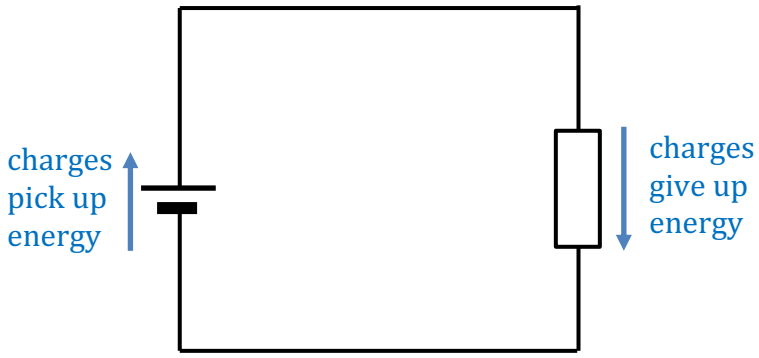
2.3.2 Voltages in series and parallel circuits

videos

Charges flow around a circuit when the circuit is complete. The charges pick up energy in the battery/power supply and distribute it to components in the circuit. Energy is conserved in this process. This means that the energy picked up is equal to the energy that is distributed.

The 'voltage' of the power supply tells you how much energy is picked up for each coulomb of charge that passes. For example, a 12 volt power supply would supply 12 joules of energy for every coulomb of charge that passes.



The formula for voltage is given by:

$$V = \frac{\Delta E}{\Delta Q}$$

where ΔE = the amount energy picked up (in joules) by an amount ΔQ of charge (in coulombs)

The unit for voltage is the volt (V).

(1) If 3C of charge flows through a battery with a voltage of 5V, what total energy is transferred to the charges? (Hint: rearrange the equation, above, to get energy.)

When charges pass through a component in the circuit (such as the resistor, in the circuit shown above), they give up some of their energy. The energy given up by every coulomb of charge passing through the component called the potential difference and is given by the formula:

$$p.d. = \frac{\Delta E}{\Delta Q}$$

where ΔE = amount of energy given up (in joules) by an amount ΔQ of charge (in coulombs)

The unit for potential difference is the volt (V).

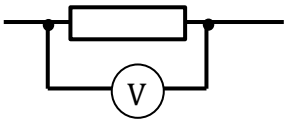
(2) Looking at the formula, above, what is an alternative unit for potential difference?

(3) 10J of energy is given up when 4C of charge flows through a resistor. What is the potential difference across the resistor?

Measuring voltage

We use a voltmeter to measure p.d./voltage in volts. The voltmeter is always connected across a component.

If we wanted to measure the p.d. across a resistor we would connect like this:



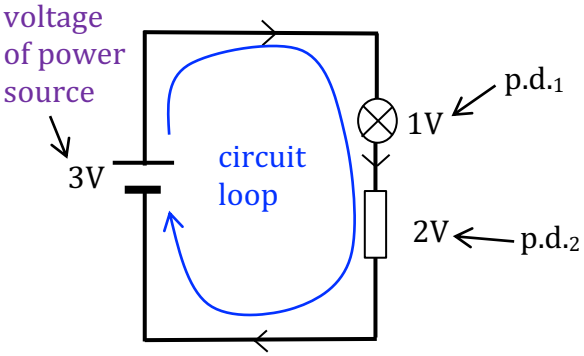
It has a very high resistance, so that no current flows through it.

Rule for voltage/p.d. in circuits

The voltage of power supply is shared out around any circuit loop.

This rule can be a little tricky. We need to clarify what a <u>circuit loop</u> is. A circuit loop is one path taken by charges as they flow from one terminal of a power supply back round to the other.

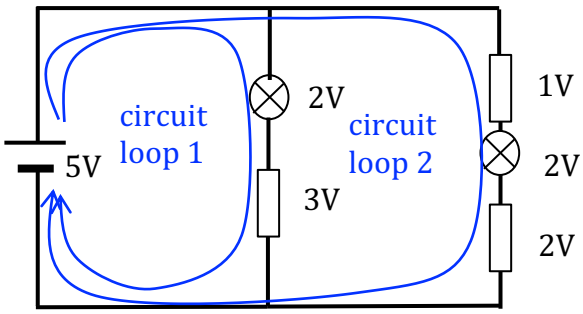
Let's have a look at the following series circuit:



This series circuit contains a power source (a cell) and two components (a lamp and a resistor).

There is only one path (one circuit loop) that charges can take. Applying the rule for voltages, 3V = 1V + 2V. I have chosen a 1V and 2V as the p.d.s across the lamp and the resistor. Equally, they might be 1.5V and 1.5V, or 0.5V and 2.5V (The p.d.s depend on the relative resistances of the components). What is important is that the voltage supplied by the power supply is shared out (completely) around the circuit loop.

In circuits where there are junctions, there is more than one possible path (circuit loop) that the charges can follow. The rule applies to all of the separate circuit loops.



Don't worry about the individual p.d.s here. It is not important whether there is a 2V or a 1V p.d. across a particular component. What is important is that 2 circuit loops are possible, and that the voltage supplied by the power supply (5V) is shared out around these 2 circuit loops. i.e. 5V = 2V + 3V for circuit loop 1 and 5V = 1V+ 2V + 2V for circuit loop 2.

(4) Work out the missing p.d.s in the following circuits. Write them in the spaces. (Hint: Trace the different loops charges can take around the circuit and apply the rule.)