# Activity E2
# Introducing magnetic fields and the electric motor effect: teacher and trainer notes

While many learners are de-motivated by traditional ‘chalk and talk’, didactic approaches to teaching theory, hands on learning has great appeal, particularly when presented in a problem solving context and when it is used to develop theoretical constructs.

This activity provides an opportunity for learners to use basic knowledge of magnetic fields to explore how magnets can be used to create motion. It is an exploratory activity and, as such, learners must be allowed to try out and test their ideas with minimum intervention from you.

Hands on, exploratory learning is challenging as it entails learning by taking risks and making mistakes. If this is a new approach for your learners, you should reassure them that if we never took risks and learned from mistakes, we would never learn anything new. Share some relevant personal examples to open up a discussion about how learning by doing has influenced your life and work and how this approach has moved pioneering engineering forward.

To ensure independent learning, it is important that you:

- check that all learners start off with the minimum knowledge needed to be successful
- ensure that all learners are clear about the purpose of the activity and its learning objectives
- ensure that all learners are clear what they have to do
- ensure that everyone experiences hands on learning
- manage the learning environment sensitively, ensuring that those who need additional support receive it discreetly, preferably through peer support
- plan and manage feedback and summary effectively to ensure that everyone reaches the correct understanding
- stand back and let them get on with it, monitoring discussion discreetly.

## Learning objectives

Learners should be able to:

- state the origin of the two magnetic fields (permanent magnet, electromagnet)
- provide a basic explanation of how the interaction of two different magnetic fields can cause movement.

## Materials required

For each learner you will need (see Figure E2.1 below):

- a mini-whiteboard
- one AA cell
- one short piece of wire with the insulation removed at each end
- one nail
- two strong cylinder magnets (provided in the resources pack).

Strong magnets are available from a number of suppliers via the internet. Typing ‘super magnets’ into a search engine will give a number of options. High strength NdFeB magnets were used in the pilots.

- example session plan from CD ROM *Resources*.

**Fig. E2.1**

## Time needed

About 45 minutes for the initial activity plus 15 minutes if the further activity is used.

## Starting points

Learners should have some basic knowledge of magnetic fields, including fields from electromagnets, but do not need any prior knowledge of electric motors.

This activity can be used at the start of the electric motor topic as full explanations of motor principles are not expected from the learners at this stage.

The main purpose of this activity is to engage, intrigue and motivate learners and to inspire an interest in, and a focus for, the theory and practical work that will follow.

## Suggested approach

To set the scene for the activity, check the extent of learners' understanding of magnets and their properties. You could have some magnets for learners to handle to start off the session and to renew their knowledge. For example:

- Ask the group to give you as many 'facts' as they can about magnets and develop a list or spider diagram on the classroom board. Ideas might include:
  - two magnets attract or repel
  - a compass is deflected by the Earth's magnetic field
  - there is a field around a magnet: evidence – iron filings
  - used to sort drinks cans
  - can be permanent or temporary.
- Ask learners to show you on their whiteboards:
  - If I bring two north poles of a bar magnet together what will happen?
  - Can I stop a bar magnet being a magnet?
  - What sort of magnets can I turn on and off?
    - > How does a crane in a scrap yard move scrap metal? An electromagnet.
    - > How do they work? By current flowing through a wire.

Allow thinking time and writing time before you ask learners to hold up their whiteboards. Use these responses to probe and clarify basic understanding if necessary. Ask learners to expand points themselves rather than doing so yourself.

Alternatively, you could invite learners to come forward to create a diagram or spider diagram of their understanding of magnets and magnetic fields on the class whiteboard. This can serve as a visual memory prompt as they make their motors and it can form a useful focus for feedback and review of learning at the end of the activity.

Revisit the learning objectives and link them to the recap on properties of magnets. Then set the learning challenge. For example:

> "Using what you know about magnets and the equipment you have in front of you, see if you can make an electric motor.
>
> Work in pairs or small groups to share ideas about what might work, what might not, and why, but then try your own ideas out for yourself.
>
> When you have each got a working motor, try to explain how and why it works."

