# Electricity and Magnestism: Teaching and Learning Issues 02

Contents



This is the ‘Teaching and Learning Issues’ that explains the particular challenges. To develop your expertise in the episode, work with the ‘Physics Narrative’ and the ‘Teaching Approaches’. Navigate to any part of the topic using the Topic Menu, or use the tabs below to stay within this episode. .

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# Challenge summary

- Challenge 1: What does the electric current measure?
- Challenge 2: What fixes how big or small the electric current is?
- Challenge 3: What gets used up?

These challenges reflect research carried out into alternative conceptions.

# Challenge 1: What does the electric current measure?

Wrong Track: The current measures how fast the charges are moving.

Right lines: The current measures how much charge passes each second.

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# Challenge 1: What does the electric current measure?

Following this line of reasoning, some pupils refer to the electric current being faster or slower when changes are made to a circuit.

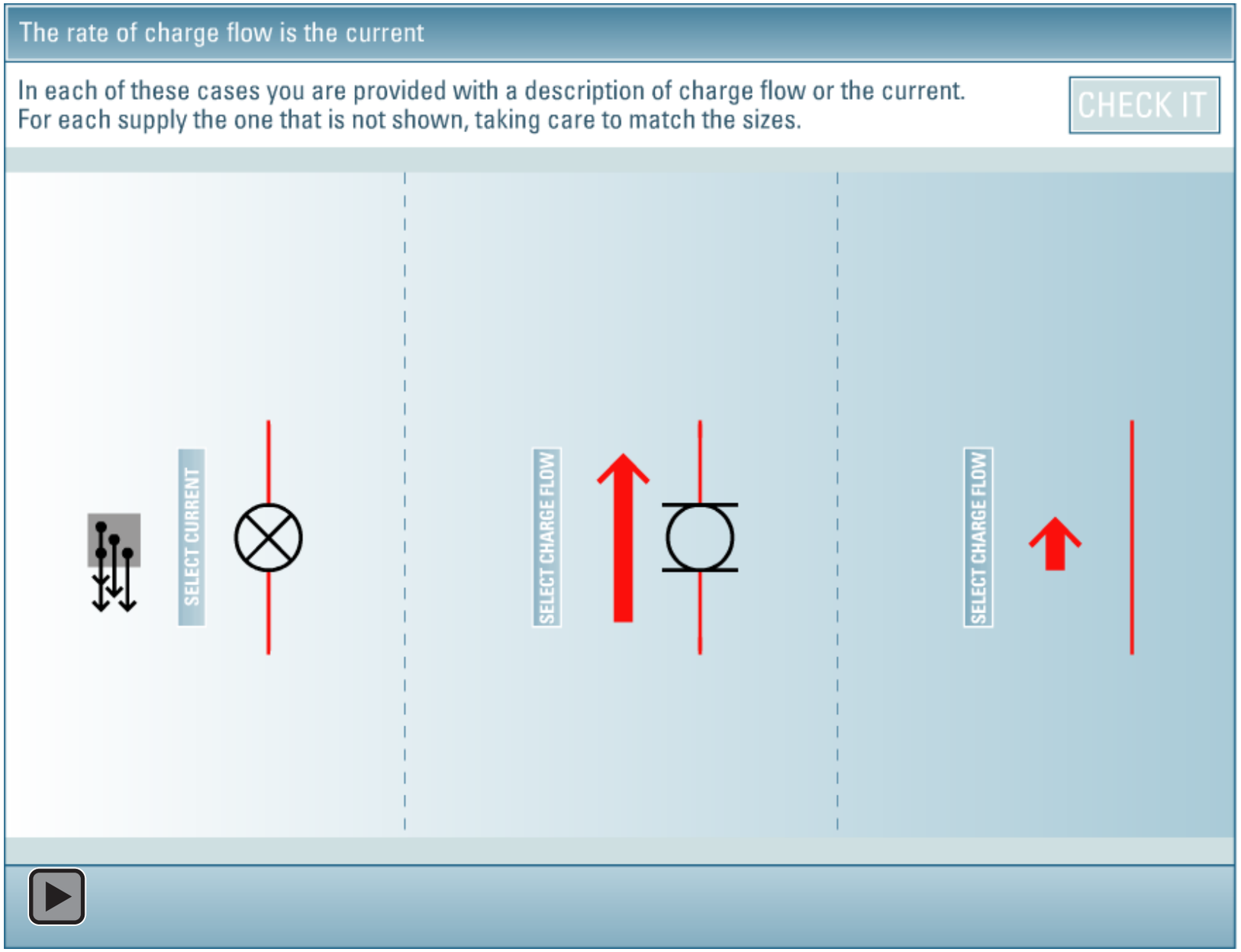
**Thinking about the learning**

The idea that the electric current is a measure of how much charge passes per unit time can be quite challenging for pupils. It is common for pupils to mix up how much charge passes with how fast the charges are moving.

