Three Nations ENERGY
www.3ne.ca

ELECTRIC

Vehicle ACTIVITY

Electromagnets

Discover how electric car motors work - Part 1

Electric motors need magnets to work.
Let's see how electricity can make a magnet.

Materials

- 2 large iron nails (3.5" works well)
- A 1.5 V battery (size doesn't matter)
- 2 electric wires, about 75 cm (30 in) each
- 1 cutting pliers
- Paper clips (or other small metal objects that are attracted to magnets like small screws, washers, etc.)
- Tape (regular or electrical)
- compass

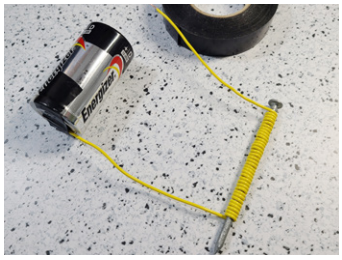
Procedure A

Warning! Disconnect the battery when not in use, otherwise the wire may become hot and cause a fire.

Step 1 Strip off 5-10 mm (1/4-1/2 in) of insulation at both ends of the wire.

Step 2 Leave about 10 cm (4 in) of wire hanging and wrap the wire tightly clockwise around the nail as shown. Over 2/3 of the nail should be covered with wire.

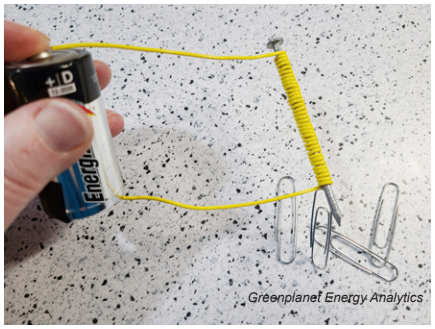
Step 3 Place the wire from the bottom of the nail onto the negative terminal of the battery and tape in place.



Step 4 Spread the metal objects on the table.

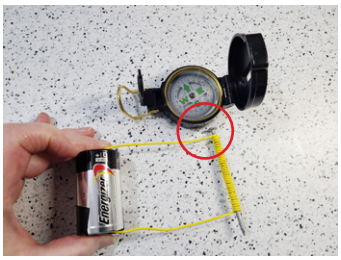
Step 5 Hold the wire from the top of the nail on the positive terminal of the battery. The wire can get hot, so only hold it for a short time.

Step 6 Hold the nail over the paper clips or metal objects. Record what happens.

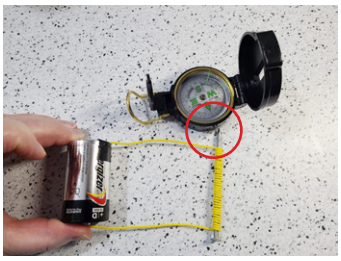


Step 7 Let go of the wire. Record your observation.

Step 8 Set the compass in front of you. Hold the wire on the positive terminal again and put the head of the nail next to the compass. What happens?



Step 9 Now set the bottom on the nail next to the compass. What happens? Record these observations.



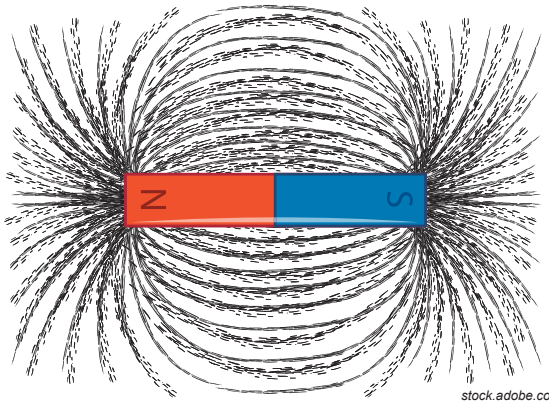
Greenplanet Energy Analytics

Explanation

About Magnetism

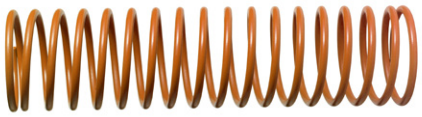
- A magnet attracts iron (and some other metals) and will align itself so that its north point will point towards the Earth's north pole.
- Magnetic material can be found in nature or can be manufactured. These magnets are called **permanent** if they always have their power to attract iron.
- Magnetism can also be created when electricity flows through certain metals.
- These metals must be good ***conductors*** (materials where electrons move easily from atom to atom when voltage is applied - like copper, aluminum, steel and brass.)
- The magnetic force starts when the electricity flows and stops if the electric current is disconnected.
- This is useful for making magnets that can be switched on and off - called **electromagnets**.

Magnetism is a force that attracts or repels other objects and is produced by the motion of electric charges.



stock.adobe.com/ca/free

Strength



stock.adobe.com/ca/free

- A straight wire won't produce a strong magnetic pull, so the wire typically is wrapped into a coil to make the magnetic field stronger.
- This coiled wire is called a **solenoid**.
- The more turns in the wire, the stronger the magnetic field.
- Having the coils tight together also increases the strength.
- Keeping the iron nail inside the coil also increases the magnetic field.