As you will have knowledge of each learner's starting point, you might want to organise the pairs or groups so that each includes a more confident learner. Peer support can benefit everyone.

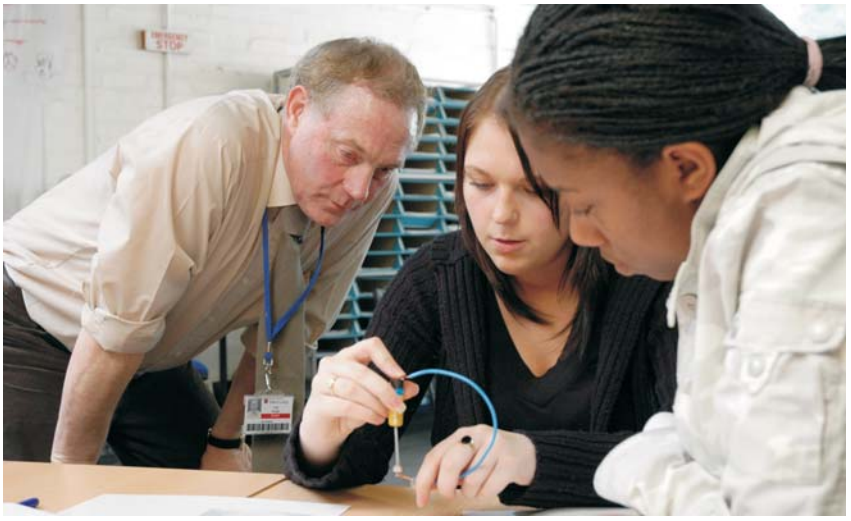
Teachers and trainers who piloted this activity found that it was necessary to:

- emphasise the importance of avoiding a direct short circuit of the battery with the wire
- provide occasional, timely hints on how to assemble the motor. For example, some useful prompts might be:
  - decide which parts of the motor are going to turn and which parts will remain stationary (two will turn; two will remain stationary)
  - the two magnets are kept together in the assembly
  - try fitting the nail between the battery and the two magnets.

However, allow learners to work independently as far as possible and do not intervene unnecessarily.

Once they each have a working model, the learners should start to discuss and agree in their pairs or groups on a simple explanation as to how the motor works.

Ask pairs to explain their own understanding orally to each other before they try to record anything. This is a useful 'rehearsal' of understanding and acts as a personal check.



## Taking feedback

You might try this in several ways.

1. Ask learners to use just one mini-whiteboard to record the pair or group explanation. Using the mini-whiteboards will help learners to draw out their ideas, change their minds and alter their explanations as their ideas develop. As you view the responses ask some to expand on what they have written. Encourage others to challenge, expand and improve on these responses until you have a class response that is correct.
2. If your learners are well bonded and confident as a group and familiar with you and each other, you might take feedback using learner demonstration. Ask a group to summarise and explain their findings on the board. Then ask others if they agree or would add or change anything. The aim is not to criticise the answer but for the class to agree a 'class answer'. You facilitate this without evaluating the answers but by

using probing questions. This approach needs to be introduced gradually, initially using volunteers, until learners become confident.

3. Ask learners to produce a poster to summarise and present their findings. This helps them to organise their understanding visually and can form the basis of an explanation or presentation to teach others. Many learners prefer their learning to be assessed in this way, particularly if they have a visual or kinaesthetic learning preference.

## Consolidating and checking learning

Close the activity using a whole class discussion and encourage learners to establish the following key points:

- there is a magnetic field due to the permanent magnets
- there is an electromagnetic field due to the current flowing through the permanent magnets
- these two magnetic fields interact, causing motion.

Take time to listen to your learners, and pick up and correct any misconceptions by asking learners to challenge, expand and improve the ideas themselves. Do this by asking open, probing questions and resist providing quick-fix answers. Make sure all learners participate in the class discussion.

Finally revisit the learning objectives and check, with the learners, that they have been achieved.

## What learners might do next

Display a variety of different motors, for example:

- an electric drill motor
- a motor with permanent magnet and electromagnet
- a motor with two electromagnets.

Ask learners if they can identify the key components, providing help if required.