•**tidal power scheme**: a dam is built across a river where it meets the sea. The lake behind the dam fills when the tide comes in and empties when the tide goes out. The flow of water turns the generator.

-advantage: no greenhouse gases are produced

-disadvantage: expensive, can't be built everywhere

•**wave energy**: generators are driven by the up and down motion of the waves at sea.

-advantage: does not produce greenhouse gases

-disadvantage: difficult to build

•**geothermal resources**: water is pumped down to hot rocks deep underground and rises as steam.

-advantage: no carbon dioxide is produced

-disadvantage: deep drilling is difficult and expensive

•**nuclear fission**: uranium atoms are split by shooting neutrons at them.

-advantage: produces a lot of energy from using very little resources

-disadvantage: producing radioactive waste

•**solar cells**: are made of materials that can deliver an electrical current when they absorb light energy

•**solar panels**: absorb the energy and use it to heat water

-advantage: does not produce carbon dioxide

-disadvantage: variable amounts of sunshine in some countries

• **Efficiency**: how much useful work is done with the energy supplied.

Efficiency (%) = Useful Work Done (J) / Total Energy Input (J)

Efficiency (%) = Useful Energy Output (J) / Total Energy Input (J)

Efficiency (%) = Useful Power Output (W) / Total Power Input (W)

•In the sun, energy is created through a process called **nuclear fusion**: hydrogen nuclei are pushed together to form helium.

1.6 (c) Work

•**Work** is done when ever a force makes something move. The unit for work is the **Joule** (J). 1 joule of work = force of 1 newton moves an object 1 metre

W = F x d

Work done (J) = Force (N) x Distance (m)

1.6 (d) Power

Power (W) = Work done (J) / Time Taken (s)

1.7 Pressure

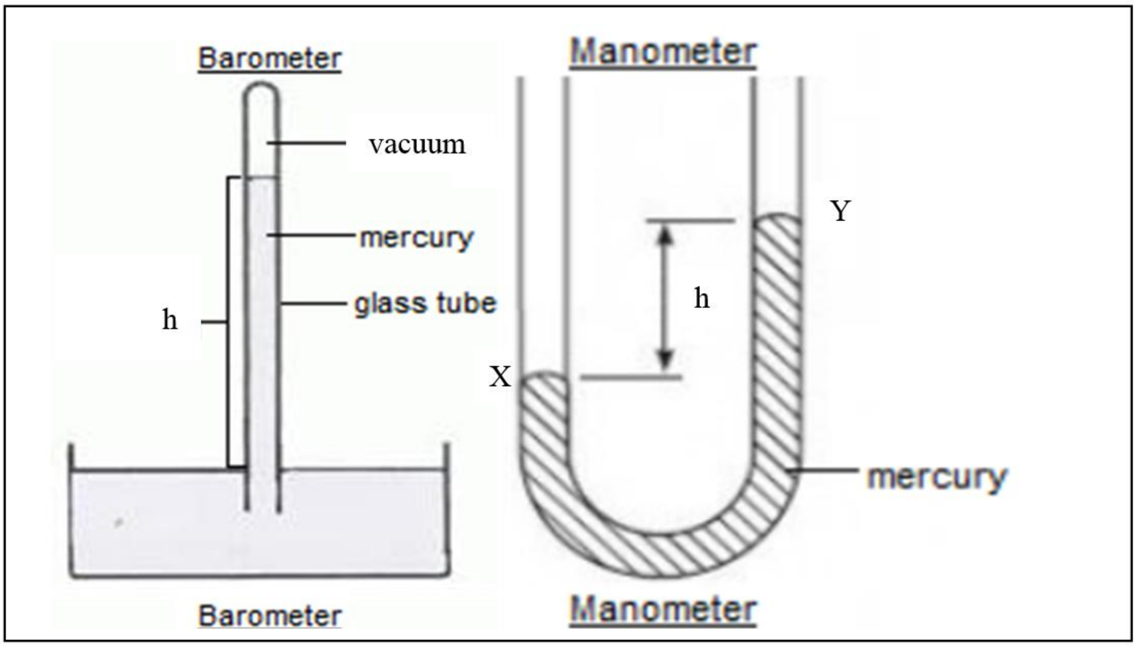
•If a heavier person steps on your foot, it hurts more than if a light person does it. If someone with high heels steps on your foot then it hurts more than if someone with large flat shoes does it, so we know that if force increases, pressure increases and if area decreases, pressure increases and vice versa.