Electric Motors for Electric Cars

The ability to turn an electromagnet on and off is the key to making an electric motor run. This allows for a very energy efficient method of turning electricity into motion. You will see this in Part 2

North or South

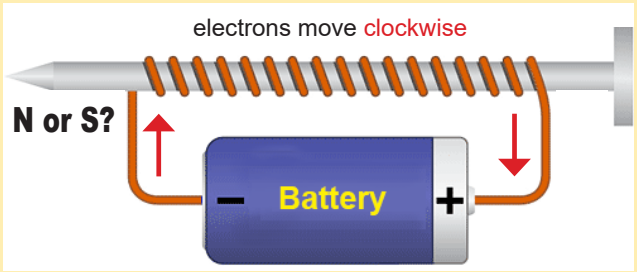
Just like regular (also called permanent) magnets, one end of an electromagnet becomes the north pole and the other becomes the south pole.

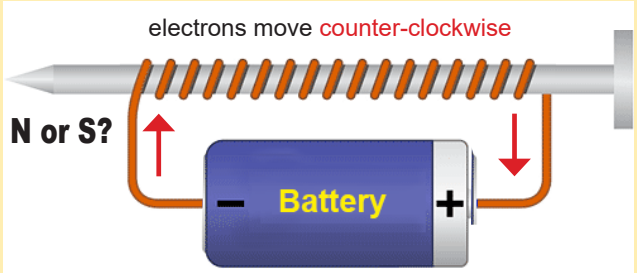
Procedure B (optional)

Use the second nail to repeat Steps 1 - 3 but this time, ***wrap the wire in the opposite direction***.

See the diagram below.

Now repeat Steps 8 and 9. Record your results





Greenplanet Energy Analytics

Name: _____ Class: _____ Date: _____

ELECTROMAGNET ACTIVITY: Student Record Sheet

Observation A

Step 6. When both ends of the wire are connected to the battery and the nail is held near some paper clips, what happens?

_____

_____

_____

Step 7. What happens when you let go of one end of the wire?

_____

_____

_____

Step 8. What happened when you put the head of the nail next to the compass?

_____

_____

_____

Step 9. What happened when you put the bottom on the nail next to the compass?

_____

_____

_____

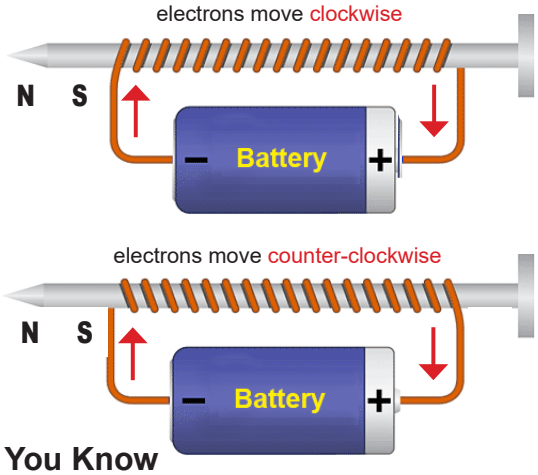
Video

Bill Nye the Science Guy Demonstrates How an Electromagnet Works

https://www.youtube.com/watch?v=sFC7-WVNUP8

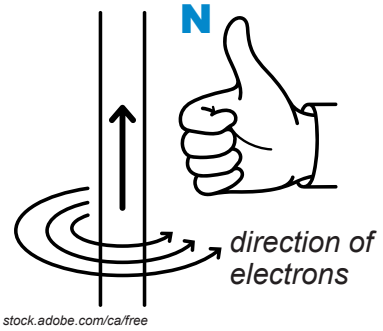
Observation B (optional)

Record the compass reading you observed in the diagrams below by circling N or S:



Now You Know

- In a circuit, electrons move from the negative end of the battery towards the positive end.
- The orientation of the magnetic field created by this electron motion changes depending on whether they are going clockwise or counter-clockwise.
- **Right-hand Rule** - Wrap your right hand around the solenoid (coil) in the direction the electrons move. Your thumb will point to the North Pole of the solenoid.



stock.adobe.com/ca/free

Questions

1. When talking about electricity, electrons move from the negative end of the battery to the _____ end.

2. You can change which end of an electromagnet points North by changing which way you _____ the wire around the nail.

3. If you wrap your right hand around the coil so your fingers point in the direction of the electron flow, your thumb will be pointing to the _____ end.

TEACHER RESOURCE

ELECTROMAGNET ACTIVITY

Teaching Notes

This activity is Part 1 of the exploration into how electric vehicles (EVs) work. This will help the students understand why EVs are more energy efficient than internal combustions vehicles, A main feature of electric motors are electromagnets. This activity allows the student to construct a simple electromagnet and test it. An optional activity is included to explore how current direction effects the direction of the poles of the electromagnet.

Which Way Does Electricity Flow?

Electron Current vs. Conventional Current

In 1752, Ben Franklin assumed that positive charge carriers flowed from positive to negative terminals. We now know this is incorrect. Electron flow is from negative to positive.

