Electrical Charges in Colloidal Solutions

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Topic

Electrophoresis

Time

½ hour preparation; 1½ hours first observations; 24 hours to final observations

Safety

This experiment must be supervised by a chemistry teacher. **Please click on the safety icon to view the safety precautions. Iron chloride will irritate your skin. Wear safety goggles, lab apron, and gloves. Wash your hands when you finish the experiment. Clean up all residue, and containerize the residue for proper disposal. Dispose of all chemicals in accordance with local, state, and federal laws.**

Materials

9-V battery or 9-V DC adapter (See Procedure for notes on how to make the adapter a safe source of current.)
scissors
filter paper
triple-beam balance scale
32 g iron (III) chloride
stove, hot plate, or Bunsen burner to boil water
22-gauge wire
250-mL beaker
wire strippers
two pencil leads (or two short pencils prepared as in step 7 of Part A)
alligator clips
U-tube
matte knife
ring stand with clamps

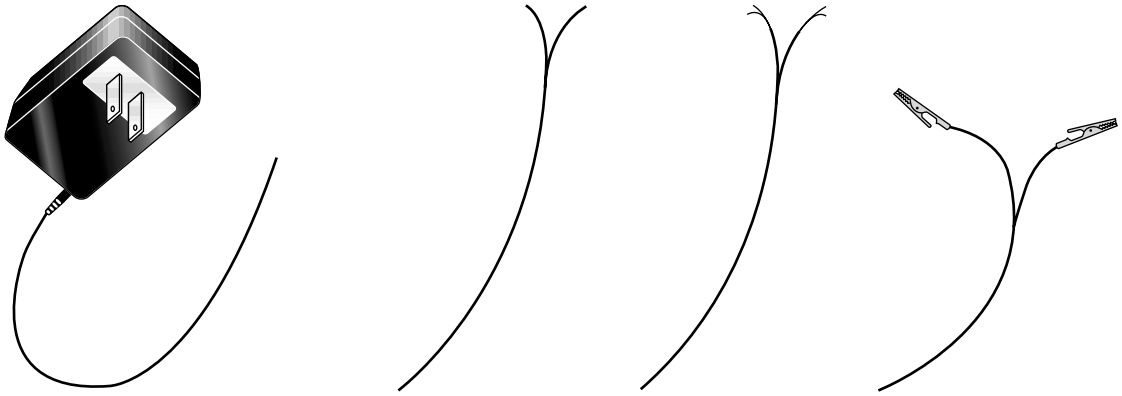
Procedure

Part A: Preparing a DC Adapter and Pencil Leads for Use

By completing the following steps, you can use a DC adapter to provide a safe source of power.

1. Cut off the end of the adapter lead, as shown in figure 1.
2. Separate the wires on the adapter at least 4 in., as shown in figure 2.
3. Strip 1 in. of the ends of the cut wires, as shown in figure 3.
4. Attach two alligator clips to the stripped wires, as shown in figure 4.
5. Determine which is the positive pole of the adapter.
6. If you are using a battery, connect the alligator clips to two pieces of stripped wire, and connect the wire to the battery.
7. Sharpen two short pencil lengths at both ends so that a good portion of graphite is exposed. Use the matte knife to strip all paint from their sides.

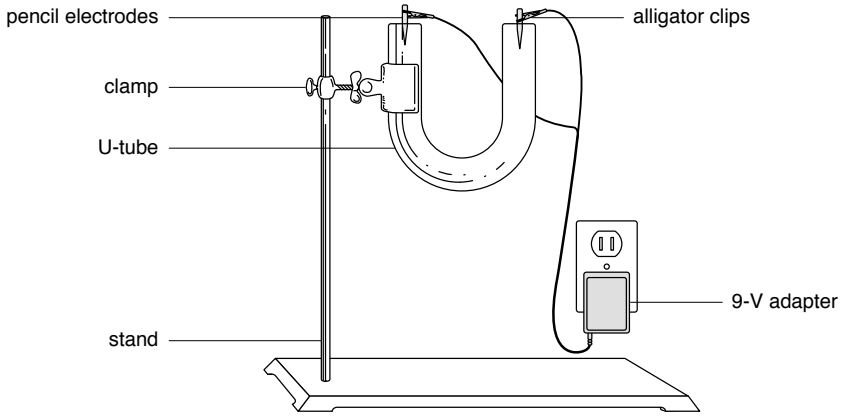
Figure 1 Figure 2 Figure 3 Figure 4



PART B: PERFORMING THE EXPERIMENT

1. Put on your laboratory apron, goggles, and plastic gloves.
2. Set up ring stand and U-tube as shown in figure 5, and heat 250 mL water.

Figure 5



3. Measure the mass of a piece of filter paper on a balance scale. Add 32 g iron (III) chloride to the filter paper on the balance. Then put the iron (III) chloride in a 250-mL beaker.
4. Add 200 mL boiling water to the beaker with the iron (III) chloride. This will form the iron (III) hydroxide colloidal solution.
5. Partly fill the U-tube with the iron (III) hydroxide colloidal solution.
6. Insert the pencil lead electrodes into the solution in the U-tube, as shown in figure 5. Connect the electrodes to the DC adapter or battery, as shown.
7. After the current has been on for 30 min, observe the liquid carefully. Record your observations.
8. Observe the colloidal solution in the U-tube 1 hr later. Has there been any change? If there has been movement in the tube, observe and record the direction of the movement.
9. Let the current remain on for another 24 hr and observe again. Record your observations.
10. Describe what changes you observed in the tube after ½ hr, after 1½ hr, and after 1 day.
11. Did the boundary between the dark liquid and the light liquid move toward the positive electrode or the negative electrode?

12. The dark liquid is made up of colloidal iron (III) hydroxide particles. Based on your observations, what charge do these particles have?

What's Going On

An electric current will cause a boundary to be produced between the dark-colored and light-colored portion of the liquid. The movement of the boundary toward the negative electrode indicates that the colored iron (III) hydroxide colloidal particles are positively charged.

Connections

Electrophoresis is an electrochemical process in which electrically charged colloidal particles (those larger than molecules but still too small to be viewed through a standard microscope) migrate toward the oppositely charged electrode when two electrodes are placed in a solution and current is applied. Electrophoresis is frequently used in protein analysis, since particles of different sizes and different charges migrate at different rates and thus separate out. You can also observe the process with other materials, such as the iron chloride used in this demonstration.

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