Electricity and Magnetism: Teaching Approaches 02

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This is the 'Teaching Approaches', showing selected possible activities suitable for the classroom. To develop your expertise in the episode, work with the 'Physics Narrative' and the 'Teaching and Learning Issues'. Navigate to any part of the topic using the Topic Menu, or use the tabs below to stay within this episode.

Start

Four approaches

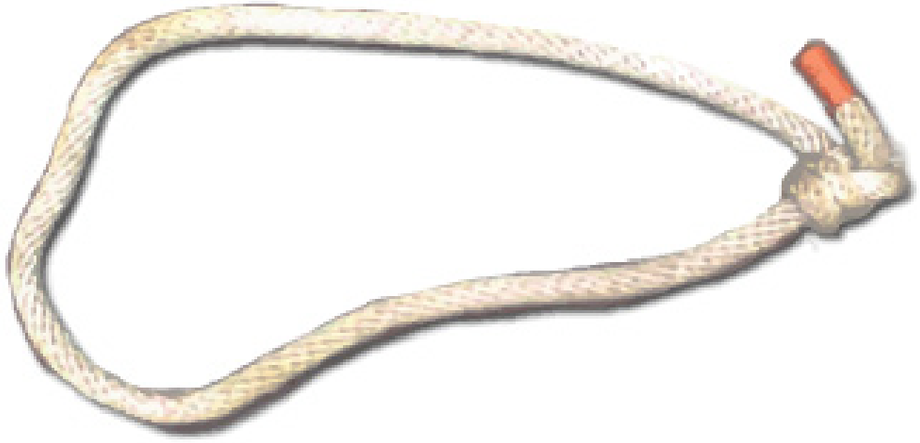
Measuring electric currents	teacher demonstration	• to introduce and discuss what is meant by electric current measurement in terms of the passage of charges • to encourage pupils to think and talk about the electric circuit model and teaching analogy • to demonstrate how to use an ammeter to measure electric currents
Predicting and measuring electric currents	class practical activity	• to encourage pupils to think and talk about the electric circuit model and teaching analogy • to enable pupils to measure electric currents with an ammeter • to emphasise the point that the electric current is not used up
Building circuits and predicting behaviour	class software based activity	• to think through the connections and to practice representing these relationships
Check questions	three diagnostic questions	• to check the pupils' understanding of ideas developed in this episode • to help identify where further teaching and learning effort may be needed

Measuring electric currents

Part 1: Measuring what?

What the activity is for

Having introduced the basic elements of the electric circuit model, attention is now turned to measuring electric currents. It is important that pupils have an understanding of what it is that they are measuring when they measure the size of electric currents.



What happens during this activity

To help the pupils visualise what it is that is being measured, it is a good idea to start with a teaching analogy. Using the rope loop, draw your pupils' attention to the following points:

- As the rope moves round, all parts of the loop move at the same speed.
- The same amount (or length) of rope passes each point in the circuit in a given time.
- If a bigger pushpull is provided by the battery, more rope passes each point in a given time (as the rope all around the circuit moves more quickly).
- If a smaller pushpull is provided by the battery, less rope passes each point in a given time (as the rope all around the circuit moves less quickly).

The point here is to make the link between the amount of rope passing in a given time and the charge passing per second (current).

Measuring electric currents

Part 2: Measuring how?

What the activity is for

The purpose of this activity is to demonstrate how to use an ammeter to measure electric currents.

What to prepare:

- 12 volt DC power supply
- 12 volt24 watt bulb in holder
- demonstration ammeter
- connecting leads

Equipment Tip: For this and other demonstrations we recommend using mounted 12 volt24 watt bulbs (car headlamp bulbs) with a 12 volt DC power supply and a demonstration ammeter.