Conventional current model still uses Franklin's description and behaves as if current flows from the positive terminal to the negative.

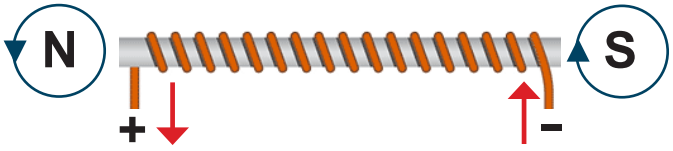
It is important to realize that the difference between conventional current flow and electron flow in no way affects any real-world behaviour or computational results. However, conventional current flow is the standard that most of the world follows which explains why most educational material uses this, even though, technically, it is wrong.

For a detailed explanation, see the article:

https://www.nutsvolts.com/magazine/article/which-way-does-current-really-flow

Polarity of an Electromagnet

There are some simple ways to help you find out which end of an electromagnet is north and which is south.



Greenplanet Energy Analytics

A. Direction of the current

Look at the ends of the coil (solenoid) from the outside; if the direction of the current goes clockwise, you are looking at the south end. If the current goes counter-clockwise, you are looking at the north end of the electromagnet.

B. Right Hand Rule

See the instructions on page 3 of the student handout.

Answer Key

Observation A

Step 6. When both ends of the wire are connected to the battery and the nail is held near some paper clips, what happens?

The paperclips stick to the end of the nail.

Step 7. What happens when you let go of one end of the wire?

The paperclips drop.

Step 8. What happened when you put the head of the nail next to the compass?

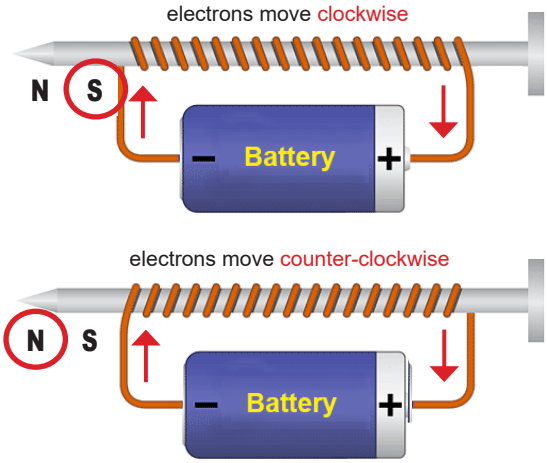
The compass swings to the (north or south)

Step 9. What happened when you put the bottom on the nail next to the compass?

The compass swings to the (south or north)

Observation B (optional)

Record the compass reading you observed in the diagrams below by circling N or S:



Greenplanet Energy Analytics

Questions

1. When talking about electricity, electrons move from the negative end of the battery to the positive end.

2. You can change which end of an electromagnet points North by changing which way you wrap the wire around the nail.

3. If you wrap your right hand around the coil so your fingers point in the direction of the electron flow, your thumb will be pointing to the North end.

TEACHER RESOURCE

EV - Curriculum Connections

Overview

These hands-on activities are a great opportunity to demonstrate how electric cars work and how solar electricity is produced.

This is a great complimentary exercise for exploring society's impact on the environment in regards to greenhouse gases.

Science Grade 7

Unit A: Interactions and Ecosystems (Social and Environmental Emphasis)

1. Investigate and describe relationships between humans and their environments, and identify related issues and scientific questions.

4. Describe the relationships among knowledge, decisions and actions in maintaining life-supporting environments

Unit D: Structures and Forces (Science and Technology Emphasis)

1. Describe and interpret different types of structures encountered in everyday objects, buildings, plants and animals; and identify materials from which they are made.

2. Investigate and analyze forces within structures, and forces applied to them.

3. Investigate and analyze the properties of materials used in structures.

4. Demonstrate and describe processes used in developing, evaluating and improving structures that will meet human needs with a margin of safety.

Science Grade 8

Unit D: Mechanical Systems (Science and Technology Emphasis)

1. Illustrate the development of science and technology by describing, comparing and interpreting mechanical devices that have been improved over time.

2. Analyze machines by describing the structures and functions of the overall system, the subsystems and the component parts.

3. Investigate and describe the transmission of force and energy between parts of a mechanical system.

4. Analyze the social and environmental contexts of science and technology, as they apply to the development of mechanical devices.

Science Grade 9

Unit D: Electrical Principles and Technologies

1. Investigate and interpret the use of devices to convert various forms of energy to electrical energy, and electrical energy to other forms of energy.

- Construct, use and evaluate devices for transforming mechanical energy into electrical energy and for transforming electrical energy into mechanical energy.

2. Describe technologies for transfer and control of electrical energy.

- Investigate toys, models and household appliances; and draw circuit diagrams to show the flow of electricity through them (e.g., safely dismantle discarded devices, such as heating devices or motorized toys, and draw diagrams to show the loads, conductors and switching mechanisms).

All curriculum connections were derived from:

https://education.alberta.ca/media/159711/elemsci.pdf