Current Events

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Topic

Electric current and electrolytes

Time

2 hours

Safety

Please click on the safety icon to view the safety precautions.
Be careful when using scissors. Dispose of all foods immediately and properly.

Materials

- one piece of cardboard (about 8½ in. 2 11 in.)
- magnet wire (available from Radio Shack)
- compass
- one hot-galvanized (*not* electrogalvanized) 1½-in. roofing nail or small strip of zinc
- one solid brass wood screw or small strip of brass or copper
- one battery (size AA)
- lemon
- assorted fruits and vegetables
- glue and scissors
- sandpaper

Procedure

Part A: Constructing the Galvanometer

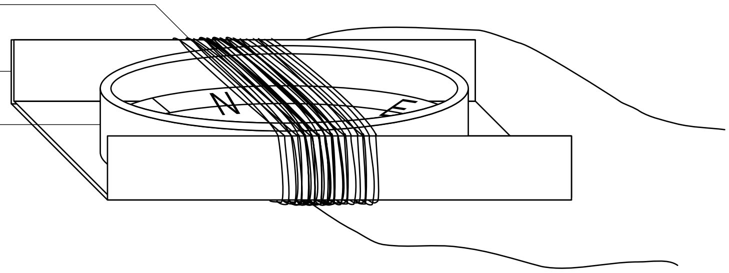
A compass is an instrument that indicates the presence of a *magnetic field*. If left undisturbed, its needle will point north, drawn by the magnetic field of the earth's north pole. When an electric current flows through a coil of wire, the movement of electrons in one direction creates a magnetic field. When the coil is brought into contact with a compass, it attracts its needle, allowing us to measure the strength and direction of the current's flow.

1. Cut two rectangular pieces of cardboard the width of the compass at the east-west axis, and 3 cm longer than the compass at its north-south axis. Fold them up on each end so that they form a cradle for the compass, with sides about 1.5 cm high when the compass is placed inside with its north-south axis pointing out at the sides. Glue the two pieces of cardboard together (see figure 1).
2. Place the compass in this cradle, again with the N-S axis pointing at the raised sides. Leaving 21 cm free, wind 300 to 400 turns of wire around it (see figure 2). (The more turns of wire around the compass, the more sensitive your galvanometer will be.)

Figure 1

Glue the two folded pieces of cardboard together.

Figure 2



3. When you finish wrapping, leave 21 cm of free wire on the other end also. Twist the free ends together near the cradle a few times to keep the coil from unraveling.
4. With the sandpaper, remove 3 cm of the plastic coating from the two ends of the wire.
5. Hold each end of wire to opposite terminals of a fresh battery, and observe the compass by looking under the wires coiled around it. What happens? Reverse the wires. What happens now? Record your observations.

PART B: GOURMET ELECTRICITY

1. Take the lemon and roll it on a table or countertop, applying pressure with your palm. This will cause the juice inside to flow more freely.
2. Insert the nail and the screw in the lemon, making sure that they don't touch each other anywhere. These are your electrodes.

Note: Make sure that there are no magnetized objects—such as batteries, radios, telephones or other electronic instruments—nearby that might distort your readings. Since metal may become magnetized, it is best to move the knife and scissors and any other metal objects away from the experiment.

3. Place the galvanometer on a level surface, and then attach the galvanometer to the electrodes in the lemon, by touching one end of the wire to each electrode. Observe what happens. Reverse the wires. Observe what happens. Record your observations on the data table, including how much the needle moves, if at all.
4. Remove the electrodes from the lemon, and rinse them under running water.
5. Repeat steps 1 to 4 with various fruits and vegetables. Omit step 1 (rolling the fruit) if it will crush or damage the fruit or vegetable (e.g., a tomato). Record your observations on the data table.

Data Table		
Fruit or vegetable	Galvanometer reading	
	First position	Wires reversed
Lemon		

About Part A

1. What is the galvanometer measuring?
2. What could you do to make the galvanometer reading stronger?
3. What happens to the compass when you reverse the wires? Why does this happen?

About Part B

1. What do all of the substances that show a reading on the galvanometer have in common?
2. Give reasons why you think the amounts of current measured by the galvanometer in the different fruits may vary and why a sample might not register at all.

