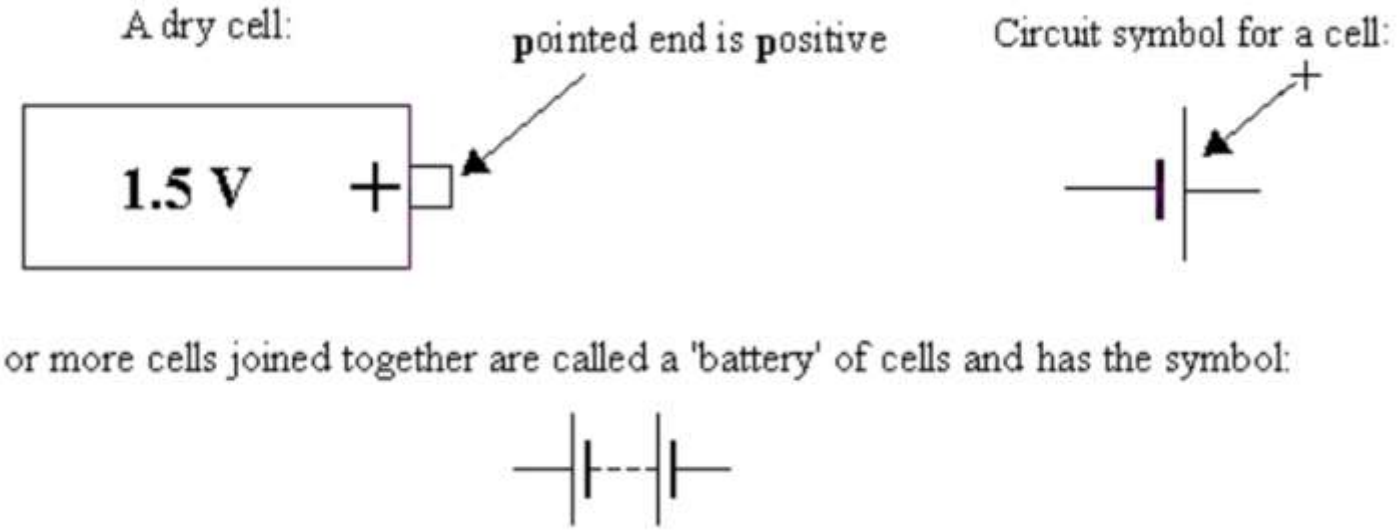
Electricity – Conductors/Insulators

- Conductors are materials or devices which contain a significantly large number of mobile charge carriers which can move along a conductor in a specific direction when a voltage is applied across a conductor
- Insulators are materials or devices that contain a small number of mobile charge carriers or immobile charge carriers (electrons bound firmly). Eg. Non-metals, plastics, glass, felt, rubber, paper, organic material, solid ionic compounds such as salts