Mixing up these two ideas is understandable. For example, if we add a second cell to a circuit with one bulb, the current increases because the charges in the circuit move round more quickly (this circuit is considered in detail in episode 3). Nevertheless, we must be clear in stating that the electric current is measured in terms of the amount of charge passing.

With a big electric current, many charges pass each second.

With a small electric current, fewer charges pass each second.



# Challenge 1: What does the electric current measure?

### Thinking about the teaching

A useful approach to getting over the idea of measuring electric current is to encourage the pupils to picture what is happening in the wires of the circuit.

### Starting with a teaching analogy

You might start with the rope loop referring to the amount of rope that passes by each second. The supermarket picture (see episode 3) is also handy here in painting a picture of the number of vans passing per second and possibly referring to “those single rubber strips” across the road, which are used to count the number of vehicles passing. You might emphasise that they do not measure how fast the cars are moving, and make a point of never talking about charges moving faster or slower when you mean only to indicate an increase of decrease of flow. Then move on to connect the flow rate of vehicles to the idea of the number of charges passing per second.

### Introducing the ammeter

In introducing the ammeter, emphasise that its job is to measure how many charges pass through that point in the circuit each second. In such a way, talking about the ammeter helps to clarify and reinforce the concept of electric current.

### Measuring currents in ampere

When the pupils start measuring electric currents, take every opportunity to talk through what is meant by the readings that they take.

# Challenge 1: What does the electric current measure?

So, the current here is 0.5 ampere and the current there is also 0.5 ampere. What does this mean? Anybody? What does it mean in terms of the charges in the circuit?

That the amount of charge passing through both points each second is the same…

Excellent! The amount of charge passing per second is the same.

# Challenge 2: What fixes how big or small the electric current is?

Right lines: The current through the circuit is 2 ampere. This rate of flow of charge is fixed by the “push” of the battery and the resistance in the circuit.

Wrong track: The current flowing in the circuit is 2 ampere. The battery is giving a current of 2 ampere.

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# Challenge 2: What fixes how big or small the electric current is?

This incorrect line of thinking may be linked to the earlier “wrong track” idea that the current originates in the battery.

**Thinking about the learning**

Having been introduced to the idea of measuring electric currents, some pupils see the battery as providing a fixed current.

**Thinking about the teaching**

The fundamental point here is that the pupils see the circuit as a whole system with the charges being set in motion by the battery and any resistance in the circuit acting to restrict that motion.

# Challenge 3: What gets used up?

Wrong track: The electric current gets used up in the bulb to make it work.

Right lines: Current is conserved and energy shifted. The current after a bulb has the same value as the current before because the same number of charges enter and leave the bulb each second. Things going in must come out! However, as each charge passes through the bulb, energy is shifted by the filament as it glows.

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# Challenge 3: What gets used up?

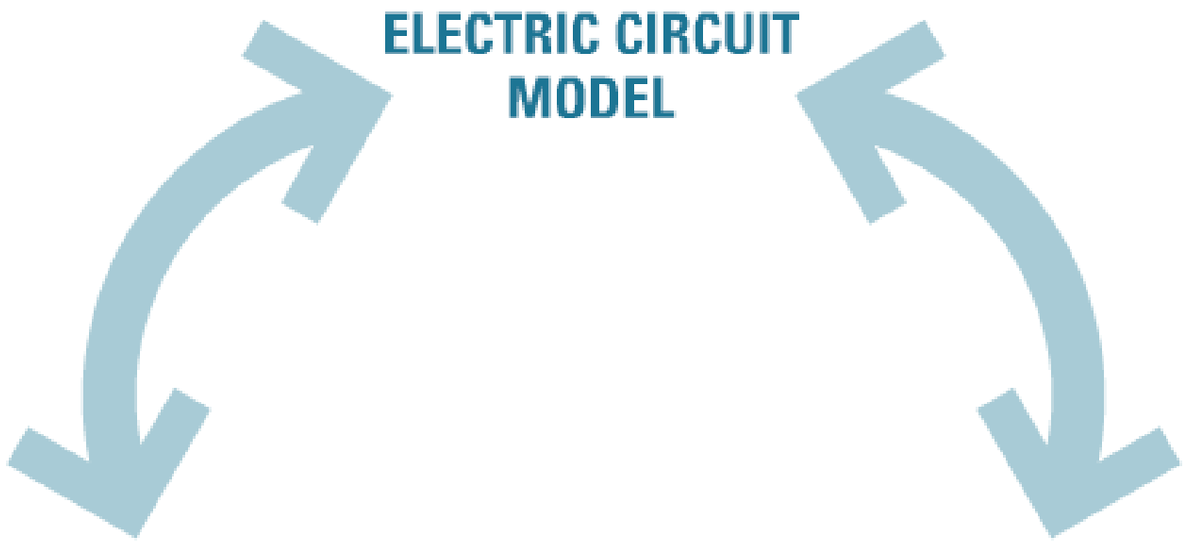
The incorrect idea here is that the current after the bulb is less than the current before the bulb, because some of the current gets used up to make the bulb work.

**Thinking about the learning**

It is clear to most pupils that something must get used up when a battery is connected to a bulb and the bulb lights up. The key learning challenge is for pupils to come to understand that the electric current is conserved whilst energy is shifted by the circuit.

**Thinking about the teaching**

To communicate the idea that electric current is conserved in the circuit, it is helpful to make practical measurements of electric current and to relate these to the electric circuit model and to the teaching analogy. So there are three things to think about:



# A choice of teaching approach

This leads to a choice of teaching approach, which involves either:

Starting with measurement: The pupils are told that ammeters measure electric currents and that they are to use an ammeter to find out what they can about current values at different points in circuits.

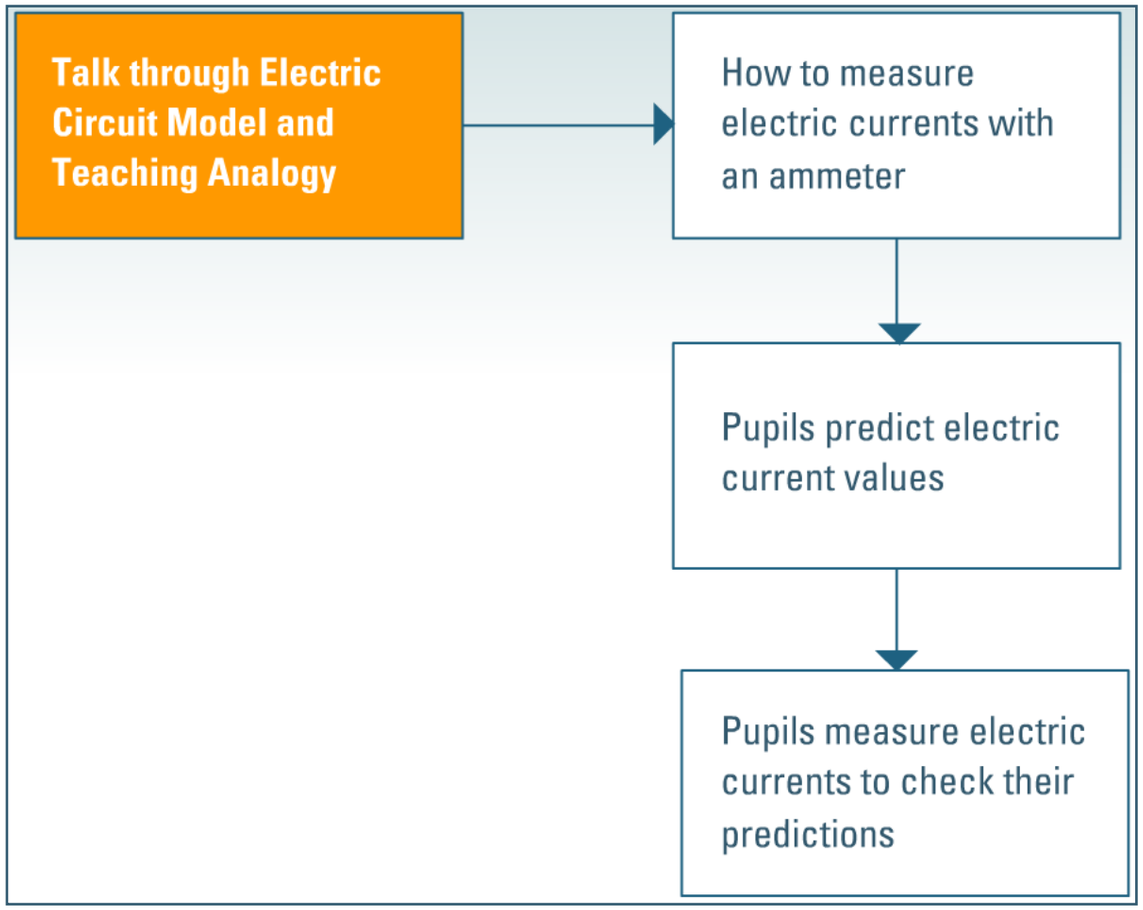
Starting with the electric circuit model/teaching analogy: The concept of electric current, as charges passing per second, is introduced (drawing on the teaching analogy) and the pupils are instructed to use this idea to make predictions of electric current values at different points in circuits.

Starting with measurements, in this particular context, does not make much sense to us, since the pupils are being asked to make measurements of "currents" when they have no idea of what an electric current is.

The approach, which we suggest, therefore, is to:

- talk through the electric circuit model, and teaching analogy, with the pupils
- demonstrate how to use an ammeter to measure an electric current
- encourage pupils use the model to make predictions of the value of the electric current at different points around various circuits
- get pupils to check their predictions through practical measurements with an ammeter

In this way the practical measurements are used to confirm the developing electric circuit model helping to make it seem reasonable and logical for the pupils.



# Appropriate accuracy

**Seeing ammeter readings as being the same**

A very practical advantage of this approach is that the pupils set about making current measurements with the expectation (hopefully!) that the current values will be the same. If the instruments indicate slight differences, these are likely to be accepted as being “just about the same”.