What's Going On

Part A: The galvanometer is measuring the flow of electric current. It does this by reacting to the strength of the magnetic field created by the current flowing through the coil of wire. This magnetic field moves the compass needle when a current moves through the wire. There are two things you could do. First you could increase the amount of current flowing through the wire by using a larger battery, such as a 6-V lantern battery or a 9-V transistor radio battery. The second thing you could do is increase the number of turns in the wire coil. This will increase the magnetic field surrounding the compass, which will increase the movement observed in the needle. When you reverse the ends of the wires, you reverse the flow of current in the wire coil. This reverses the polarity of the magnetic field, which causes the needle to move in the opposite direction.

Part B: All of the fruits and vegetables you tested contain liquids. If one caused the needle on the galvanometer to move, the liquid inside is an electrolytic solution that causes a current to flow through the coil of wire. The electricity generated is caused by a series of chemical reactions taking place between the electrolytic solution and the metal electrodes. The amount and type of electrolyte available to these reactions will determine the strength and duration of the electrical current measured by the galvanometer. Some fruits and vegetables naturally contain stronger electrolytic solutions than others. Electrolytes are highly volatile (quickly evaporating) and reactive substances, so the fresher the sample the more electrolyte available. A stale or rotten fruit or vegetable may have used up its electrolyte.

Connections

An *electrolyte* is a chemical compound that, in liquid or moist paste form, allows an electric current to flow through it. If two pieces of metal of different types (called *electrodes*) are placed in an electrolytic solution, a reaction will occur. As the metals react with the solution, one electrode will transfer electrons through the solution to the other, causing an electric current to flow through a wire connecting them outside of the solution. Certain foods, as well as ordinary batteries, contain electrolytes. In this experiment you made a *galvanometer*, an instrument used to measure small amounts of electric current, and then tested some common foods to see if they contain electrolytes.

Safety Precautions

READ AND COPY BEFORE STARTING ANY EXPERIMENT

Experimental science can be dangerous. Events can happen very quickly while you are performing an experiment. Things can spill, break, even catch fire. Basic safety procedures help prevent serious accidents. Be sure to follow additional safety precautions and adult supervision requirements for each experiment. If you are working in a lab or in the field, do not work alone.

This book assumes that you will read the safety precautions that follow, as well as those at the start of each experiment you perform, and that you will *remember* them. These precautions will not always be repeated in the instructions for the procedures. It is up to you to use good judgment and pay attention when performing potentially dangerous procedures. Just because the book does not always 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, stop to find out for sure that it is safe before continuing the experiment. To avoid accidents, always pay close attention to your work, take your time, and practice the general safety procedures listed below.

PREPARE

- Clear all surfaces before beginning work.
- Read through the whole experiment before you start.
- Identify hazardous procedures and anticipate dangers.

PROTECT YOURSELF

- Follow all directions step by step; do only one procedure at a time.
- Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eyewash, and first-aid kit.
- Make sure that there is adequate ventilation.
- Do not horseplay.
- Wear an apron and goggles.
- Do not wear contact lenses, open shoes, and loose clothing; do not wear your hair loose.
- Keep floor and work space neat, clean, and dry.
- Clean up spills immediately.
- Never eat, drink, or smoke in the laboratory or near the work space.
- Do not taste any substances tested unless expressly permitted to do so by a science teacher in charge.

USE EQUIPMENT WITH CARE

- Set up apparatus far from the edge of the desk.
- Use knives and other sharp or pointed instruments with caution; always cut away from yourself and others.
- Pull plugs, not cords, when inserting and 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 low-current materials.
- Be careful when using stepstools, chairs, and ladders.

USING CHEMICALS

- Never taste or inhale chemicals.
- Label all bottles and apparatus containing chemicals.
- Read all 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 INSTRUCTIONS

- Use goggles, apron, and gloves when boiling liquids.
- Keep your face away from test tubes and beakers.
- Never leave heating 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 a fire extinguisher on hand.

WORKING WITH MICROORGANISMS

- Assume that all microorganisms are infectious; handle them with care.
- Sterilize all equipment being used to handle microorganisms.

GOING ON FIELD TRIPS

- Do not go on a field trip by yourself.
- Tell a responsible adult where you are going, and maintain that route.
- Know the area and its potential hazards, such as poisonous plants, deep water, and rapids.
- Dress for terrain and weather conditions (prepare for exposure to sun as well as to cold).
- Bring along a first-aid kit.
- Do not drink water or eat plants found in the wild.
- Use the buddy system; do not experiment outdoors alone.

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 thoroughly.
- Clean up all residue, and containerize it for proper disposal.
- Dispose of all chemicals according to local, state, and federal laws.

BE SAFETY-CONSCIOUS AT ALL TIMES