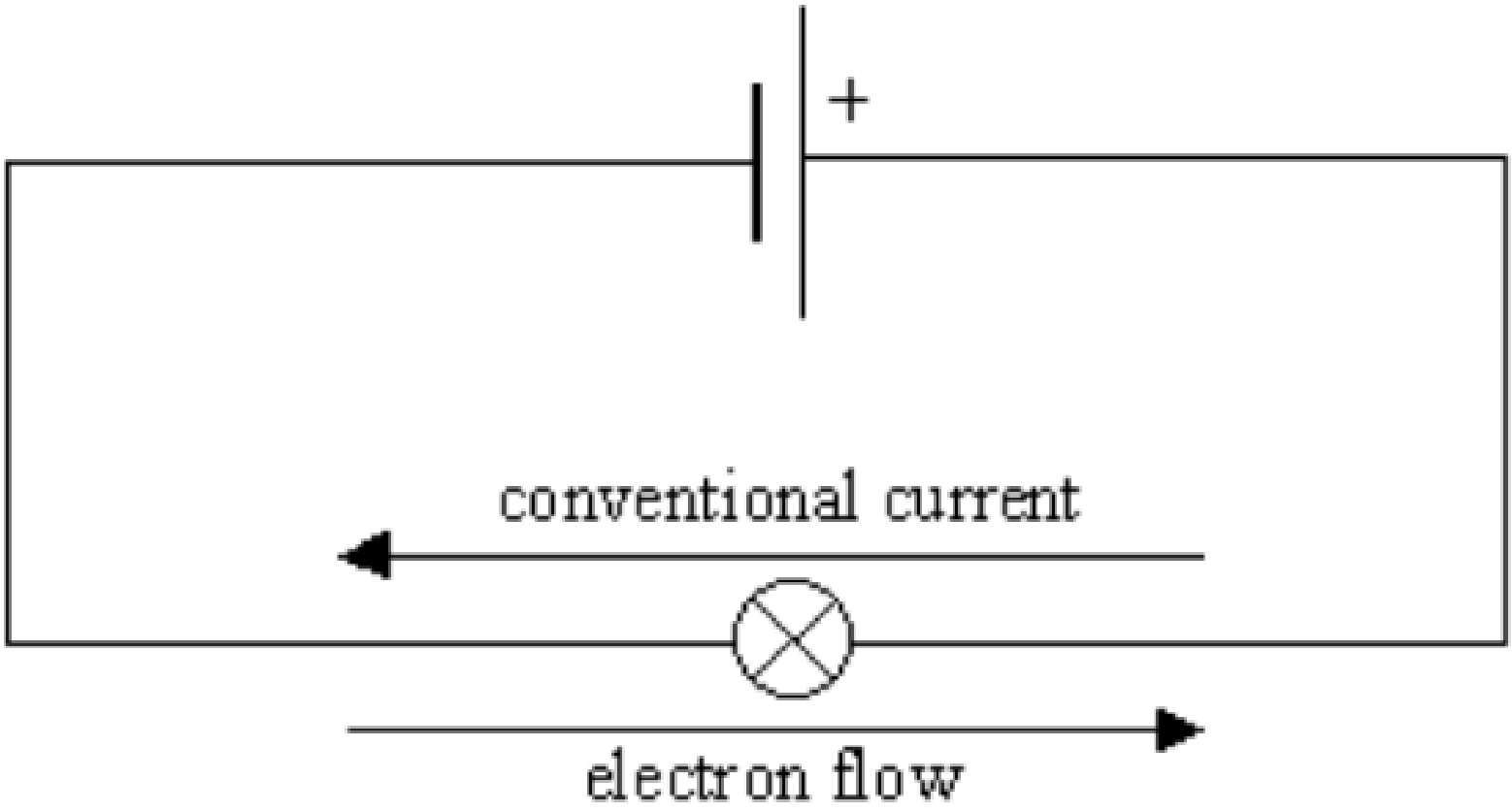
CIRCUITS

- A circuit is a closed path through which an electric current flows.

