# TWO PARALLEL WIRES CARRYING CURRENT IN THE SAME DIRECTION ATTRACT, IN THE OPPOSITE DIRECTION REPEL

## TOPIC:

Electromagnetism

## SCIENTIST:

André-Marie Ampère 1775–1836

## INTRODUCTION:

When Hans Oersted (see 1.037) showed by chance that a compass needle was deflected by a wire carrying an electric current, it was the first suggestion of a link between electricity and magnetism. André-Marie Ampère immediately carried out a number of experiments to investigate the phenomenon. In his best-known experiment, which you will repeat now, Ampère laid two wires side by side. When he passed a current through them in opposite directions, the wires repelled each other; when he passed a current through the wires in the same direction, they attracted each other. He then made one of the wires movable so that it could move away from the other when the currents ran in opposite directions and move toward the other when the currents ran in the same direction. Clearly, with the two wires behaving so much like magnets, here was further evidence that electricity and magnetism were inextricably linked.

## TIME NEEDED:

1 hour

## MATERIALS:

- 3 m insulated bell wire
- wire strippers
- piece of lumber (approximately 2 in. x 1 in. x 6 in.)
- 2 DC power packs
- 2 pieces of styrofoam packing (approximately 15 cm x 15 cm x 10 cm)
- wire coat hanger
- pliers
- wire cutters (if pliers do not have cutting blades)
- metric ruler
- sandpaper
- transparent tape

## Original Materials:

In his original experiment Ampère used two wires, in much the same way as in this experiment: one wire was fixed and one was movable. He would not have been able to obtain insulated wire, and the battery he used would have been much more primitive.

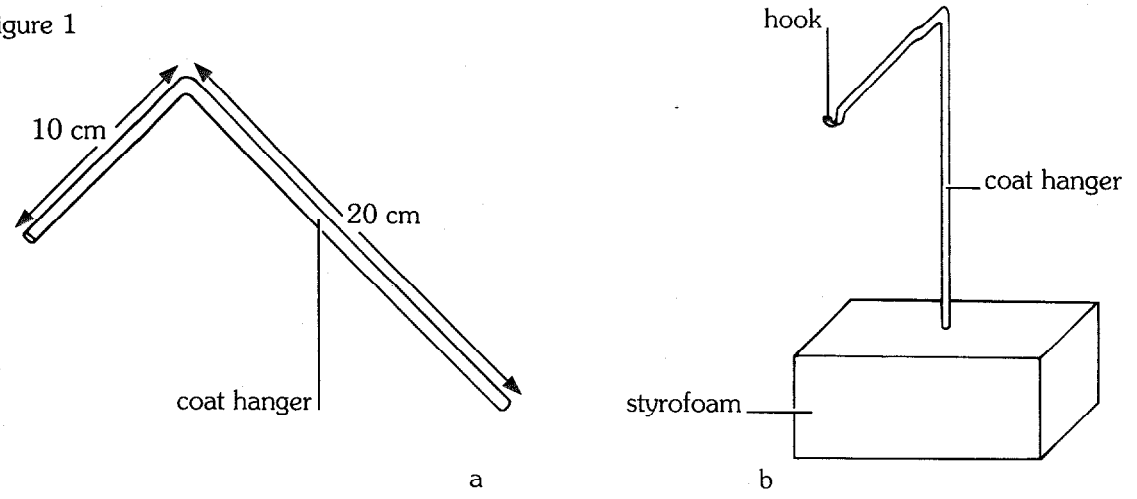
### *Safety Precautions*

Adult supervision required. Please read and copy the safety precautions at the beginning of this book. Take care when using the pliers to cut the coat hanger. Electricity can cause dangerous shocks. Be careful not to expose any live wires. Do not touch any wires while the circuits are connected.

