THE MOVEMENT OF A CURRENT-CARRYING WIRE IN A MAGNETIC FIELD

TOPIC:

Electricity and Magnetism

SCIENTIST:

Michael Faraday 1791–1867

INTRODUCTION:

In 1820 Hans Oersted (see 1.037) demonstrated that a compass needle moved if it was brought close to a wire carrying an electric current. This momentous discovery excited the scientific world and encouraged many scientists to research into the link between electricity and magnetism. One such scientist, Michael Faraday, wanted to find out if he could use electricity and magnetism to produce movement. He tested his ideas in the following way. He put a bar magnet, upright, into a container of mercury (he used mercury because it conducts electricity). Then he took a length of straight, stiff copper wire and connected one end to a battery terminal; he dipped the other end into the mercury. He connected a second length of wire to the other terminal of the battery; its free end was supported a few centimeters above the container of mercury. A metal rod was suspended from the free end and allowed to dangle in the mercury. When Faraday completed the circuit, the metal rod rotated around the upright magnet like someone stirring a cup of coffee with a spoon. The passage of an electric current through the metal rod had induced a magnetic field in it; this, in turn, had been repelled by the magnetic field of the bar magnet, causing the rod to rotate around the magnet. Faraday had made a simple electric motor.

TIME NEEDED:

30 minutes

MATERIALS:

DC power pack or 3V battery
60 cm bell wire
2 large bar magnets, approximately 2.5 cm x 2.5 cm x 8 cm long
masking tape
cutting board
wire strippers
metric ruler

Original Materials:

In his original experiment Faraday used mercury. You cannot use mercury because it releases a harmful vapor; instead, you will carry out a similar experiment that shows the movement of a current-carrying wire in a magnetic field.

Safety Precautions

Adult supervision required. Please read and copy the safety precautions at the beginning of this book. Electricity can cause dangerous shocks. Be careful not to expose any live wires.

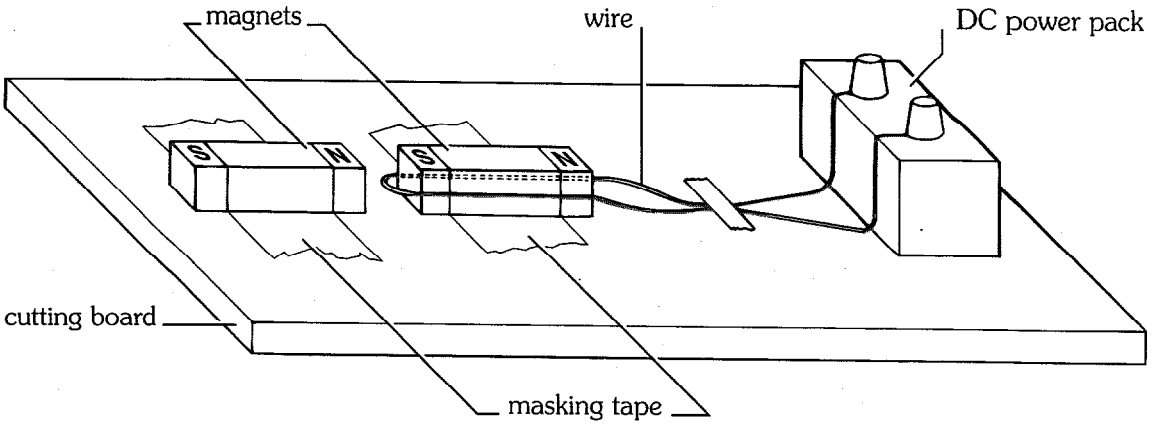
PROCEDURE:

1. Take one of the magnets and tape it to the cutting board using masking tape.
2. Take the second magnet and tape it to the cutting board so that its south pole is facing the north pole of the other magnet and is approximately 3 cm away from it.

3. Strip 3 cm of insulation from both ends of the bell wire. Make sure the DC power pack is switched off. Attach the ends of the wire to the terminals of the DC power pack. Alternatively, if using a battery, attach the end of one piece of wire to one terminal of the battery, holding it in place with masking tape.

4. Position the loop of bell wire so that it passes between the two magnets. Hold the wire steady between the magnets and power pack or battery using masking tape. Then bend the loop of wire so that it is not resting on the cutting board and is free to move up and down (see figure 1).

Figure 1



5. Set the power pack to 3 volts. Switch on the power pack and record what happens. Alternatively, if using a battery, hold the free end of the wire against the free terminal of the battery and record what happens.

