

A **fuse** contains a **thin wire** that **melts** and **breaks the circuit** if the current is too big.

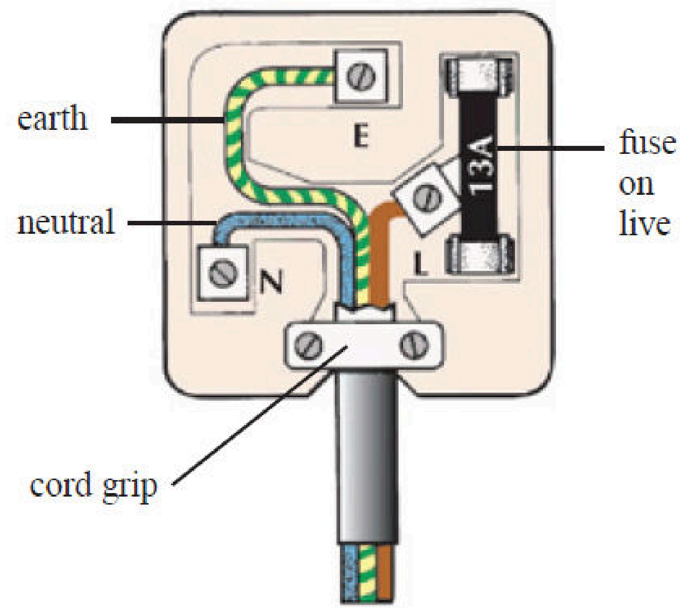


51.2 To Wire a Plug Correctly

About **5 cm** of the **white insulation** is removed from the end of the flex.
The **brown** and **blue** wires are cut back by **3 cm**.
About **0.5 cm** of the **insulation** is removed from each of the **coloured wires**.

The **exposed ends** of the wires are connected to the **terminals** of the plug. **Blue** to **neutral** on the **left**; **yellow/green** to **earth** in the **middle**; and **brown** to **live** on the **right**.

All **screws** on the **terminals**, **cord grip** and **plug cover** are then **tightened** firmly.



Electronics

- **Electronics** is the careful and exact **control** of very **small electric currents**.
- A **diode** is an **electronic component** that will allow **current** to flow in **one direction** only.
- A **light emitting diode** (**LED**) is a **diode** that gives out **light** when a current flows through it.
- **LEDs** use far **less current** than a bulb.
- A **light dependent resistor** (**LDR**) is a **resistor** whose **resistance depends** on **light**.
- When **light** falls on an **LDR**, its **resistance decreases** and the **current** therefore **increases**.

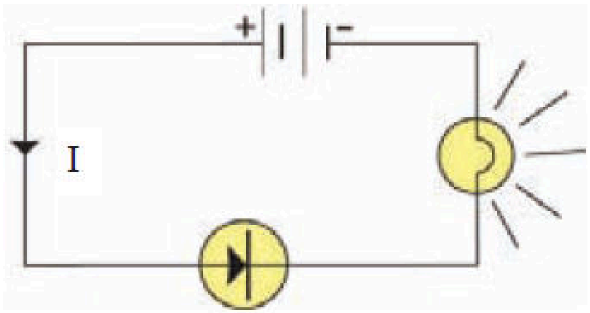
EXPERIMENTS:

52.1 To Show the Action of a Diode

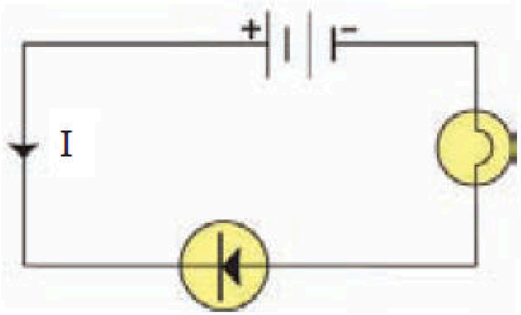
When the **diode** is wired in **forward bias** (**positive** to **positive** of the diode) the **bulb lights**.

When the diode is wired in **reverse bias** (**positive** to **negative** of the diode) the bulb **does not light**.

diode in forward bias

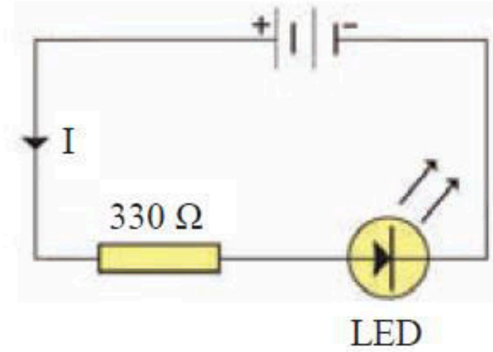


diode in reverse bias



52.2 *To Show the Action of an LED*

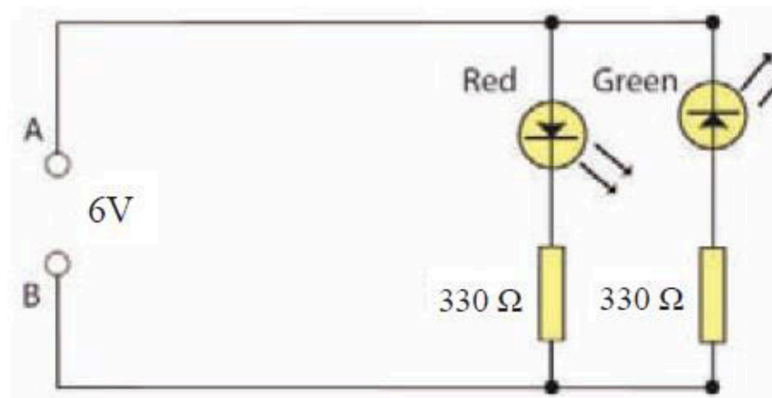
An **LED** gives out **light** when wired in **forward bias** (**positive** to **positive**) as shown.
The **resistor** protects the LED from too high a current.



52.3 *Using LEDs to Test the Polarity of a Battery*

When **terminal A** is connected to the **positive** of the **battery**, the **red** LED (in forward bias) **lights**.

When **terminal A** is connected to the **negative** of the **battery**, the **green** LED (in forward bias) **lights**.



52.4 *To Show the Use of an LDR*

When **light** is shone on the **LDR**, its **resistance decreases**, the reading on the **ammeter** shows a **higher current** flowing, and the **bulb** lights **brighter**.

The **resistance** of the **LDR decreases** when **light** shines on it.