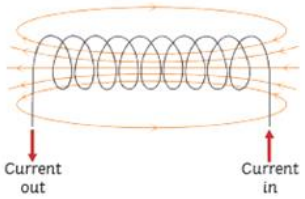
Solenoid

A circular **magnetic field** is produced when a current is passed through a conducting wire. This produces an **induced magnet**.

Switching off the current causes the magnetism to be lost.

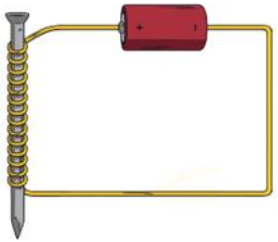
The strength of the magnetic field can be increased by increasing the current flowing through the wire. The strength of the magnetic field is stronger closer to the wire.

Coiling the wire to form a **solenoid** will also increase the strength of the magnetic field. The strength of the magnetic field created by a solenoid is strong and uniform throughout.



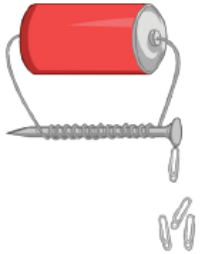
Electromagnet

When electrical charge flows in a wire, a magnetic field is created around the wire. The larger the current, the stronger the electromagnet. The strength of the magnetic field can be increased by wrapping the wire around a magnetic material, such as iron.

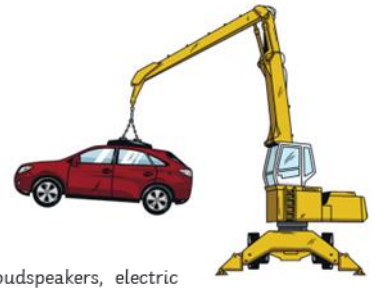


Independent variable – number of coils of wire
Dependent variable – number of paperclips picked up
Control variables – current supplied to the circuit, core material, width of wire, length of wire, potential difference of the battery or power pack

The **greater the number of coils**, the **stronger the electromagnet** and the more paperclips it will pick up.



Electromagnets are useful because they can be switched on and off. This makes them suitable for sorting scrap metal at a recycling centre.



Electric motors, loudspeakers, electric bells and remotely controlled door locks all use **electromagnets**.

Magnetic Field

Magnetism

Remember that only **iron**, **cobalt** and **nickel** (or alloys containing these metals) are magnetic.

Magnetism is a **non-contact force**. Magnetic materials can be magnetised or will be attracted to a magnet. There are three magnetic metals: **iron, nickel** and **cobalt**. Steel is also magnetic because it contains iron.

A bar magnet is a permanent magnet. It has a **north pole** and a **south pole**.

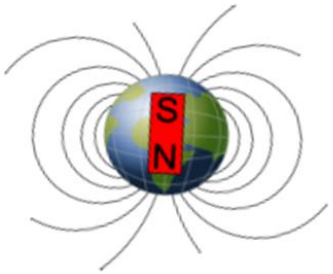
Like poles repel. This means that the two poles push each other away.

Opposite poles **attract**. This means that the invisible magnetic force between the magnets pulls the poles towards each other.

A **permanent magnet** is one with its own magnetic field. The magnetism cannot be turned on or off e.g. a bar magnet or a horseshoe magnet.

An **induced magnet** is a material which becomes magnetic only when placed within a magnetic field. Induced magnets only attract other materials and lose most (if not all) of their magnetism when removed from the magnetic field e.g. iron filings.

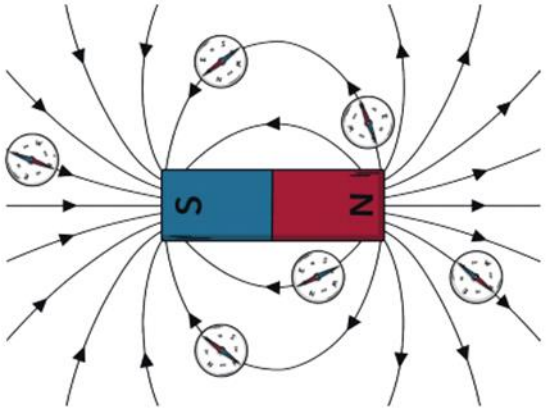
The Earth



The *Earth* behaves as if it contains a giant magnet.

The magnetic field around a magnet can be shown as a series of lines around the magnet. The magnetic field lines can be plotted using a plotting compass.

The compass will always point towards to the south pole, wherever the compass is placed near the magnet. The arrows show the direction of the magnetic field.



