Lesson 6

# May the force be with you

Making an electromagnet

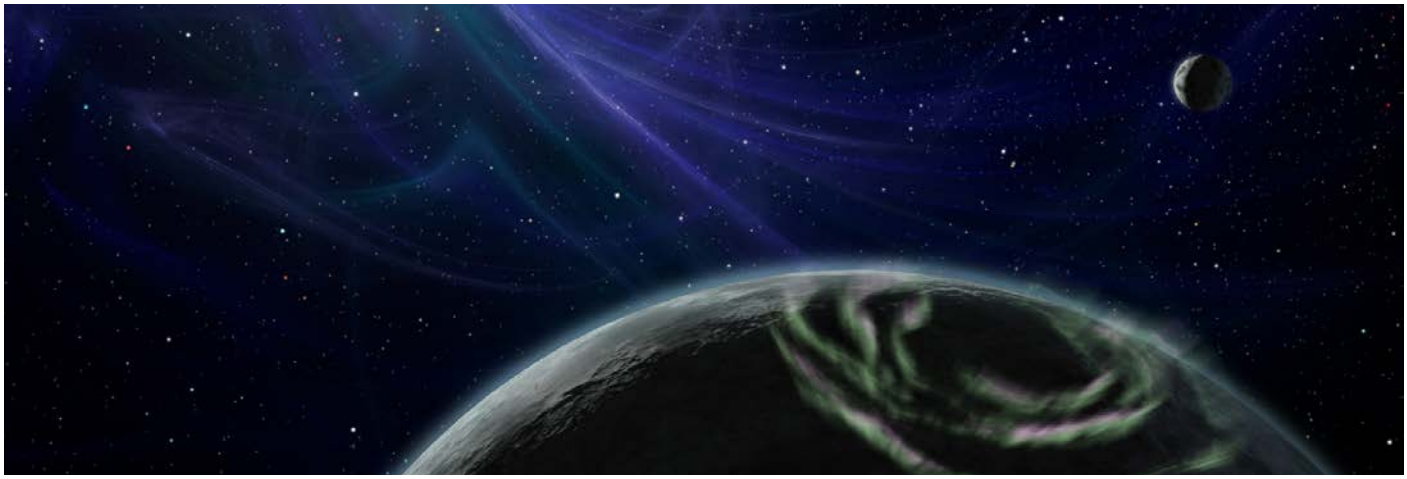
**Curriculum links**

**England** Forces and magnets | Electricity | Properties of materials

**Scotland** Forces | Electricity

**Wales** How things work-magnetic forces | Uses of electricity and its control | Enquiry skills

**Northern Ireland** Properties of materials and their uses



Exoplanet with high levels of elctromagnetic radiation. Credit: NASA/JPL-Caltech/R. Hurt (SSC)

## Background

The discovery of exoplanet Proxima b, a potentially Earth-like world orbiting Proxima Centauri, the closest star to our own Sun, gave rise to several questions concerning its potential to host life. Huge amounts of radiation emanating from its star bombard this exoplanet. Since it is closer to its star than Earth is to the Sun, for life to survive, it would require a very strong magnetic field. On Earth, a magnetic field around the planet protects all living creatures from dangerous cosmic rays.
In this activity, the children investigate magnets, make a simple electromagnet and investigate its properties.

## Objectives

**To learn:**

- magnetic poles are in pairs
- opposite poles attract and like poles repel
- some materials are attracted by magnets
- an electric current in a wire produces a magnetic field around the wire

### Resources per group of four

Magnets: bar, circular, horseshoe x 2
Plastic container holding:
Insulated wire (minimum 2m)
Wire strippers
Large iron nails x 2 (thick and thin)
Paper clips
AA battery x 3
Battery holder
Switch
Wire with crocodile clips x2
Tape
Scissors

## Advance preparation

Teachers could make simple electrical switches with the children if commercial switches are not available. (Instructions in teacher information)

Teachers may wish to prepare badges for the role of astrophysicist.

Make and test one electromagnet prior to the activity. Magnet strength will vary according to the number of coils of wire.