Measuring electric currents

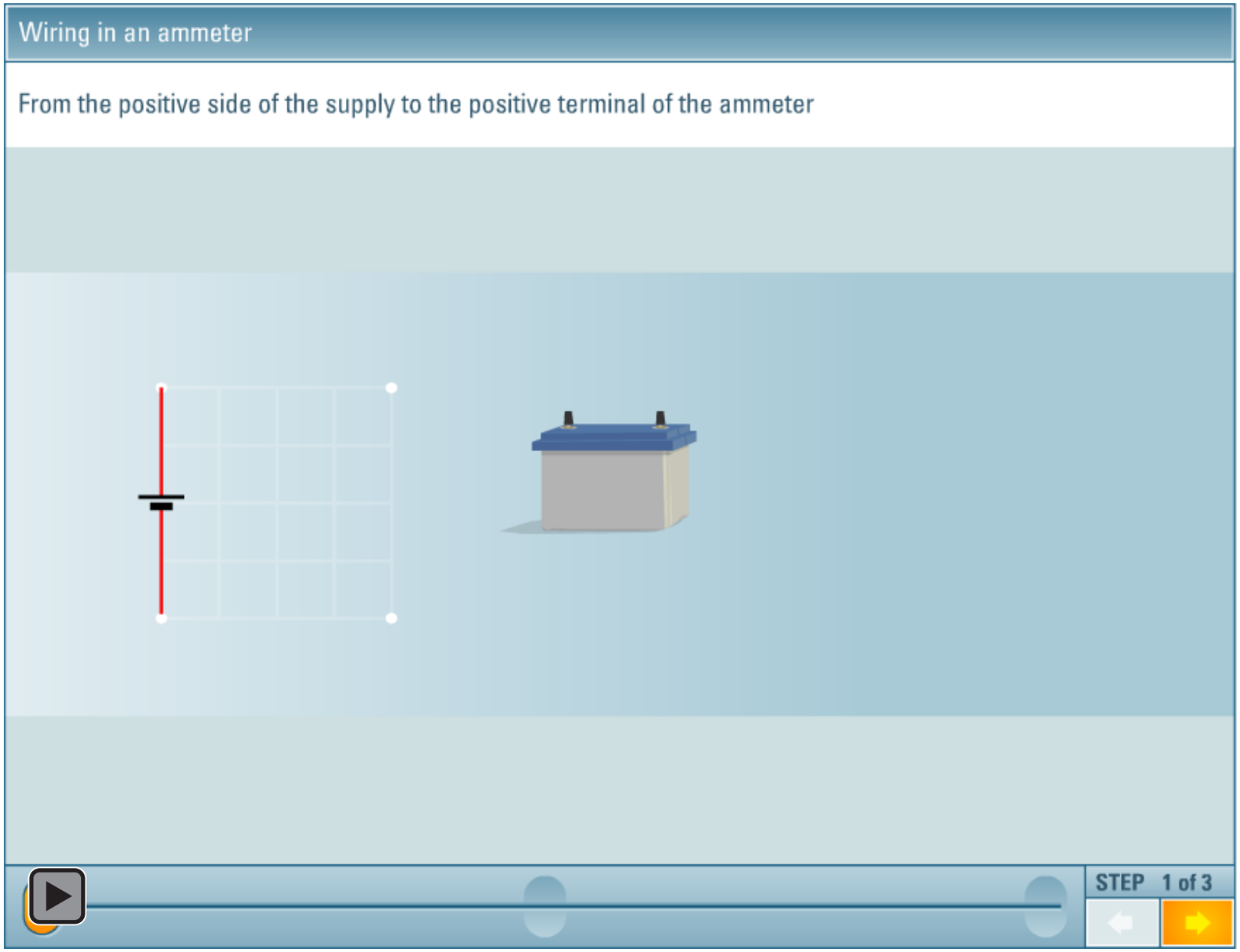
What happens during this activity

Demonstrate how to connect the ammeter by talking through and demonstrating the following sequence with the pupils:

Step 1: Make the complete batterybulb circuit.
"So we make the connection from the positive side of the supply to the bulb and then from the bulb back to the negative terminal. Switch on and…hola!…the bulb lights".