Pressure (Pa) = Force (N) / area (m^2)

P = F/A

•The barometer has a tube with vacuum at the top and mercury filling the rest. The pressure of the air pushes down on the reservoir, forcing the mercury up the tube. You measure the height of the mercury in the tube, and the units used are **mm of mercury**. 760 mm of mercury (101 KPa) is called 1 atmosphere.

•A **manometer** measures the pressure difference. The height difference shows the **excess pressure**: the extra pressure in addition to atmospheric pressure.



Pressure in liquids increases with depth and given by this formula:

$$P = \rho \times g \times h$$

Pressure (Pa) = Density (kg/m^3) x Gravity (m/s^2) x Height (m)

Mercury has a density of 13600 kg/m^3. So for the manometer the difference between the pressure at X and Y is **13600 x 10 x h**

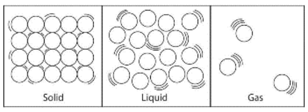
For the manometer, the pressure of the atmosphere in Pa can be found from

P = ρ x g x h = 13600 x 10 x h (where h is in metres)

2. Thermal physics

2.1 Simple kinetic molecular model of matter

2.1 (a) States of matter



Solid: fixed shape and volume

Liquid: has fixed volume but changes shape depending on its container

Gases: no fixed shape or volume, gases fill up their containers

2.1 (b) Molecular model

Solid:

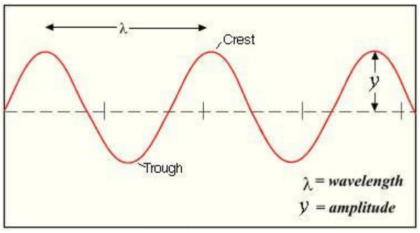
1. Strong forces of attraction between particles
2. Have a fixed pattern (lattice)
3. Atoms vibrate but can't change position.

Liquid:

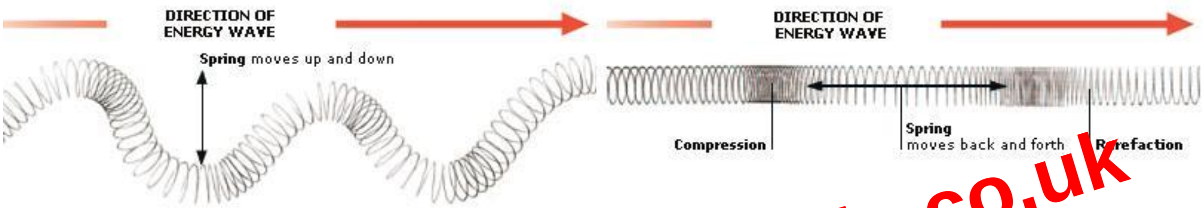
1. Weaker attractive forces than solids
2. No fixed pattern
3. Particles slide past each other.

Gas:

1. Almost no intermolecular forces

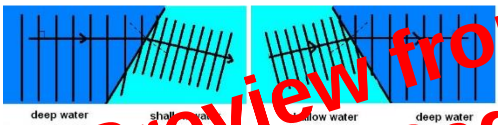


•**Transverse waves** (e.g. light waves) have oscillations at right-angles to the direction of travel, where as in **longitudinal waves** the oscillations are in the direction of travel. Transverse waves have **crests** (peaks) and **troughs**; whereas longitudinal waves (e.g. sound waves) have **compressions** and **rarefactions**.

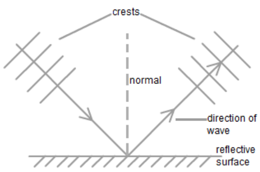


Reflection, refraction and diffraction of water waves

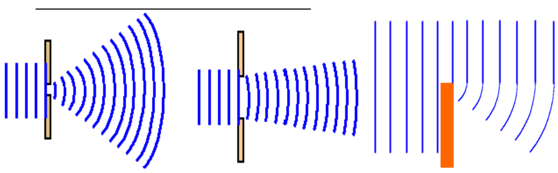
Refraction:

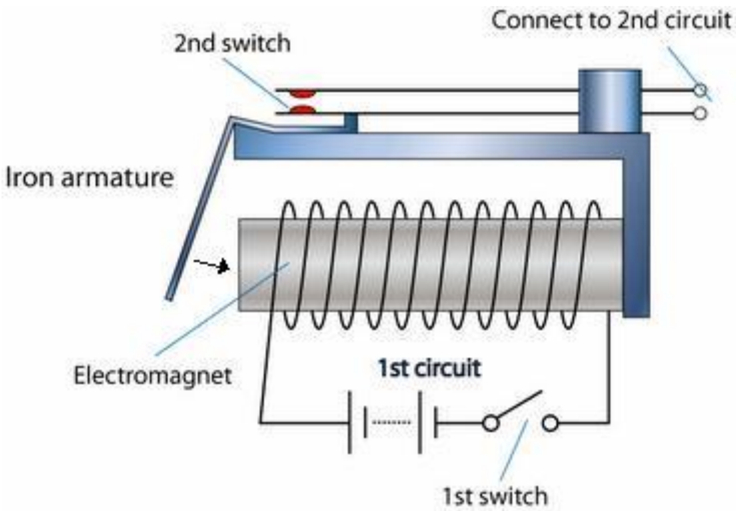


Reflection:

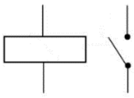


Diffraction:

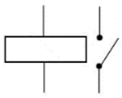




Normally closed relay (symbol):

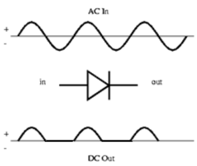


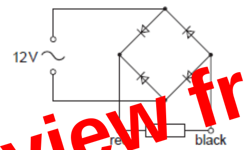
Normally open relay (symbol):



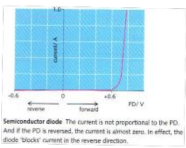
•**Diode**: a device that has an extremely high resistance in one direction and a low resistance in the other, therefore it effectively only allows current to flow in 1 direction (the arrow on it is pointing in the conventional current direction).**Forward bias** is when the diode is pointing in the direction of the conventional current and **reverse bias** is the opposite

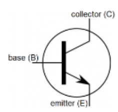
It can be used in a **rectifier**. A rectifier turns AC current into DC current.



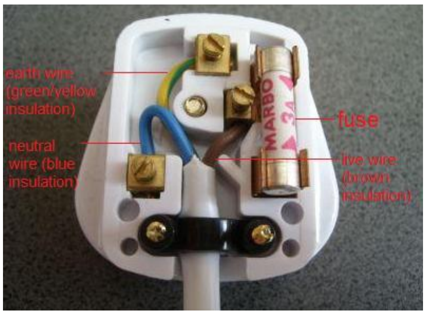


Diodes work when the PD exceeds 0.6V so the PD vs. current graph would look like this:

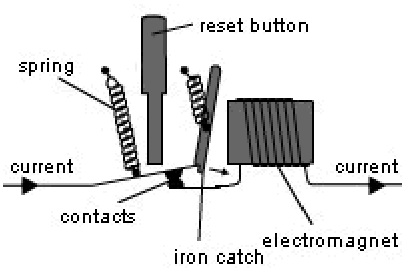


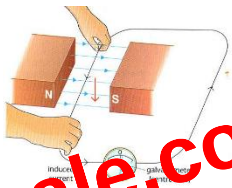


•**Transistor**: used for amplifying signals and for switching. It has three terminals: the **emitter**, **base** and **collector**. Using a transistor, a small current in one circuit can controls a large current in the other. The conventional current direction has to be the same as the arrow for it to work. If no current travels from the base to the emitter, the transistor has a blocking effect (on the left):



•**Circuit breakers**: an automatic switch which if the current rises over a specified value, the electromagnet pulls the contacts apart, breaking the circuit. The reset button is to rest everything. It works like a fuse but is better because it can be reset.





<u>4.5 Electromagnetic effects</u>

<u>4.5 (a) Electromagnetic induction</u>

•An induced EMF can be made in several ways:

1. If a wire is passed across a magnetic field, a small EMF is induced, this is **electromagnetic induction**. If the wire forms part of a complete circuit, the EMF makes a current flow. This can be detected using a galvanometer. <u>The EMF induced in a conductor is proportional to the rate at which the magnetic field lines are cut by the conductor</u>.

The induced EMF can be increased by:

-moving the wire faster

-using a stronger magnet

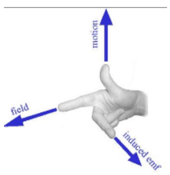
-increasing the length of wire in the magnetic field – for example, looping the wire through the field several times.