## Activity

### Introduction

Show the children an image of exoplanet Proxima b, explaining that it is a distant planet orbiting a star called Proxima Centauri, the closest star to our Sun. Although the planet orbits its star in the habitable zone, it experiences huge winds 2,000 times those on Earth and is bombarded with radiation. A magnetic field around the planet would be needed to protect any potential life.

In this activity, the children freely investigate magnets of various kinds, testing attraction and repulsion between poles, and magnetic strength; they also investigate materials attracted by magnets. After discussion of their results, explain that electricity can be used to make a magnet; this is called an electromagnet.

Each group uses the materials provided in the containers to make an electromagnet. They first test its effectiveness using paper clips. Next, the groups discuss materials they would like to test with their electromagnet before collecting a variety of materials.

### Investigate

How many paper clips will the electromagnet attract?

Does changing the number of coils of wire alter the strength of the magnet?

Is there a link between the number of coils and number of paper clips the magnet can attract?

Can you add a switch to turn on and off the flow of electricity and thus your magnet?

What effect does increasing the voltage by using a more powerful battery, or adding more batteries, have upon the magnet?

Does using a longer, shorter, thinner or thicker nail affect the strength of the magnet?

What materials can you lift using magnetic attraction?

The data collected during their investigation into the link between number of coils of wire and number of paper clips attracted could later be displayed as graphs. The children present their findings in the form of a presentation or poster.

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| Number of coils: | Number of paper clips: |
|---|---|
| | |
| | |
| | |

## Plenary

Each group chooses a method of sharing its findings with the class. Summarise the results on the whiteboard. Did the groups find a connection between the number of coils of wire and the strength of the electromagnet? Did they increase the strength of their magnet? How? What materials were attracted to the magnet? Do the groups agree?

## Extension

The children might research exoplanet Planet HD 209458b Osiris, a Hot Jupiter, approximately one third larger and lighter than Jupiter. Proxima b could also be researched. https://www.nasa.gov/content/goddard/hubbles-new-shot-of-proxima-centauri-our-nearest-neighbor/

https://en.wikipedia.org/wiki/Proxima_Centauri_b

## Teacher information

Our planet's magnetic field is thought to be generated deep down in the Earth's core. As the Earth spins, liquids in the planet's core swirl around. The liquid iron conducts electricity, generating electric currents which in turn create magnetic fields. Scientists have developed a method which allows them to estimate the magnetic field of a distant exoplanet outside our solar system orbiting a different star. They used the Hubble Space Telescope to observe when the planet passed across the star. Next, they studied the absorption of the star's radiation by the planet's atmosphere before finally estimating the size of the magnetic fields around the planet.

Magnetic fields are produced when electrons in a metal object are spinning in the same direction. An electromagnet is a type of magnet that uses electricity, and a magnetic material such as iron, to produce magnetic fields. We cannot see magnetic fields but we can measure their effects.

**To make a simple electromagnet:**

- Strip the insulation from the ends of the wire
- Set up the resources in a plastic container that won't conduct electricity
- Hold the wire approx. 20cm from its end. Place it at the head of the nail and wrap it around the nail. Continue wrapping the wire around the nail without overlapping the wire, until reaching the tip of the nail
- Ensure that you wrap the nail with the wire running in the same direction so that the electricity can flow in one direction
- Connect the ends of the wire to the two terminals, the positive and negative ends of the battery, placing a piece of tape or elastic band across each to maintain a connection.
- When the second end of the wire is attached, the battery will begin to conduct electricity through the wire coil and the nail will become magnetised
- Swapping the connections will also switch polarity of the magnetic field created
- Test the electromagnet by placing it next to a paper clip or other metals.

**Simple switch**

To make a simple switch: Two small nails, each with a paper clip placed under the tip of the nail, are tapped into a small wooden block. Wires are attached to the head of each nail using crocodile clips. Swinging the paper clips into contact with one another completes the circuit. Follow the link below for instructions on making this and another example of a simple switch.
http://homeschoolandthings.blogspot.co.uk/2013/03/making-simple-switch-for-electrical.html