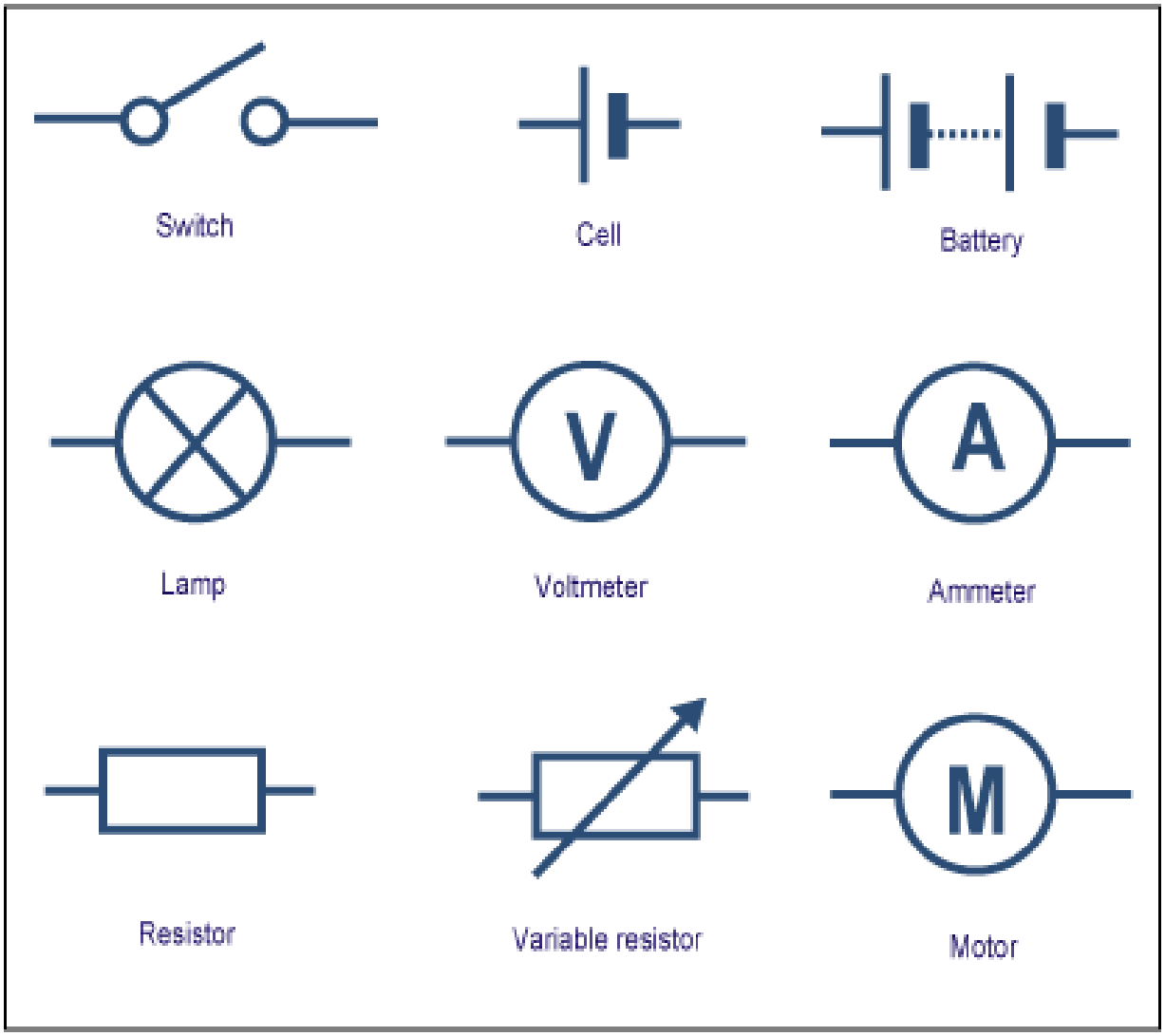


Conventional Current

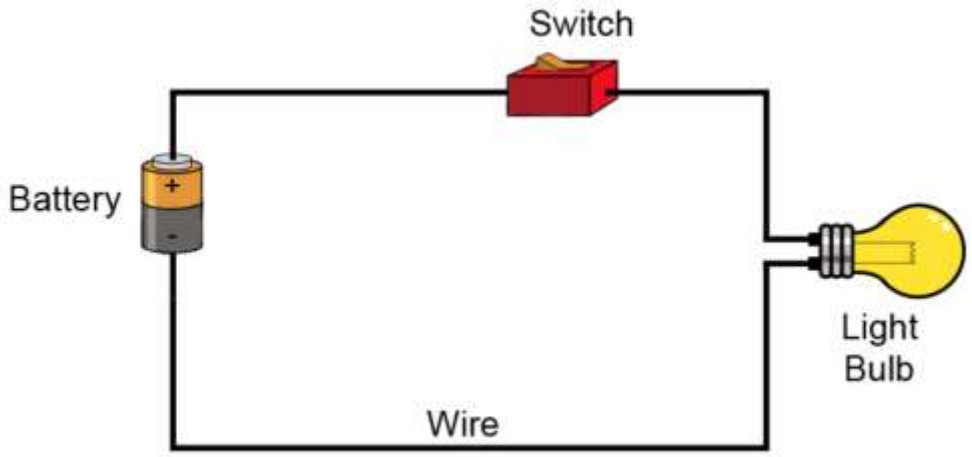
- It was originally decided to treat electric current as being a flow of positive charges, moving from the positive to the negative terminal – and this is referred to as the direction of “conventional current flow”. Later, however, electrons were discovered, and they turned out to be negative, and they move in the opposite direction, from negative to the positive terminal.