The current and EMF direction can be reversed by:

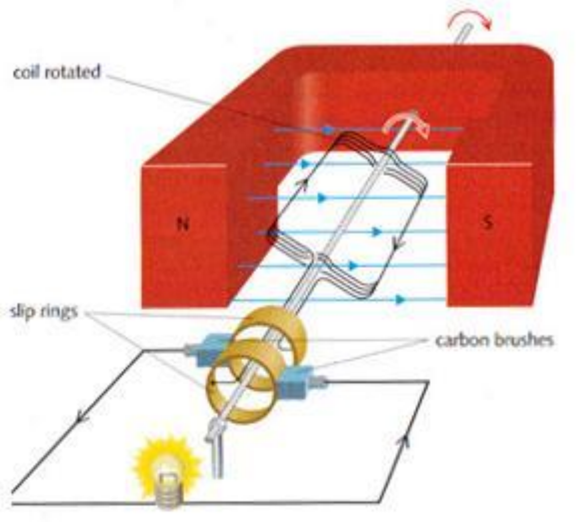
-moving the wire in the opposite direction

-turning the magnet round so that the field direction is reversed

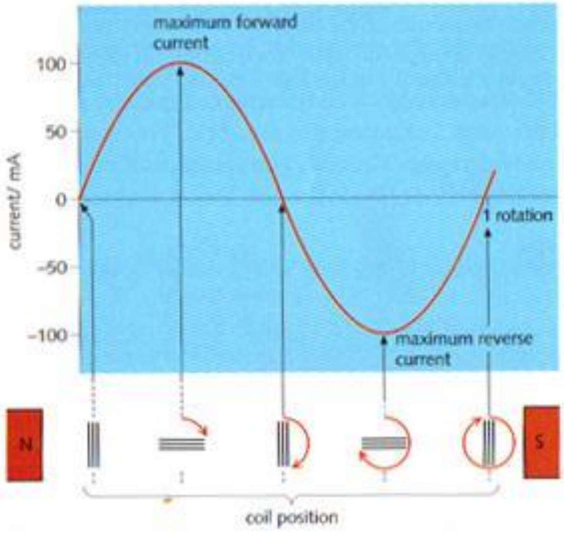
The current direction is given by **Fleming's right-hand rule**:



2. A bar magnet is pushed into a coil. If the coil is part of a circuit, a current will flow;



Simple AC generator, connected to a bulb



Graph showing the generator's AC output

4.5 (c) Transformer

•AC currents (only, not DC) can be increased or decreased by using a transformer. A transformer is made of a **primary/input coil**, a **secondary/output coil** and an **iron core**. The iron core gets magnetised by the incoming current. This magnetism then creates a current in the leaving wire. The power is the same on both sides (since we assume 100% efficiency and that all the field lines pass through both coils). You can figure out the number of coils and the voltage with:

Output voltage / Input voltage = Turns on output coil / Turns on input coil

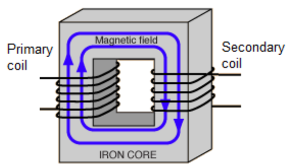
$$V_2 / V_1 = n_2 / n_1$$

Input voltage × input current = output voltage × output current

$$V_1 \times I_1 = V_2 \times I_2$$

$$\text{Power}_1 = \text{Power}_2$$

A transformer works by **mutual induction**. As you saw before, an EMF (and current) can be induced by *moving* a magnetic field. A *changing* magnetic field can have the same effect. Turning an electromagnet next to a coil on or off will induce a very short-lasting EMF in the coil, but leaving the electromagnet on will not, since the magnetic field is not changing. Switching the electromagnet off will induce an EMF in the opposite direction of switching it on. The EMF can be increased if the core of the electromagnet goes right though the second coil or increasing the number of coils in the second coil. An alternating current in a transformer's primary coil creates an alternating magnetic field in the core and therefore in the second coil. The alternating magnetic field creates an alternating voltage in the second coil.



• A step-up transformer increases the voltage and a step-down transformer decreases it.
• Transformers are used to make high voltage AC currents. Since power lost in a resistor = R × I^2, having a lower current will decrease the power loss. Since transmission cables are many kilometres long they have a lot of resistance, so a transformer is used to increase the voltage and decrease the current to decease power lost.
•The advantages of high-voltage transmission:
-less power lost
-thinner, light, and cheaper cables can be used since current is reduced

4.5 (d) The magnetic effect of a current

•Magnetic field around a current carrying wire and a solenoid: