Electricity and Magnetism: Teaching Approaches 07

Contents

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

Exploring electromagnetism

Oersted's experiment	teacher demonstration	• to demonstrate Oersted's famous and very important experiment
The BIG electromagnet	teacher demonstration	• to capture pupils' interest • to reinforce the point that the strength of an electromagnet depends on the number of coils
Mapping the field of an electromagnet	class exploration	• to give direct physical experience of the controllable magnetism of electromagnets • to emphasise similarities with the magnetic field of a bar magnet
Electromagnetic devices	teacher demonstration	• to show real devices in action • to develop ordered, detailed explanations
Progress check	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

Oersted's experiment

What the activity is for

Oersted's experiment was of fundamental importance to the development of physics in making the link between electrical and magnetic effects. Here we demonstrate what was involved in Oersted's discovery of electromagnetism, in no more than 10 minutes.

What to prepare:

- transparent compass
- OHP
- long wire
- a power supply capable of providing about 5 ampere.

What happens during this activity

Even though Oersted's experiment is of ground-breaking significance in the history of physics, it can seem unimportant to pupils. The secret here is to try to generate some of the surprise and interest that Oersted himself experienced when he first witnessed this phenomenon.

Try carrying out the demonstration on the glass of an overhead projector as follows:

- Place a plotting compass on the projector and agree with the class that it is pointing north south.
- Draw the attention of the class to the circuit you have set up which consists of a single, long loop of wire.
- Start moving the wire (circuit switched off) over the top of the compass and along the line of the compass needle. Ask the class what they think will happen. Nothing!
- Now keep the wire along the line of the compass needle and switch on the electric current. The compass needle swings around so that it now lies across the line of the wire (at right angles to its original position).
- The KEY question here is: "What does the movement of the compass needle tell us?" The answer is simply that the electric current in the wire must be producing a magnetic field.
- Switch off the electric current and the compass needle swings back again. Line up the wire with the needle once again but this time with the wire under the compass. Prepare to switch the circuit on again.
- Ask the class to predict what will happen to the compass needle.
- When the electric current is switched on the compass needle is once again deflected across the line of the wire, but this time in the opposite direction. If the class has already used plotting compasses to map the fields of permanent magnets, they may be able to work out that there is a magnetic field around the current-carrying wire and that it is circular in shape.

Make the link to Oersted's experiment and then quickly move on to explore what happens with lots of coils of wire in the BIG electromagnet.

The BIG electromagnet

What the activity is for

The main purposes of this activity are to capture pupils' interest and imagination and to develop the idea that the strength of an electromagnet depends on the number of coils of wire.

What to prepare:

- A demonstration electromagnet made from:
  an iron C-core of the type used in Westminster Electromagnetism kits
  a long length of insulated wire (about 5 metre) which is coiled around the core
  a low voltage power supply (about 12 volt, direct current)
  a matching C-core
  100 gram and 1 kilogram slotted masses to hang from the electromagnet assembly

The electromagnet is assembled and then hung from the ceiling with some very strong string. The matching C-core is introduced to the electromagnet and masses are added to it, suspended from a loop of strong string.

What happens during this activity

This is a teacher demonstration which serves to illustrate just how powerful magnetic forces can be. Rather than have the pupils working with iron nails and small coils of wire (to build relatively weak electromagnets) we would recommend this approach.

- Assemble the electromagnet and switch on the electric current. Make the point that you are using a low voltage supply and speculate as to how strong the electromagnet is likely to be.
  "Will it hold the second C-core?"
  "Yes, it will!"

- Start adding masses to the string round the second C-core:
  "Will it take an extra 100 g?"
  "Yes, it will!"

- Go through the whole process of adding masses in a slow and deliberate way, building up the tension. Ask the pupils to predict how much the electromagnet will hold. A science teacher colleague actually performs this demonstration in a darkened room, with a strong light focusing on the electromagnet (high drama!). Eventually you will be adding 1 kilogram at a time as it becomes evident that this electromagnet is much stronger than any pupil might have anticipated:
  "Isn't that amazing? By far the best thing you'll see today…or all week for that matter!"

The electromagnet we use will hold about 4 kilogram. Given the size of the load you need a soft landing site (we use a waste-paper bin with a piece of old blanket inside) to catch everything when the electromagnet can no longer hold up the load.

Mapping the field of an electromagnet

What the activity is for

The field of a solenoid is just like that of a bar magnet, except that you can get inside the coil. By using a high current power supply you can explore this field with compasses and with iron filings.

What to prepare:

For the demonstration

- solenoid with only a few well spaced turns mounted on a transparent base for the OHP
- OHP
- a power supply capable of supplying about 8 ampere.
- iron filings
- about 12 transparent compasses

Per pair

- 1 metre of bare-ended wire
- 10 cm of broomstick dowel around which to wind the wire to make the solenoid
- a power supply capable of providing about 5 ampere.
- compass

What happens during this activity

Pupils wind their own solenoid, taking care to leave enough wire at the ends to connect it to the power supply. Then remove the dowel. Run the current through the solenoid only for short lengths of time, applying about 2 volt across the ends. Warn the pupils that the wire will get hot enough to burn them. Explore the magnetic field around and through the solenoid. Ensure that similarities with the bar magnet are noticed, and that pupils switch the solenoid on and off with the compass near it. Use the reaction of the compass to the switching to emphasise that the solenoid forms a temporary magnet. Use the demonstration solenoid on the the OHP to summarise their findings.

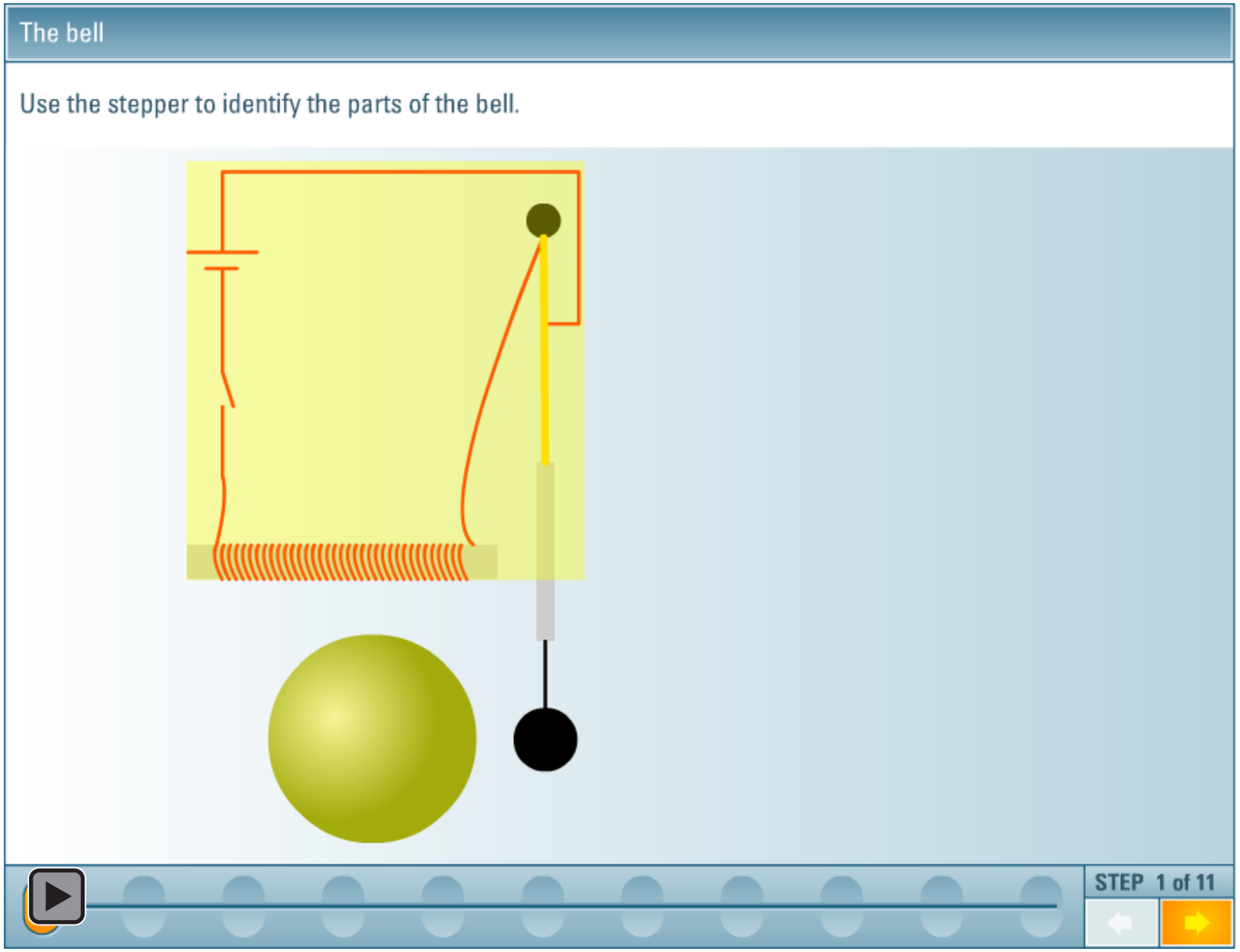
Electromagnetic devices

What the activity is for

Electromagnetic machines are very common. The aim of this activity is to make clear how a small selection of these work, drawing on the behaviour of electromagnets that pupils have seen.

What to prepare:

- a mounted relay with power supplies, switch and lamp. You should aim to have a mounted demonstration relay with the two circuits quite separate, and run from two separate power supplies, with one small (for the low current circuit), and one large (for the high current circuit which might conveniently drive a large lamp).
- a mounted bell. The mounted bell should display as much of the mechanism as possible.
- you might consider using a video camera to provide an enlarged display of the demonstration.
- these two interactive objects

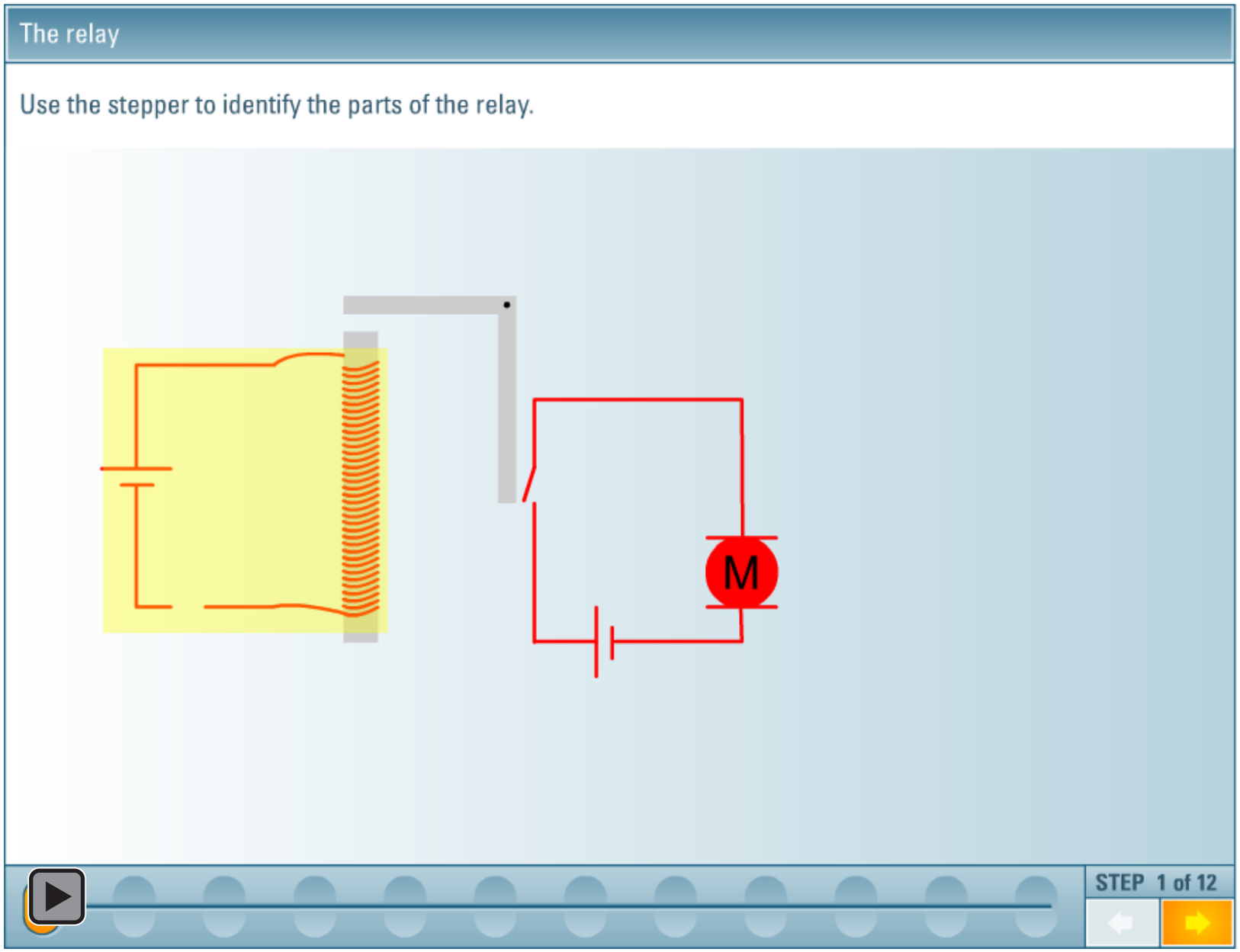


Electromagnetic devices

What happens during this activity

Show the bell in action, focusing on the make and break switch inside the bell. Use the interactive object to review the pupil's understanding. You could also reverse this order, talking through the interactive object yourself, then showing the real bell.

Show the relay in action, focusing on the two separate circuits and the magnetic link between them. Use the interactive object to review the pupils' understanding. You might call pupils to the front to provide a commentary for each stage.



Progress check

You can use the following questions to check your own understanding and your pupils' understanding

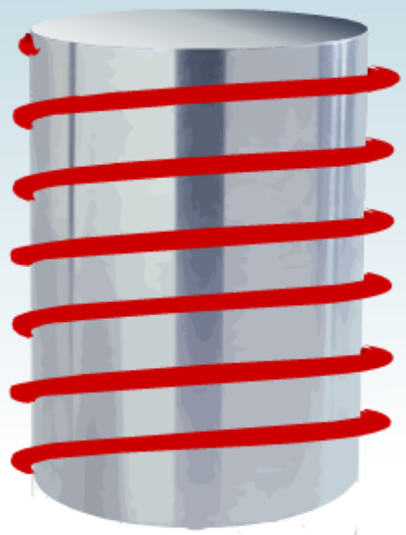
Check your understanding of electromagnetism

Question 1 of 4

Anita and Julia have made a simple electromagnet with an iron core and wire, and are now trying to make it stronger. They try:

1. Using more turns of wire
2. Using a thinner iron core
3. Increasing the electric current
4. Using an aluminium core

Which of these would work?



	CORRECT	INCORRECT	DON'T KNOW
a) 1 and 2	☐	☐	☐
b) 2 and 3	☐	☐	☐
c) 1 and 3	☐	☐	☐
d) 3 and 4	☐	☐	☐
e) 1 and 4	☐	☐	☐

Once you are happy with your answer click 'check it' to continue

CHECK IT