# PROCEDURE:

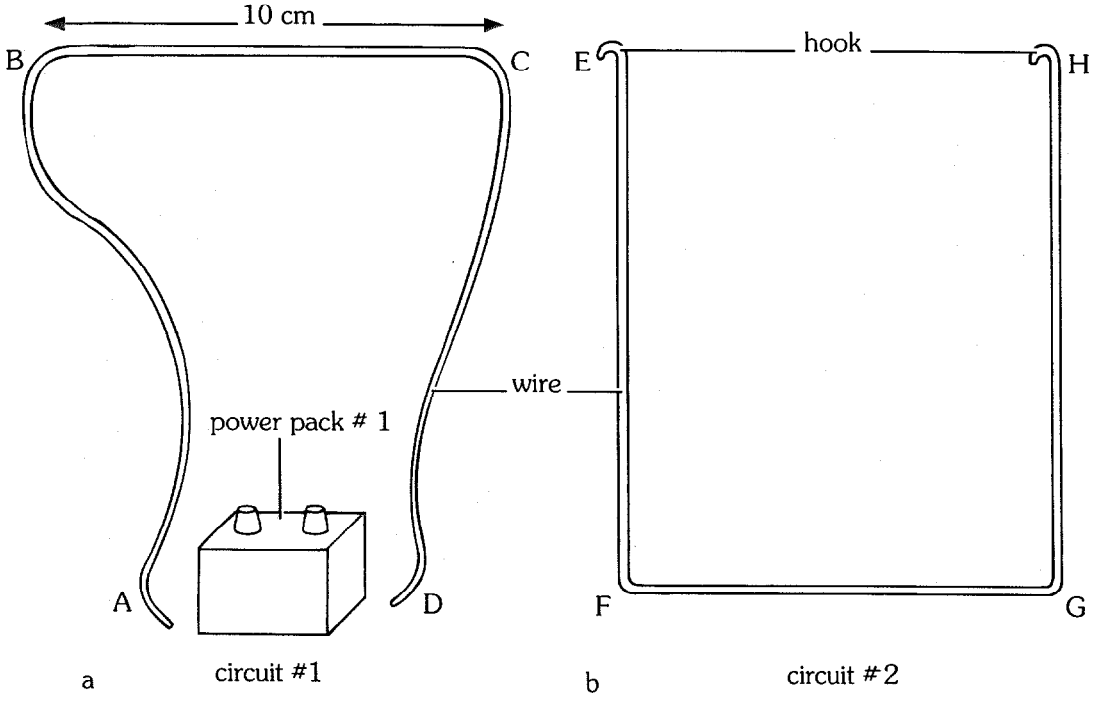
1. Put the two pieces of styrofoam on a flat surface approximately 10 cm apart.
2. Using the pliers or wire cutters, cut the hook from the coat hanger. Straighten out the rest of the coat hanger and cut two pieces, each 30 cm long, from it. Use sandpaper to remove the coating from the coat hanger pieces.
3. Bend each piece of coat hanger into an L-shape as shown in figure 1a. Using the pliers, make a small hook at the end of the shorter length of the L of each piece. Push the other end of each piece, by the same distance for both pieces, into a piece of styrofoam (see figure 1b).

Figure 1




4. Cut the bell wire into two equal lengths.
5. Take one of the wires. Strip 3 cm of insulation from the ends of the wire using wire strippers. Bend the piece of wire into the shape ABCD shown in figure 2a. Do not connect the wire to power pack #1 (to complete circuit #1) until instructed to.
6. Cut a piece of wire 40 cm long from the second piece of wire. Strip 3 cm from the ends of the wire. Bend it into the shape EFGH shown in figure 2b, making small hooks at points E and H.

Figure 2



7. Now hang the wire EFGH from the two hooks at the end of the pieces of coat hanger stuck in the styrofoam (see figure 3). Adjust the position of the L-shapes so that the portion FG is approximately 2.5 cm above the surface of the table.

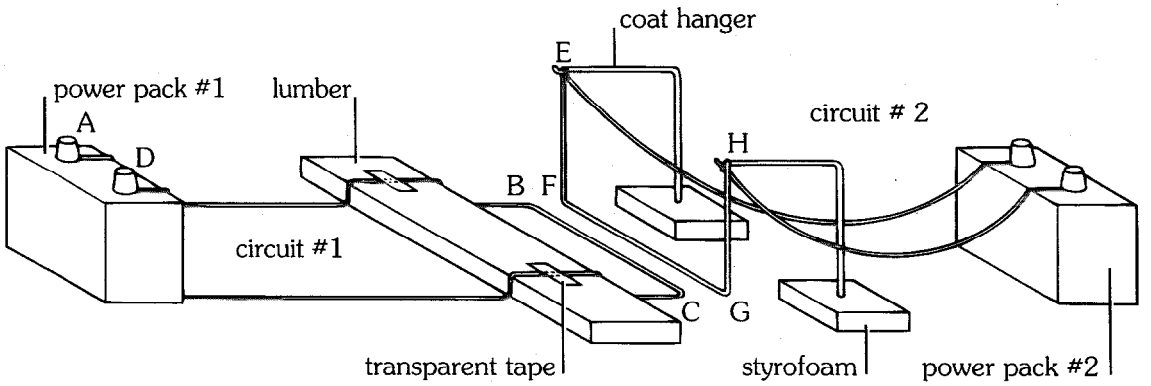
8. Cut two further pieces of wire, each 40 cm long. Strip 2 cm from the ends of each piece of wire using wire strippers.

9. Connect one end of one piece of wire to point E and one end of the other piece of wire to point H. Connect the other ends of the wires to the terminals of power pack #2 to make circuit #2. Make a note of which wire is connected to which terminal.

10. Position the piece of lumber (on its 2-in. wide surface) parallel to, and 5 cm from, wire FG. Attach it to the table using transparent tape.

11. Now position wire ABCD so that wire BC is parallel to, and 2 cm from, wire FG (see figure 3). Attach wires DC and AB to the piece of lumber using transparent tape.

Figure 3




12. Connect ends A and D to power pack #1 to complete circuit #1. Record what happens. Also make a note of which wire is connected to which terminal.

13. Repeat step 12 but reverse the direction of current flow in circuit #1 by disconnecting A and D and reconnecting them to opposite terminals. Record what happens.

## ANALYSIS:

Note: By convention, current flows from the positive terminal of the battery to the negative terminal.

1. Describe what happened when you connected circuit #1 in step 12.
2. Describe what happened when you reversed the connections A and D in step 13.
3. From the notes you made during the experiment, work out in which direction the current was flowing through a) circuit #2 and b) circuit #1 in step 12 and in step 13.
4. From your answer to question 3, can you deduce the relationship between the current direction and the behavior of hanging wire EFGH to fixed wire BC? Do some research. What is the reason for this relationship?

## 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