Step 2: Make a gap and connect in the ammeter.
"Ok, switch off again. Now then! Where do you think the ammeter might go? Does it matter where in the circuit you connect it? Why? Now let's make a GAP in the circuit where the meter is to go. So remove this lead and place the ammeter here".

Step 3: Connect the ammeter the right way round
"We then need to connect the ammeter the right way around. The ammeter has a positive terminal and a negative terminal. The positive terminal of the ammeter must be connected to the positive side of the supply".



Measuring electric currents

Switch it on, and the ammeter gives us the current reading. Every time you use an ammeter I want you to follow this same procedure. Make the circuit; make a gap in the circuit; and be careful to connect the ammeter the right way around.

Emphasising the point of making a GAP in the circuit and placing the ammeter in the gap helps to promote an understanding of electric current measurement. All of the charges flowing around the circuit must pass through the ammeter. All of the passing charges are counted in the ammeter.

A small helper at work

You could almost imagine that there is a little helper inside the ammeter. The little helper is armed with a stop watch in one hand and a counting stick in the other. As the charges pass through the meter the little helper has the job of counting the amount of charge passing each second, and this is the current reading.

Predicting and measuring electric currents

What the activity is for

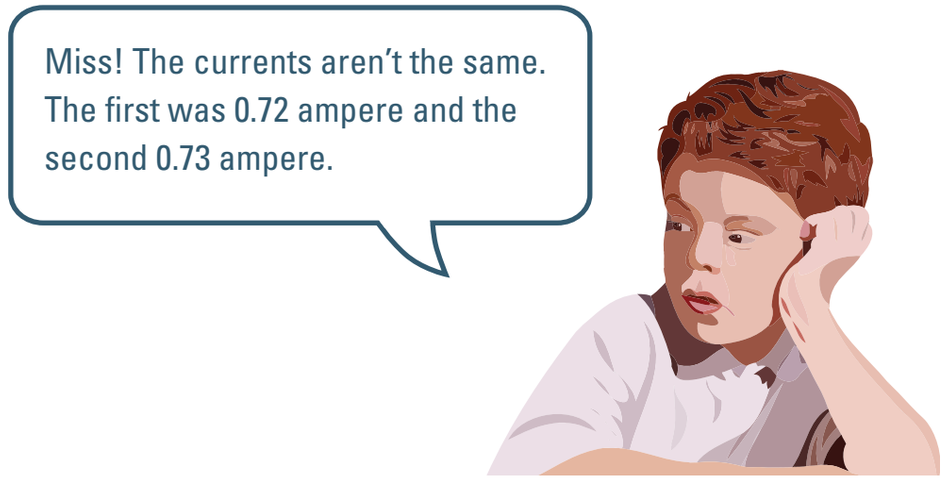
Having introduced what is involved in measuring electric currents, the pupils are now given the opportunity to make some measurements for themselves. This is an important practical activity for directly addressing the idea that the electric current does not get used up.

The approach taken is to encourage the pupils to think and talk about the electric circuit model and teaching analogy before taking the actual current measurements. To this end, the pupils are asked to make predictions of current values before they make each measurement.

What to prepare:

- batteries
- bulbs
- ammeters
- connecting leads
- support sheet: Predicting and measuring currents

Equipment Tip: For the purposes of this activity, it is much easier for the pupils to use digital meters. Given the aim of establishing that the current is the same around each circuit, it makes sense to use less sensitive ammeters. It is not helpful for pupils to measure current to one-hundredth of an ampere and then to worry about differences between readings in the second decimal place. The scenario to avoid is:



Avoid this by using an ammeter with a scale which reads to one-tenth of an ampere.

Predicting and measuring electric currents

What happens during this activity

You might introduce this activity in the following way:

OK, we have the idea that the ammeter measures the electric current and this gives us the amount of charge passing each point per second. If we measure the current here, and then here on the other side of the bulb, what would you expect to get?

