

A MAGNET FOLLOWS THE ROTATION OF A COPPER DISK

TOPIC:

Electromagnetic Induction

SCIENTIST:

Dominique Arago 1786–1853

INTRODUCTION:

Dominique Arago lived at a time when great advances were being made in the fields of electricity and magnetism. While on a visit to Greenwich Royal Observatory in London in 1824 he noticed that a compass needle moved if placed near a rotating copper disk. He repeated this observation as an experiment. He suspended a compass needle (which is magnetic) over a copper disk. When the disk was spun around, the compass needle followed the rotation of the disk. It was not until 1831, however, that Michael Faraday (see 1.016) provided an explanation for this intriguing phenomenon. Faraday's explanation was that the compass needle's own magnetic field induced an electric current in the rotating disk; this, in turn, produced a magnetic field in the disk, so causing the compass needle to rotate, following the motion of the disk. Here you will repeat Arago's experiment.

TIME NEEDED:

45 minutes

MATERIALS:

piece of sheet aluminum or copper
approximately 20 cm x 20 cm and
0.5 mm thick

finepoint marker

metal-cutting shears

Fun tak®

plate or saucer approximately 15 cm diameter

bar magnet approximately 7 cm long

cotton thread

pencil

scissors

record player turntable (preferably an old one)
with 45 rpm speed option

plastic wastebasket with top opening smaller
than that of the turntable

ring stand with clamp

metric ruler

Note: You will need an electricity supply (e.g., a wall outlet) nearby.

Original Materials:

Arago used a copper disk and a suspended compass needle. The copper disk was turned by hand.

Safety Precautions

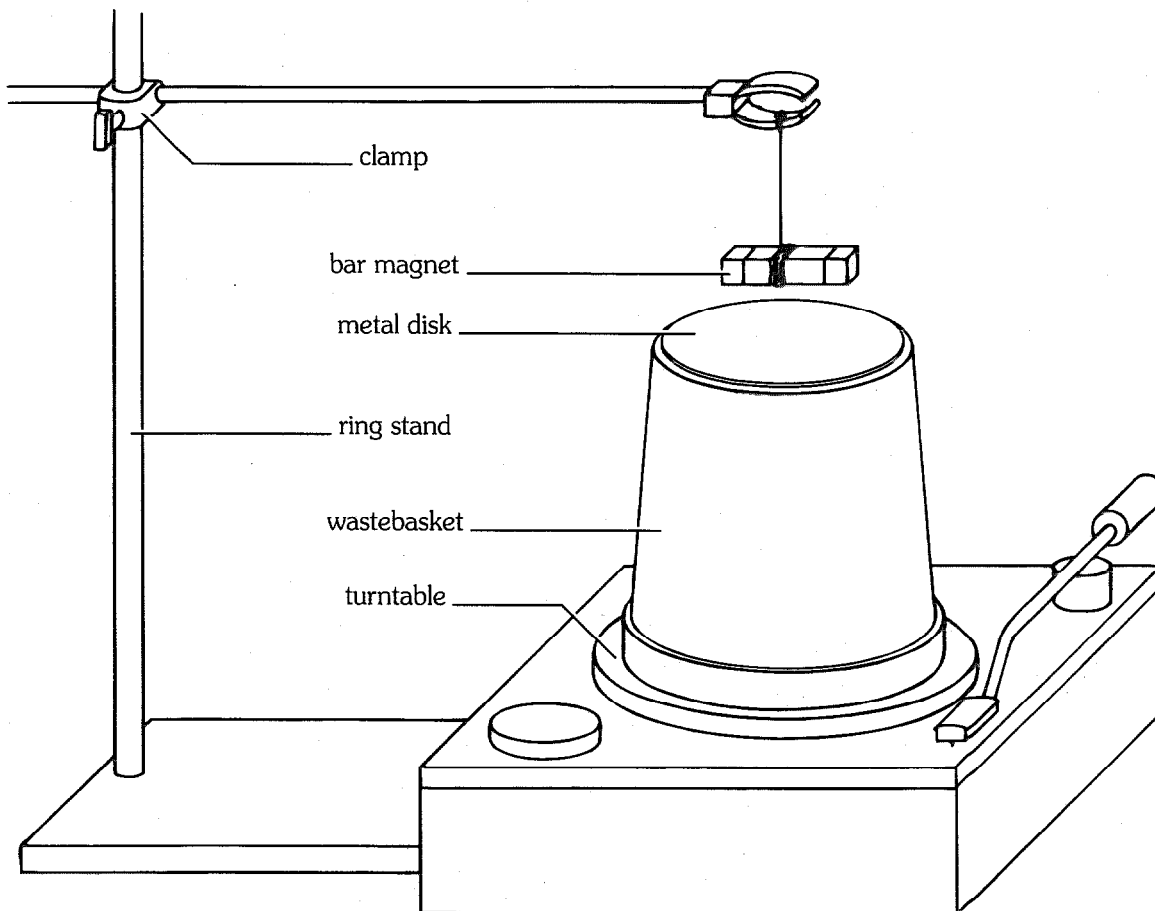
Adult supervision required. Please read and copy the safety precautions at the beginning of this book. Be careful when cutting metal. Electricity can cause dangerous shocks. Be careful not to expose any live wires.

PROCEDURE:

1. Connect the record player to an electricity supply.
2. Turn the wastebasket upside down and place it on the turntable (see figure 1).

3. Turn on the record player and adjust the speed to 45 rpm. If the wastebasket is not centrally positioned, turn off the record player and reposition the wastebasket.
4. Place the metal sheet flat on a table. Put the plate or saucer upside down on the sheet. Use the plate as a template by drawing around it on the metal sheet using the marker. Cut out the circular shape using metal-cutting shears.
5. Put a small piece of Fun tak® in the center of the base of the metal disk. Put the metal disk centrally on top of the upturned wastebasket, and push it down slightly so that the Fun tak® holds it in place.

Figure 1



6. Cut a piece of cotton thread approximately 30 cm long. Tie one end around the bar magnet so it can be suspended horizontally. Tie the other end around the clamp attached to the ring stand.
7. Adjust the position of the ring stand and the height of the clamp so that the bar magnet is hanging approximately 2 cm above the center of the metal disk.
8. Turn on the turntable. Leave it on for approximately one minute, then turn it off. Allow the suspended magnet to find its own point of rest. Carefully note the resting position in relation to the metal disk by holding a pencil parallel to the magnet.
9. Holding the pencil still, switch on the turntable again. Record what happens.

ANALYSIS:

1. What happened when the turntable was switched on and left on?
2. Do some research. Explain your answer to question 1.

OUR FINDINGS:

See Section VIII.

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