+
conventional current
electron flow

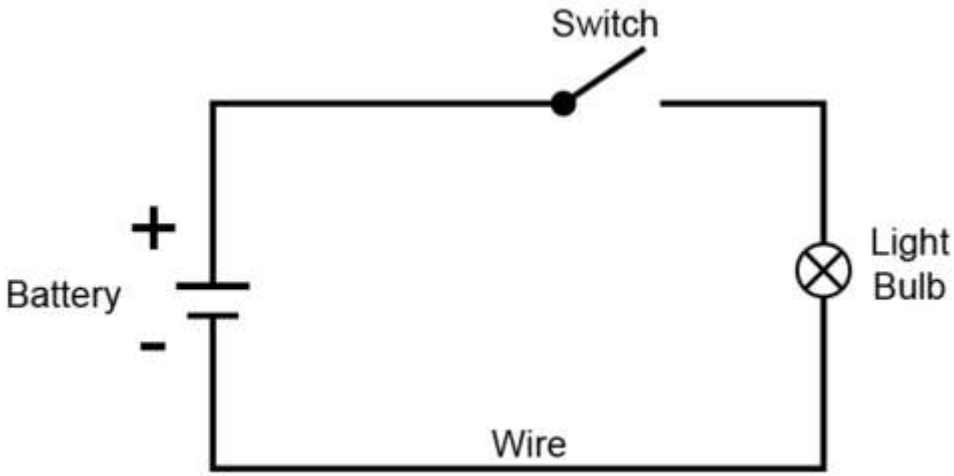
Circuit Symbols



A simple circuit

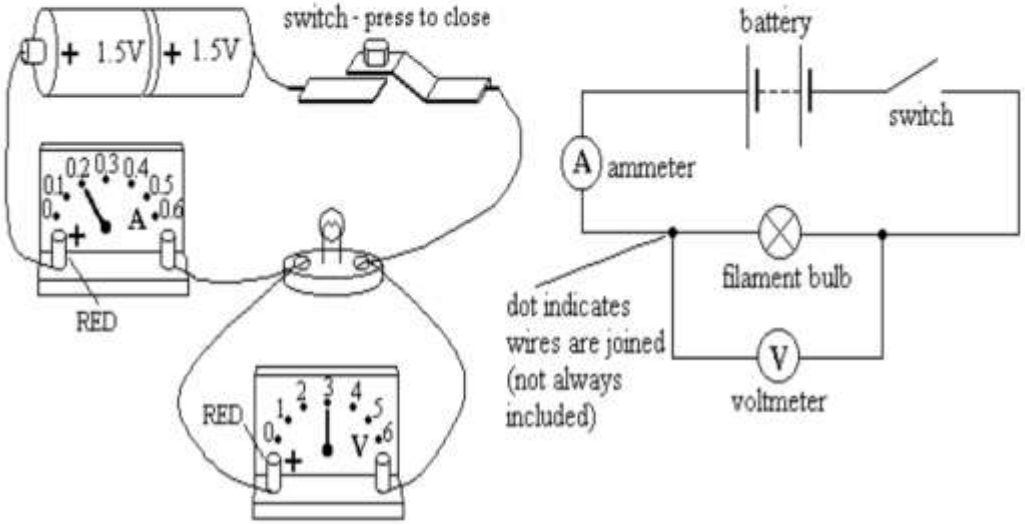


Which is represented by the symbols:



Circuit diagrams

The left hand diagram below represents an actual set-up (not drawn to scale) and the right hand diagram is the corresponding circuit diagram. The bulb is rated at 3V, so it is fully bright when the switch is closed:



An electrical circuit, such as the above, can be thought of as being made up of a sets loops, each containing components in series with each other. The above circuit contains two loops. The top loop has a switch, a battery, an ammeter (A) and a small bulb. These components are put in the corresponding positions in the circuit diagram, using standard symbols. The switch is the type which is 'usually open' - i.e. you have to press it to complete the connection, and so complete the circuit. When released, the switch springs open again, which breaks the circuit, stopping the current. A switch may not be indicated in the later diagrams, but there is usually one in an actual set-up. The second loop in the above circuit just consists of the bulb and the voltmeter (V).