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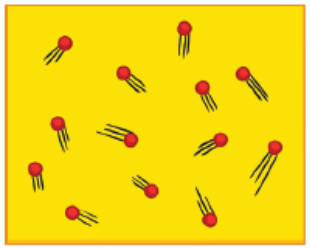
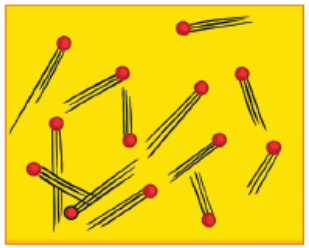
Internal energy

Particles within a system have kinetic energy when they vibrate or move around. The particles also have a potential energy store. The total internal energy of a system is the kinetic and potential energy stores.



Low Temperature



High Temperature

If the system is heated, the particles will gain more kinetic energy, so increasing the internal energy.

Conservation and transfer

Energy can never be created or destroyed, just transferred from one form to another. Some energy is transferred usefully and some energy gets transferred into the environment. This is mostly wasted energy.

Energy can be transferred in the following ways:

mechanically – when work is done;

electrically – when moving charge does work;

heating – when energy is transferred from a hotter object to a colder object.

SHC

Some materials need more energy to increase their temperature than others.

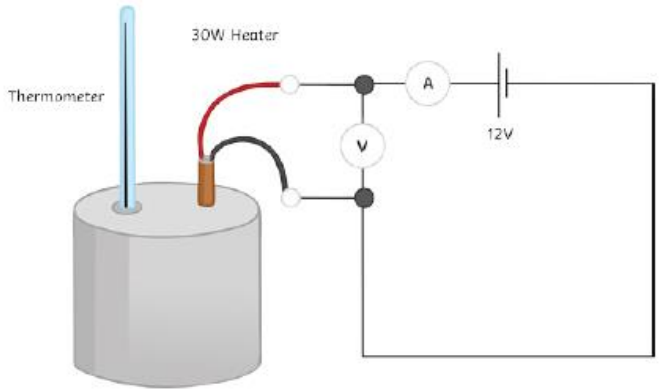
change in thermal energy = mass × specific heat capacity × temperature change

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

(J) (kg) (J/kg°C) (°C)

Specific heat capacity is the amount of energy needed to raise the temperature of 1kg of a material by 1°C.

Equipment



Required practical method

1. Using the balance, measure and record the mass of the copper block in kg.
2. Wrap the insulation around the block.
3. Put the heater into the large hole in the block and the block onto the heatproof mat.
4. Connect the power pack and ammeter in series and the voltmeter across the power pack.
5. Using the pipette, put a drop of water into the small hole.
6. Put the thermometer into the small hole and measure the temperature.
7. Switch the power pack to 12V and turn it on.
8. Read and record the voltmeter and ammeter readings – during the experiment, they shouldn't change.
9. Turn on the stop clock and record the temperature every minute for 10 minutes.
10. Record the results in the table.
11. Calculate work done and plot a line graph of work done against temperature.

independent variable – material

dependent variable – specific heat capacity

control variables – insulating layer, initial temperature, time taken

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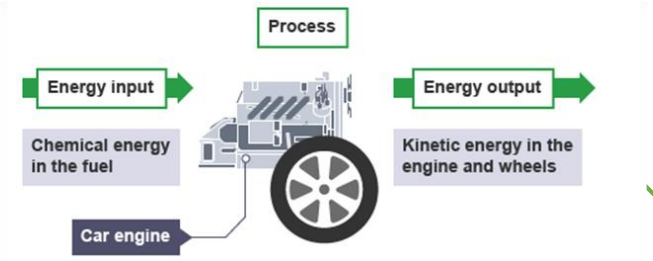
Energy Transfer Diagrams

Different forms of energy can be transferred from one form to another. Energy transfer diagrams show each form of energy - whether it is stored or not - and the processes taking place as energy is transferred.

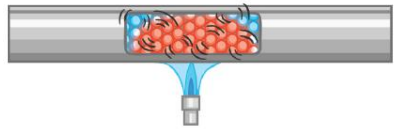


Lubrication

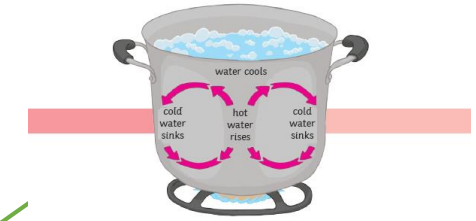
Lubrication reduces the amount of friction. When an object moves, there are frictional forces acting. Some energy is lost into the environment. Lubricants, such as oil, can be used to reduce the friction between the surfaces.

Transfer

Conduction – when a solid is heated, the particles vibrate and collide more, and the energy is transferred.



