

Episode 101: Introduction to circuits

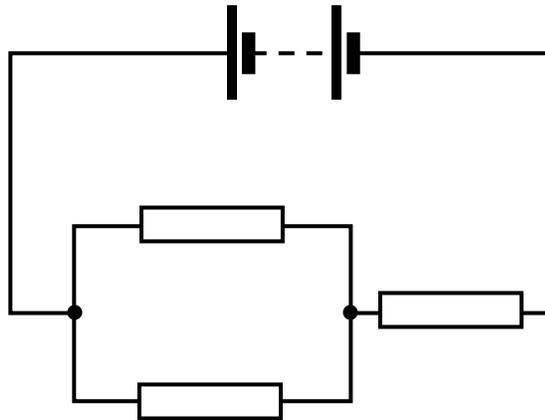
Depending on the ability and experience of your students you may need to spend time reviewing their previous knowledge and rehearsing the language that will be needed to cope with what follows.

Summary

Demonstration and Discussion: Talking about circuits. (30 minutes)

Student Activity: How current flows. (20 minutes)

Demonstration: Using multimeters. (15 minutes)



Demonstration + discussion:

Talking about circuits

One way to review your students' existing understanding of simple circuits would be to ask questions about a concrete example (e.g. the circuit shown above) and correct misunderstandings.

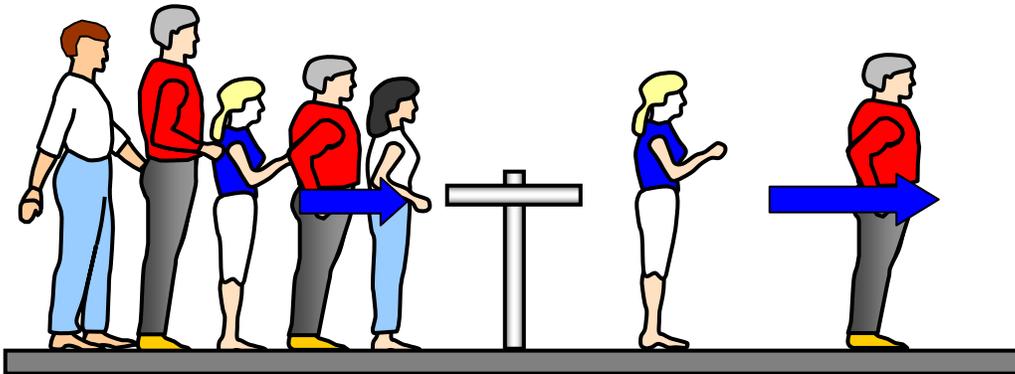
Set up the circuit using batteries and three identical resistors. At the same time, show the circuit diagram. Give a running commentary as you connect up: "Position the components as shown in the diagram. Starting from the – of one cell, connect up in a clockwise direction"

(Note that you could use lamps instead of resistors, but remember that resistance changes with temperature so filaments with equal cold resistance will not have equal resistance when different currents flow through them.)

Point out that there is little to be seen with a circuit like this, but they already know quite a lot about how to describe the invisible processes which are going on. Pose some questions about the circuit; here are some suggestions:

- Get them to imagine charge carriers moving around the circuit - what happens at a junction? (Current divides, re-combines.) At this stage, don't worry about the distinction between conventional current flow (from + to –) and electron flow.

- Rehearse flow analogies - people queuing to go through two turnstiles/traffic at a junction/water in a central heating system etc. (Be aware that each analogy has its pitfalls!). The key point is that charge has to be accounted for (i.e. it is conserved).



- Give values of current at a particular point (e.g. leaving the cell or in one of the parallel arms) and ask them for values at other points.
- How would they measure these currents? (Check they know how to add an ammeter to the circuit.)
- Ask students to make up sentences relating to the circuit using the terms 'series' and 'parallel'. (Two of the resistors are connected in parallel with each other. The cells are connected in series, etc.) Relate these terms to current flow. (Series = same current flows through one component then the next; parallel = current divides up, or is shared.)
- Give them pds across the cell and the single resistor and ask for the pd across the parallel resistors. How would they measure these pds? (Check they know how to add a voltmeter to the circuit.)
- Vary the circuit by having two resistors in one arm and one in the other.
- A tricky question: How do charge carriers 'know' how much resistance is ahead of them? They don't, but charge density adjusts very rapidly - like traffic on a motorway that backs up for a long distance before road works or an accident constricts the flow. (Again, be aware of the limitations of this analogy)

Student activity:

How current flows

If your students are unfamiliar with your standard electric circuit equipment (they may have come from another institution), give them a short activity to allow them to familiarise themselves with such components as power supplies, connecting wires, ammeters, resistors and lamps.

Ask them to set up a circuit which will demonstrate some aspect of how current flows. Then they should be able to demonstrate what their circuit shows to the rest of the class. They should accompany their description with a circuit diagram.

(Some can be expected to show that current is the same around a series circuit, and others that it divides in a parallel circuit. However, you could initially leave them to decide for themselves what they will show.)

Demonstration:

Using multimeters

If you expect your students to make use of multimeters, it is worth taking the time to explore them now. There are a wide range of multimeters in use in school physics faculties. Make sure you are familiar with the ones that will be used. It is valuable, prior to using them for measurements, to give out meters (e.g. in pairs) and take your class through the rules for connection. With a weaker group you may find it is worthwhile providing a pictorial instruction sheet. Most multimeters are fused. Make sure you know what currents are likely to be drawn and insist that student use an appropriate range. Otherwise you are likely to end up with a lot of blown fuses and confused students. If you have access to a PC projector a webcam and a laptop you can demonstrate the use of the meter and project an image of the connections.