First of all, talk it through with your partner. Think about the electric circuit model with the charges moving round. Think about the rope loop. I'll give you a few minutes and then we'll talk through your ideas.

OK, people are suggesting that the current should be the same in both places because the rope just keeps going round, or the charges just keep moving round the circuit. As James says, none are added or lost.

Well, collect the equipment and use an ammeter to measure the current values for yourselves. There are 3 circuits to investigate. Go to it!

For this activity, the pupils should ideally work in pairs and each pair has one ammeter, which is placed in the different positions in circuits A, B and C as shown on the support sheet. Some pupils may think that they need three ammeters for Circuit B. This is not the case!

As the pairs of pupils complete their measurements, it is a good idea to collect the current values on the board or on a large sheet of poster paper, so that the pattern of findings becomes apparent to all.

Predicting and measuring electric currents

The current stays the same all of the way round each of the circuits. By this stage the pupils should have a clear picture of why this makes sense.

In terms of the electric circuit model: The number of charges passing per second is the same all around the circuit. In the bulbs, energy is transferred but the charges keep going.

In terms of the rope loop: All parts of the loop move around at the same speed (watch the red ribbon) as the “battery” sets it in motion.

Be sure to allow pupils to talk through these new ideas, as they review the current values for the whole class.

Drawing on pupil thinking

You might make the “wrong track” pupil ideas an explicit part of your classroom discussions by introducing them to the lesson yourself:

Teacher: “Now then, in one of my other classes one of the boys said that the charges all come out of the battery when the circuit is switched on. Was he right? What do you think about that?”

In this way the possible “wrong track” step in learning is brought out into the open and addressed, rather than just left lurking in pupils’ thoughts! Part of the trick of building expertise in any area of teaching is to be able to anticipate pupils’ questions and problems.

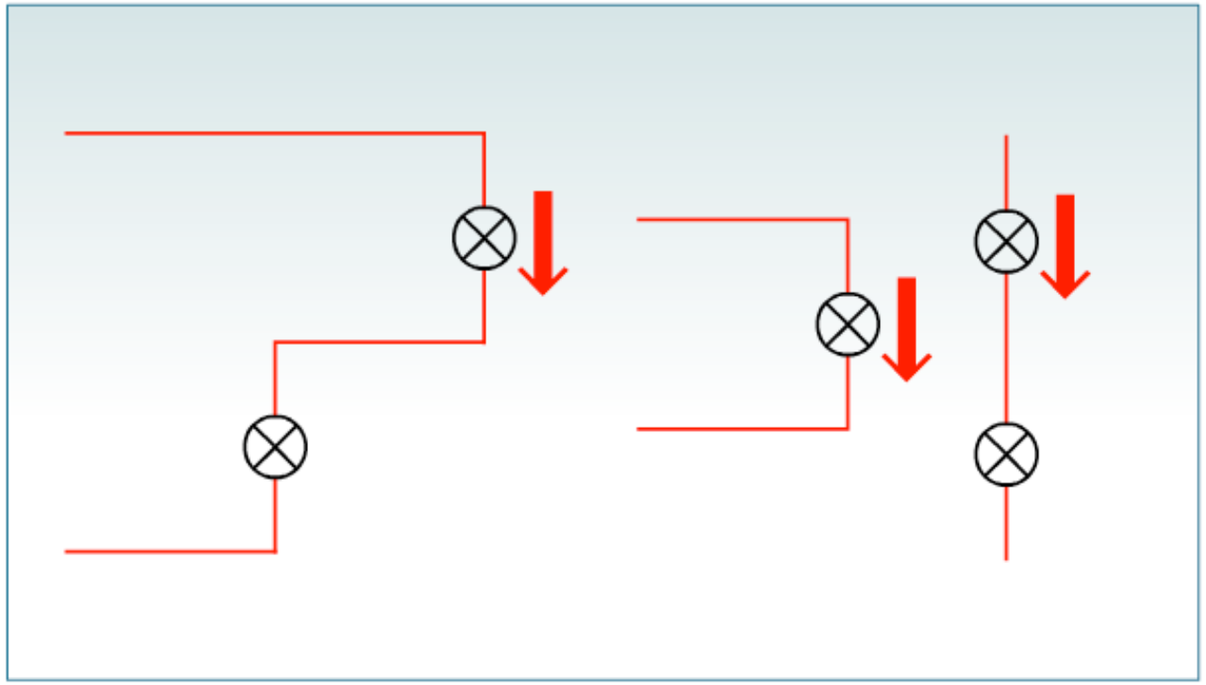
Building circuits and predicting behaviour: Current and charge flows

