Rationale: According to the California State Science Content Standards, electricity and magnetism are important concepts for 4th grade students.

Disclaimer: Some of the procedures for the activities contained in the lessons have been adapted from various resources listed throughout the module.

Part 1A: Electric Current

introduces ideas of electric current from the microscopic and macroscopic points of view

Activity Summary:

• Introduction	Part 1 Worksheet Item 1
• Parts of the atom	Part 1 Worksheet Item 2
• Simple series circuit	Part 1 Worksheet Item 3
• Microscopic view of circuit	Part 1 Worksheet Items 4 and 5
• Conductors and insulators	Part 1 Worksheet Item 6
• Conductivity test	Part 1 Worksheet Items 6 and 7
• Experimental conclusions	
• Special materials	

Part 1B: Static Electricity

introduces idea of static electricity

Activity Summary:

- Electroscope
- Charging balloon
- Balloon/string experiment
- Balloon/electroscope experiment
- Review

File Summary:

- E&M_1a_doc
- E&M_1a_teachers
- E&M_1a_wksht
- E&M_1a_wksht_key
- E&M_1b_doc
- E&M_1b_teachers

Part 1A: Electric Current

Objectives:
After participating in the program *Electricity and Magnetism, Part 1A*, students will be able to:

- assemble a simple circuit using insulated wires, battery, small light bulb, and bulb holder
- explain that electrons traveling through a completed circuit constitute an electric current
- recognize that electrons travel readily in some materials and do not travel in others
- test materials and classify them as conductors or insulators
- list several uses for conducting and insulating materials

Vocabulary:

circuit - a complete path over which current may flow
open circuit - an electrical circuit that is broken and thus carries no current
closed circuit - an electrical circuit that is complete and can carry a current
electron - an elementary particle found in all atoms (not in the nucleus) which carries a negative charge
proton - an elementary particle found in the nucleus of all atoms which carries a positive charge equal to the negative charge of an electron
neutron - an elementary particle found in the nucleus of all atoms which carries no electrical charge
conductor - a material through which electricity can readily flow
insulator - a material through which electricity cannot readily flow

Lesson Plan:

Materials:

For each group:

- 3 sets of insulated wires (with alligator clips)
- 6 V battery
- light bulb and holder
- bag of test materials (glass, magnet, washer, marble, Al foil, eraser, nail, rubber band, penny, screen, sponge, wood, plastic, pencil lead, etc.)
- bag of special materials (ITO coated glass, diode, LED, conductive polymer)

For each student:

- worksheet

Time:

activity 1: 5 minutes
activity 2: 5 minutes
activity 3: 10 minutes
activity 4: 5 minutes
activity 5: 10 minutes
activity 6: 5 minutes
activity 7: 5 minutes
activity 8: 5 minutes

Activities:

1. (5 minutes)
   - Have students sketch on their worksheets, two items they used today that run on electricity.
   - Briefly take survey of the students to see how many different items they listed.

2. (5 minutes)
   - Ask the students to identify the parts of the atom and the charges of the various particles on their worksheets. If they have not yet studied the atom, you may want to skip this or simply show them the parts of the atom.

3. (10 minutes)
   - Have students work in groups of 3 or 4, depending on how the room is set up.
   - Hand out boxes containing the bulbs, batteries, wires, and the bag of test materials.
   - Ask students to make the bulb light. There are several ways to make this circuit so have them use two wires, the battery and a bulb in its holder.
   - Ask students to draw on their worksheets the circuit they made.
   - After the students have drawn their circuit, get them to help you draw it on the blackboard for discussion. Go over this circuit and make sure they see that it is like a circle.
   - What happens if one of the wires is disconnected? (The circuit is opened and the bulb no longer lights. This is called an open circuit.)
   - Have them help you trace the path of electrons in the closed circuit.

4. (5 minutes)
   - Move on to what is happening inside the wires. How are the electrons moving?
   - Ask students to draw on the worksheet how electrons would be moving with respect to the atoms inside the wire. (The atoms would be stationary and the electrons would be moving down the wire in one direction or the other.)
   - Now consider that the circuit was opened somehow. Draw the electrons in the wire now . (Electrons would be moving around each atom, but would not travel down the wire.)

5. (10 minutes)
   - Introduce the ideas of conductors and insulators. (In a conductor, electrons are free to move. In a completed circuit, electrons can move around just like in the wire in #4 of the worksheet. Current can flow in a conductor. In an insulator, electrons are tightly bound to the nucleus of each atom. They cannot leave their atoms to flow as a current. Even in a completed circuit, the electrons in an insulator will behave like those in the wire in #5 of the worksheet. Current does not flow in an insulator.)
   - Ask the students to sort the materials from their bags into two piles, one for conductors and one for insulators.
   - Have students fill out the chart (#6) in the worksheet with their predictions as they go.

6. (5 minutes)
   - After giving students some time to sort the test materials, ask them to brainstorm about how to test for conductivity in their materials.
   - Steer the discussion towards the method using the battery, two test leads (insulated wires with alligator clips at each end), and a test object inserted between the leads. If some students have another equally good idea of how to do this, allow them to use their own method.
   - Have students sketch their test circuit in the worksheet.
   - Then have students test the materials to see if they properly sorted them.

7. (5 minutes)
   - Go over the results of the conductivity test and ask students to draw any conclusions (e.g., metal objects conduct electricity).
   - Ask the students to propose uses for the two classes of materials. (*e.g.:* Wires in an electrical cord would be made from a conducting material; electrical cords have an insulating material around them so we don't get shocked.)

8. (5 minutes)
   - Hand out the bag of special materials.
   - Have students guess whether each item will conduct electricity or not. Have students test the materials. They will need some guidance, especially for the diode and LED.
   - Ask students which materials surprised them and why.
   - Explain what each item is and that it has special properties that make it behave differently than other similar materials. (The diode and LED (light emitting diode) conduct electricity in only one direction. The LED also gives off light of a specific color when it is in the conducting mode. The ITO coated glass conducts electricity because it has a transparent electrode on one side. The conductive polymer conducts electricity because of its special chemical structure.)

References and Extension Ideas:

The following resources were used in developing this lesson plan. Some of the activities were adapted from these sources. Many ideas for extension activities can be found in them as well.

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18. *The Science Teacher*, October 1999, “Electromagnetic/Mechanical Resonator”, pp. 56-58.