slightly squashed, which caused some difficulty or resistance to the water flowing. The water has not been cut off, but the flow (current) has been reduced.

You have two choices. You can ask the child to step off the hose, or you may be able to turn the tap on further to increase the flow of water back to where is was.

In removing the child from the hose, you have removed the resistance, so the flow has increased. In turning the tap on further you have increased the water potential, pushing more water through the hose. Either way you are now filling the pool as quickly as before. If you had chosen to turn the tap on further, you might have a different problem if the child then steps off the hose, but that is another matter.

In electrical terms, a device that restricts the flow of current is called a 'resistor'. How much difficulty it presents to the flow of current is called its resistance. This corresponds to the weight of the child standing on the hose.

A resistor of higher value will offer more resistance or difficulty to the flow of current. If the voltage stays the same then a higher resistance will result in a lower current flowing.

Increasing the voltage (like turning the tap further on) will give the electrons more energy, causing an increase in the current.

Clearly the voltage, the current and the resistance are related somehow. An increase in voltage causes an increase in current and an increase in resistance causes a decrease in current.

The actual relationship is:

$$\text{Current (I)} = \frac{\text{Voltage (V)}}{\text{Resistance (R)}}$$

This relationship was first set out clearly in 1826 by a physics teacher in Cologne, George Simon Ohm. The relationship is named after him.

Ohm's Law

THE CURRENT flowing through a circuit is directly proportional to the applied voltage and inversely proportional to the resistance. A useful way of remembering this is shown in **Fig 4**.

Referring again to Fig 4, if you place a finger over the item you wish to calculate, the formula for the calculation is shown by the remaining quantities. **Fig 5** demonstrates this.

Examples of calculations using Ohms Law are shown in the panel above.

1. A torch bulb has a resistance of 10 ohms, and is designed to run at 3V. What current will flow when correctly connected?

   The formula to use is: $\text{Current (I)} = \frac{\text{Voltage (V)}}{\text{Resistance (R)}}$

   So, inserting the numbers... $\text{Current (I)} = \frac{3}{10} = 0.3\text{A}$

2. For the electric fire, we were told it ran on 230V and drew 10A. What is its resistance?

   The formula to use is: $\text{Resistance (R)} = \frac{\text{Voltage (V)}}{\text{Current (I)}}$

   So, inserting the numbers... $\text{Resistance (R)} = \frac{230}{10} = 23\Omega$

Uses for resistors

So far we have looked at the resistance of items such as light bulbs and electric fires.

In electronic circuits it is often necessary to deliberately limit the flow of current. To do this a device called a resistor is used to insert some resistance into the circuit. The circuit symbol for a resistor is a rectangular box. This is shown in **Fig 6** and is marked 'R'.

A low value resistor will have little effect on the flow of current and the bulb will glow quite brightly. A higher value of resistor will have a greater limiting effect on the current, and the bulb will then be much less bright. If the resistor value is too high, the bulb may not glow at all.

In Fig 6, let us say there is a choice of values for the resistor R. The choices are: 1Ω, 2Ω, 5Ωand 10Ω(remember, Ωis ohms). Which value of resistor will allow the bulb to glow the brightest?

The lower the value of the resistor, the less it limits the flow of current, so the lowest value will give the brightest glow. Therefore, choose the 1Ω resistor.

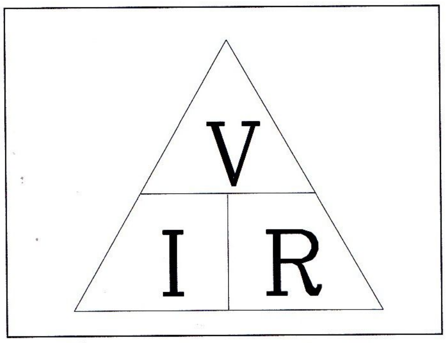

Fig 4: The relationship between voltage (V), current (I) and resistance (R).

$$I = \frac{V}{R} \qquad V = I \times R \qquad R = \frac{V}{I}$$

Fig 5: The formulae for calculating current (I), voltage (V) and resistance (R).

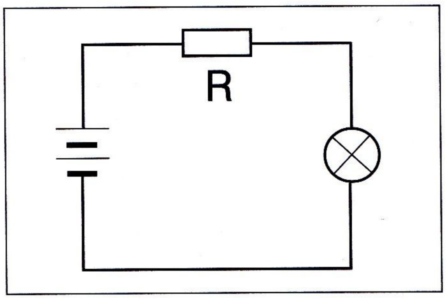

Fig 6: An electric circuit with some added resistance.

Alternating currents & Voltages

SO FAR WE HAVE looked at the current flowing from a battery. It flows out of the positive terminal, round the circuit, the bulb or whatever, and back to the negative terminal. The electricity always flows the same way. It is called 'direct current' (DC or d.c.) because it always flows in the same direction.

Alternating current (AC or a.c.) is different. It keeps on changing direction, first one way and then the other.

AC is easier to generate and easier to change from one voltage to another. The mains electricity supply to the house is alternating current. The generator at the power station is a large coil of wire rotating in a powerful magnetic field. If we look at just one wire in the rotating coil, it is first going up through the field, then, half a turn later, coming down.