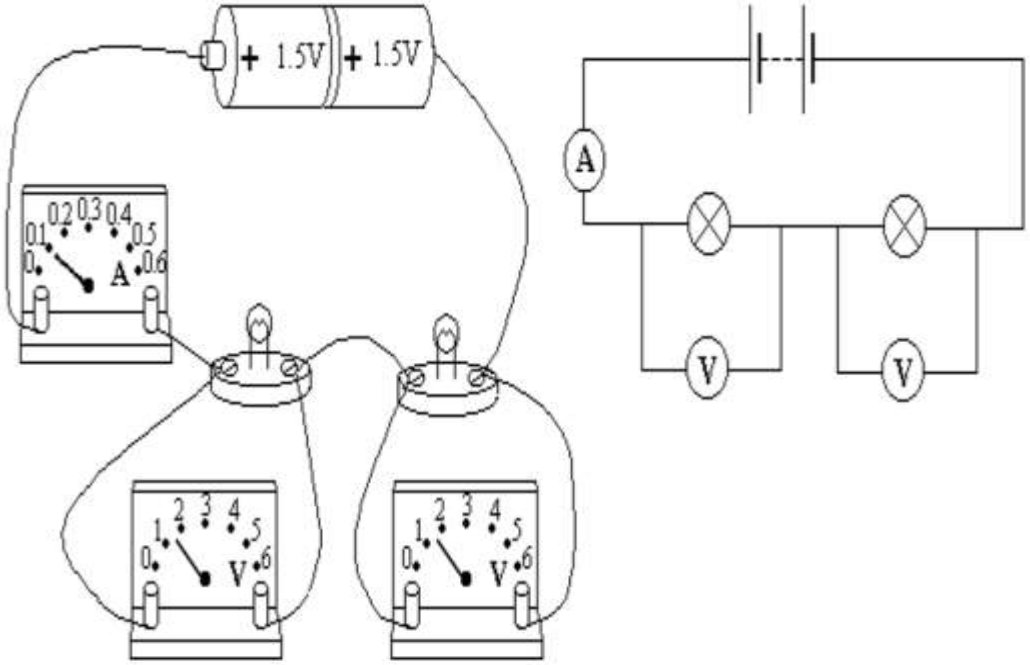
Notice that:

- the ammeter measures the current *through* the bulb (in amps, A), since the same current goes through the ammeter and the bulb (assuming that very little goes through the voltmeter)
- the voltmeter measures the voltage *across* the bulb (in volts, V), since the same voltage is across the voltmeter and the bulb

Bulbs in Series

Bulbs in series

The diagram below shows two bulbs arranged in series. The bulbs are each identical to the one in the previous diagram:



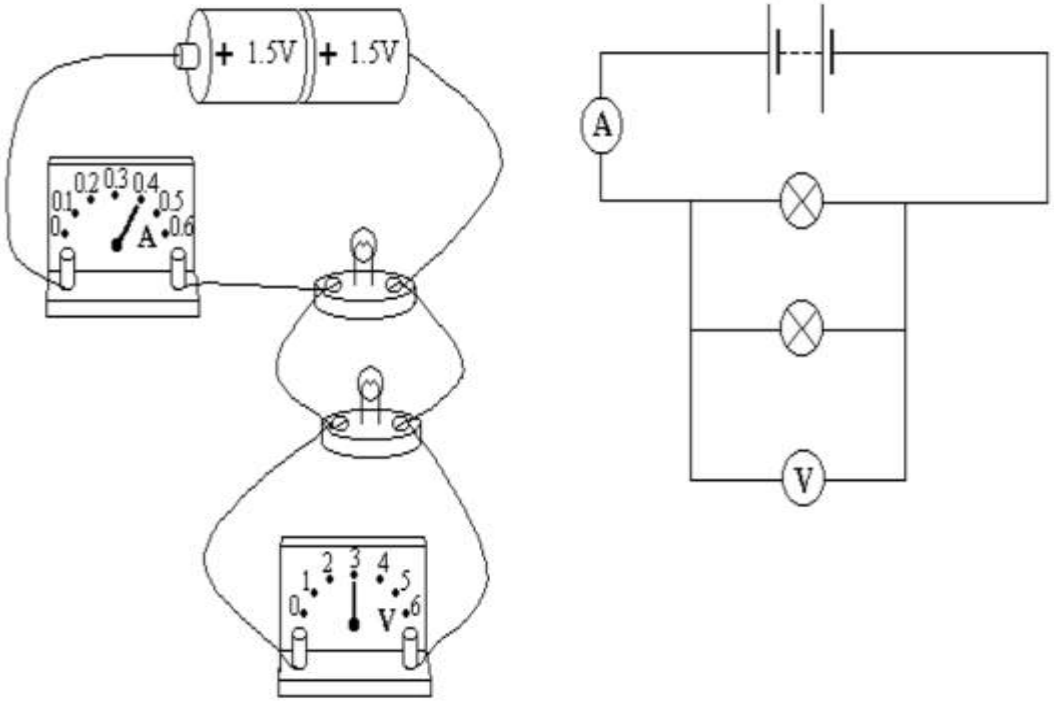
In this case, the 3V is shared by the bulbs, 1.5V across each. The current is half what it was, so both bulbs will be dull. If the supply voltage were increased to 6V, both bulbs would be fully bright.