We suggest that you use parts of the circuits here to allow your class to concentrate on two aspects of the behaviour of circuits:

- Current does not get lost as it passes through circuit elements in series.
- "Charge flows" and "currents" are equivalent descriptions.

One way to use this software is to build parts of circuits and then use the current and charge flow arrows to describe them. Pupils could be involved in setting the challenges or in doing the labelling, either as a whole class activity or working in small groups. In all cases, the class can use the precision of the diagrams to fix and discuss the relative magnitudes of currents and charge flows.

For these circuits, we suggest that you use a mixture of current and charge flow labels; then increase the current and get the pupils to alter the charge flow labels to match, or change the charge flow labels and get the pupils to match the currents. An alternative is to compare lots of elements: "Here are four lamps with different currents. Add charge flow representations to match these pictures."



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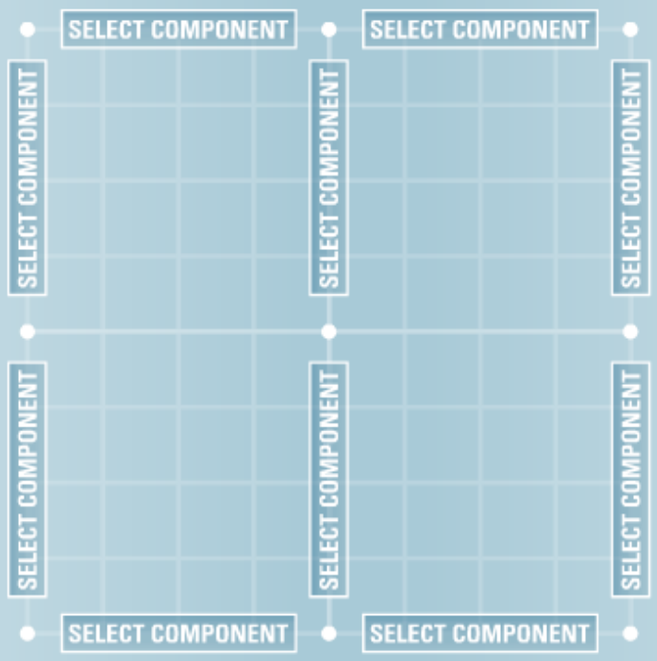
Building circuits



SHOW / HIDE

RESET

STEP 1 of 2

Check questions

What the activity is for

The diagnostic questions can be used to check the pupils' understanding of key ideas introduced in this episode.

What to prepare:

- copies of these three sheets

What happens during this activity

The questions might be used for homework or as the basis for discussion in class.

Electric current at points

This question asks about the relative size of the electric current at two points on either side of a bulb. Some pupils may think that the bulb must use up some of the current.

a. The electric current is the same at a and b.
b. The current is the same all round the circuit.

Battery and bulb

This question probes pupils' ideas about what is happening (unseen) inside the wires of a circuit.

a. There is an electric current in wire B from the bulb to the battery.
b. The current in wire B is the same as in wire A.

Current motor

This question asks about the relative size of the electric current at two points on either side of a motor. Some pupils may think that a motor must use up some current (even if they think a bulb would not).

a. The reading on ammeter A2 is exactly 0.4 ampere.
b. The current is the same all around the circuit.