6. Switch off the power pack or disconnect the battery. Reverse the connections. Repeat step 5.

ANALYSIS:

1. What happened when the power pack was turned on, or the battery was connected, in step 5?
2. Why do you think this happened? (Remember that when an electric current passes through a piece of wire it produces a magnetic field traveling around the wire.)
3. What happened when you reversed the connections in step 6?
4. Why do you think this happened?

OUR FINDINGS:

Click on above link to see what we found.

SPECIAL SAFETY NOTE TO EXPERIMENTERS

Each experiment includes any special safety precautions that are relevant to that particular project. These do not include all of the basic safety precautions that are necessary whenever you are working on a scientific experiment. For this reason, it is absolutely necessary that you read, copy, and remain mindful of the General Safety Precautions that follow this note.

Experimental science can be dangerous, and good laboratory procedure always includes carefully following basic safety rules. Things can happen very quickly while you are performing an experiment. Things can spill, break, even catch fire. There will be no time after the fact to protect yourself. Always prepare for unexpected dangers by following basic safety guidelines the *entire* time you are performing the experiment, whether or not something seems dangerous to you at a given moment.

We have been quite sparing in prescribing safety precautions for the individual experiments. We made this choice for one reason: We want you to take very seriously every safety precaution that is printed in this book. If you see it written here, you can be sure that it is here because it is absolutely critical to your safety.

One further note: The book assumes that you will read the safety precautions that follow, as well as those in the box within each experiment you are preparing to perform, and that you will *remember* them. Except in rare instances, these precautions will not be repeated in the procedure itself. It is up to you to use your good judgment and pay attention when performing potentially dangerous parts of the procedure. Just because the book does not say BE CAREFUL WITH HOT LIQUIDS or DON'T CUT YOURSELF WITH THE KNIFE does not mean that you should be careless when simmering water or stripping an electrical wire. It does mean that when you see a special note to be careful, it is extremely important that you pay attention to it.

If you ever have a question about whether a procedure or material is dangerous, wait to perform it until you find out for sure that it is safe.

GENERAL SAFETY PRECAUTIONS

Accidents caused by carelessness, haste, insufficient knowledge, or taking unnecessary risks can be avoided by practicing safety procedures and being alert while conducting experiments. Be sure to check the experiments in this book for additional safety regulations and adult supervision requirements. If you will be working in a lab, do not work alone.

PREPARING:
—Clear all surfaces before beginning experiments
—Read the instructions before you start
—Know the hazards of the experiments and anticipate dangers

PROTECTING YOURSELF:
—Follow the directions step-by-step; do only one experiment at a time
—Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eye wash, and first-aid kit
—Make sure there is adequate ventilation
—Do not horseplay
—Wear an apron and goggles
—Do not wear contact lenses, open shoes, loose clothing, or loose hair
—Keep floor and work space neat, clean, and dry
—Clean up spills immediately
—Never eat, drink, or smoke in laboratory or work space
—Do not eat or drink any substances tested unless expressly permitted to do so by a knowledgeable adult

USING EQUIPMENT WITH CARE:
—Set up apparatus far from the edge of the desk
—Use knives and other sharp or pointed instruments with caution
—Pull plugs, not cords, when removing electrical plugs
—Don't use your mouth to pipette; use a suction bulb
—Clean glassware before and after use
—Check glassware for scratches, cracks, and sharp edges
—Clean up broken glassware immediately
—Do not use reflected sunlight to illuminate your microscope
—Do not touch metal conductors
—Use only low voltage and current materials such as lantern batteries
—Be careful when using stepstools, chairs, and ladders

USING CHEMICALS:
—Never taste or inhale chemicals
—Label all bottles and apparatus containing chemicals
—Read labels carefully
—Avoid chemical contact with skin and eyes (wear goggles, apron, and gloves)
—Do not touch chemical solutions
—Wash hands before and after using solutions
—Wipe up spills thoroughly

HEATING SUBSTANCES:
—Use goggles, apron, and gloves when boiling water
—Keep your face away from test tubes and beakers
—Never leave apparatus unattended
—Use safety tongs and heat-resistant mittens
—Turn off hot plates, bunsen burners, and gas when you are done
—Keep flammable substances away from heat
—Have fire extinguisher on hand

FINISHING UP:
—Thoroughly clean your work area and glassware
—Be careful not to return chemicals or contaminated reagents to the wrong containers
—Don't dispose of materials in the sink unless instructed to do so
—Wash your hands
—Clean up all residue and put in proper containers for disposal
—Dispose of all chemicals according to all local, state, and federal laws

BE SAFETY CONSCIOUS AT ALL TIMES