Convection – when a liquid or a gas is heated, the particles move faster. This means the liquid or gas becomes less dense. The denser region will rise above the cooler region. This is a convection current.



Heat can be transferred by **infrared radiation**. Unlike **conduction** and **convection** - which need particles - infrared radiation is a type of **electromagnetic radiation** that involves waves.

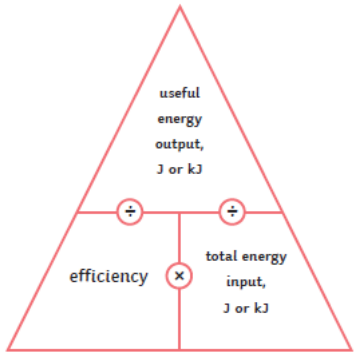
Efficiency

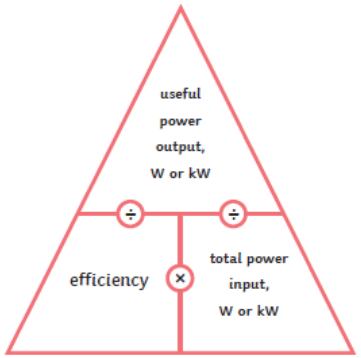
When energy is transferred, some energy is wasted. The less energy that is wasted during the transfer, the more efficient the transfer.

Some energy is always wasted. Nothing is 100% efficient.

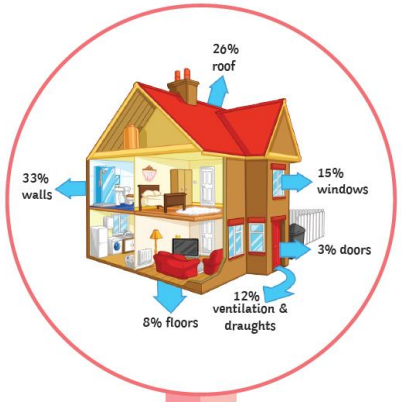
$$\text{efficiency} = \frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$$

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$





Insulation



Insulation – reduces the amount of heat lost. In your home, you can prevent heat loss in a number of ways:

- thick walls;
- thermal insulation, such as:
- loft insulation (reducing convection);
- cavity walls (reduces conduction and convection);
- double glazing (reduces conduction).

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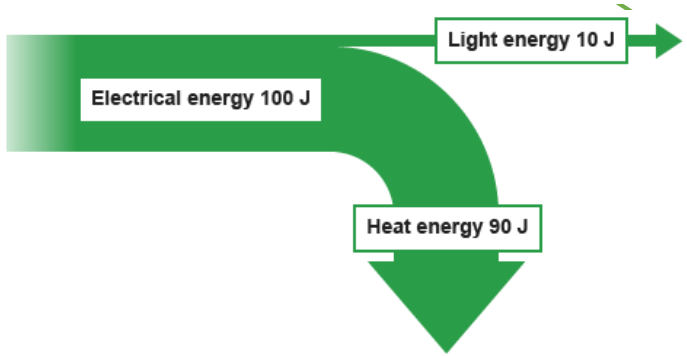
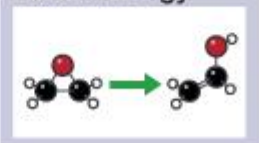
Sankey Diagrams

Sankey diagrams summarise all the **energy transfers** taking place in a process. The thicker the line or arrow, the greater the amount of energy involved.



Energy forms

Type of energy	Description	Type of energy	Description
Kinetic 	The energy in moving objects – also called movement energy	Electrical 	Energy in moving charges or static electric charges
Heat 	Also called thermal energy	Elastic potential 	Stored energy in stretched or squashed objects
Light 	Also called radiant energy	Nuclear 	Stored in the nuclei of atoms
Gravitational potential (GPE) 	Energy stored in raised objects	Internal energy 	Contained in a thermodynamic system
Chemical 	Stored energy in fuel, foods and batteries	Strain energy 	Released when atoms in a molecule rearrange themselves in a chemical reaction
Sound 	Energy released by vibrating objects		

Pay back time

The payback time of an energy-saving solution is a measure of how cost-effective it is. The payback time will be shortest if the cost of installation is low compared to the savings made each year

Thermal conductivity

There are a number of factors that affect how energy flows through an object. A very important factor is what the object is made from.
The conductivity of materials can be compared by examining the time taken to transmit energy through them. A fan of rods made of different materials can be heated at one end with the same flame. Whichever rod gets hottest first at the other end is the best conductor. The material that heats the quickest is said to have a high thermal conductivity.