Lots of coloured bulbs, connected in series (like the above two bulbs), are sometimes used for decorative lights - one problem is that if one bulb 'blows', the current is stopped, so they all go out, and each has to be checked to find the faulty one.

Bulbs in Parallel

Bulbs in parallel

Again, the bulbs are the same as above:



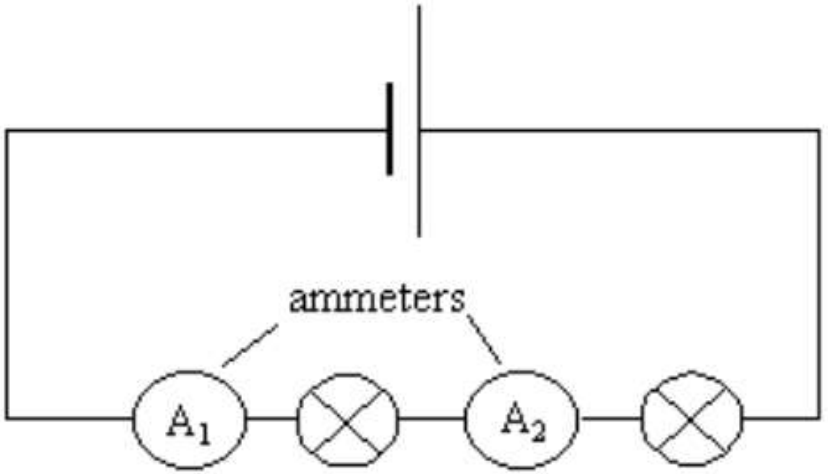
The two bulbs are said to be 'in parallel' with each other because there is the same voltage across each of them.

Because the voltage is the same for each, they will both carry the same current, 0.2A. So the total current supplied by the battery is now 0.4A, and the battery will run out twice as fast as before.

An advantage of this arrangement is that if one bulb fails, the other will keep shining, since they are powered individually by the battery.

Currents in series

Currents in series

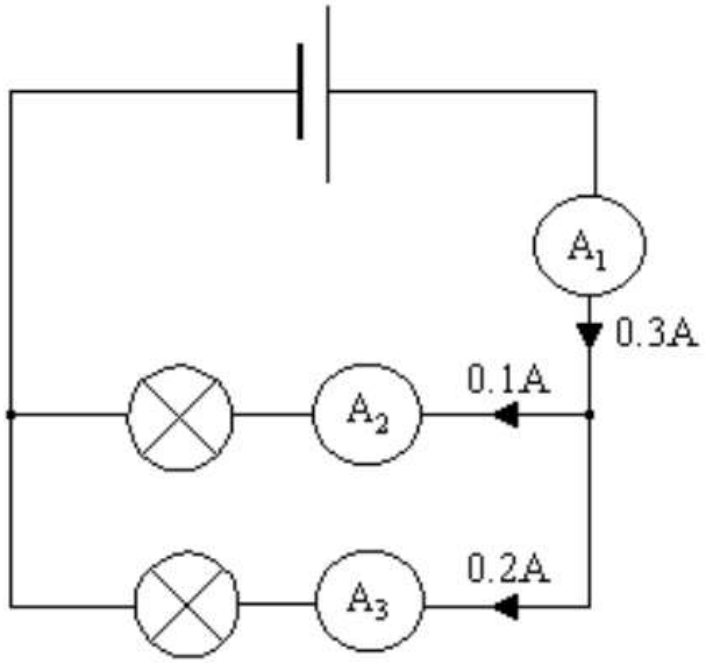


Both ammeters read 0.2A - this indicates that:

- *the size of the current current is the same at every point in a series circuit*

Currents in parallel

Currents at a junction



In the above, the bulbs are not the same, so the currents through them are different. But, notice that 0.1 + 0.2 = 0.3. This indicates that:

- *when a current splits at a junction, the total current total remains the same*