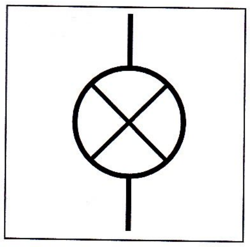

Fig 2: The circuit symbol for a light bulb. There is no polarity for a filament bulb, so it can be connected either way around.

The battery provides the electrical energy. It has two connections, a positive connection and a negative connection. The electricity flows out of the positive connection along the connecting wire, through the bulb and back along the lower wire to the battery's negative connection. Electricity, unlike water, needs a complete circuit or path to flow round. There must be a continuous route from the positive side of the battery round the circuit and back to the negative side. The route is completed inside the battery.

A single cell provides about 1·5 volts of 'push', or electrical potential, to cause the electricity to flow. More cells can be connected together to provide a higher voltage or 'potential difference' (p.d.).

Some electrical or electronic devices are very sensitive to which way round the battery is connected. The two connections of the battery are sometimes called its poles, and connecting them the right way round is called the correct 'polarity'.

A light bulb (**Fig 2**) is a thin filament of wire in a glass bulb where all the air has been sucked out, ie a vacuum. If electricity is passed through the bulb the filament glows white hot and gives off heat and light. It does not matter which way the electricity passes through the bulb, so the bulb does not have a polarity to worry about.

In **Fig 3** you will see that the battery, a single cell, has now been connected to the bulb to form a battery and bulb circuit. The bulb will light.

Care must be taken to ensure the battery is of the correct voltage for the bulb, or it will either be too dim or too bright and possibly 'blow'.

Conductors & Insulators

The connecting wire we use to join the battery to the bulb is a conductor, it conducts electricity because the electrons can move freely. Metals are conductors. The wire should also have a plastic sheath or covering. That is an insulator which does not conduct electricity. The electrons cannot move in an insulator. Wood, rubber, glass and ceramics are also insulators but if they get wet, the electricity may be able to flow through the surface water and still give you a nasty shock. It is wise to be very careful in wet conditions.

A torch bulb requires 3 volts and draws 0·3 amps when it is lit. What is its power?

$P = V \times I$ = 3 volts × 0·3 amps = 0·9 watts

A larger torch runs at 6V and draws 0·5A when lit. What power is the battery supplying?

$P = V \times I$ = 6V × 0·5A = 3 watts

A 230V mains lamp draws 0·2A, what power should it be marked?

$P = V \times I$ = 230 volts × 0·2 amps = 46 watts

An electric fire draws 10A when run from the 230V mains. What is its power?

$P = V \times I$ = 230 volts × 10 amps = 2,300 watts (or 2·3kW)

Power & Resistance

THERE ARE TWO other electrical units we need to consider.

Power

When a current flows through a device the electrons transfer some of their energy to it. Bulbs light up, motors spin and a radio will make a sound.

If we think about this a little more we can see that to make the bulb brighter, the motor spin faster or the radio louder, the energy has to be transferred more quickly.

To deliver the energy more rapidly we can do two things.

a) Give the electrons more energy. We do this by using a battery or power supply with more Volts ie, a greater potential difference.

b) Increase the rate at which the electrons move around the circuit. In other words we increase the Current flowing in the circuit.

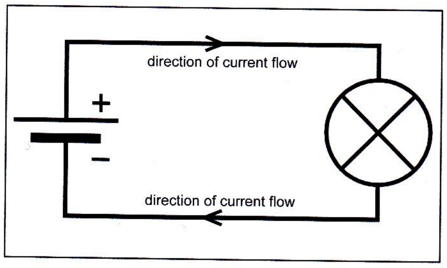

Fig 3: A single cell battery and bulb circuit.

Power is a measure of how quickly the device transfers the energy we deliver to it. As the bulb gets brighter, the motor spins faster and radio gets louder we say they are absorbing more POWER and working harder. A powerful device is transferring a great deal of energy each second.

Working out the Power absorbed:

Power (Watts) = Potential Difference (V) x Current (I)

$$P = V \times I$$

The PD tells us how much energy each electron has and the current tells us how many electrons are arriving each second to transfer their energy. Multiplying V and I tells us how much energy is arriving and how quickly it is being transferred, it tells us the Power being absorbed by the device.

We measure Power in a Unit called a Watt. A one Watt bulb transfers one unit of energy every second to heat and light. A 1kW kettle will take twice as long to boil as a 2kW kettle if they both have the same amount of water.

Examples of power calculations are shown in the shaded panel above.

Resistance

Resistance is a measure of how difficult it is for electricity to flow. The symbol for resistance is 'R' and it is measured in ohms (symbol 'Ω', the Greek letter omega).

The concept of resistance may be easier to visualize if you are filling the paddling pool using a hose. A young child stands on the hose. The flow of water reduces. The hose has been