PIÈCE de RÉSISTANCE

GRADES 6 - 8

SOUTHERN COMPANY

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PIÈCE de RÉSISTANCE

SNC - Plant Farley

LESSON PLAN

Lesson Title: Pièce de Résistance

Lesson Description: Students will apply concepts related to electricity, resistance, and thermal energy by conducting a miniature water heater. The exercise is designed to complement / reinforce discussion of concepts regarding electrical resistance.

Grade Level: 6-8 (modify as needed for each grade level)

Subject Area(s): Physical Science

Objectives: Students will:
- construct a miniature water heating unit
- observe and measure temperature increases over time
- collect and plot data on graph paper
- analyze and discuss observations and data with other students
- relate findings to principles of electrical resistance and thermal energy

Materials:
- 6 volt lantern batteries
- 3 different sizes (diameters) of bare copper, aluminum, or alloy (e.g. Nichrome) wire
- Pyrex test tubes, 10 mm X 75mm
- electrical tape
- distilled water
- pencils
- graph paper
- thermometers (alcohol)
- stopwatches (or watches with second hands)
- volumetric pipets

Correlations (NSES):
- Content Standard A – Science as Inquiry
  - develop abilities to do scientific inquiry
  - develop understandings about scientific inquiry
- Content Standard B – Physical Science
  - develop an understanding of motions and forces
  - develop an understanding of transfer of energy
- Content Standard E – Science and Technology
  - develop abilities technological design
  - develop understanding about science and technology
- Content Standard F – Science in Personal and Social Perspectives
  - develop understanding of science and technology in society

Curriculum Integration:
- Mathematics (measurements)
- Vocational Education (electricity)

Process Skills:

- Observation
- Comparison
- Collection of data
- Measurement
- Counting
- Research
- Inference
- Investigation/experimentation
- Interpretation of data
- Analysis of data
- Description of findings
- Communication of ideas
- Construction of model

Background Information:

- Main ideas

  Principles related to resistance such as:
  - the flow of electrons through a conductor is electric current
  - resistance is a measure of how difficult it is for electrons to flow through a conductor
  - resistance varies with the length, thickness, and type of material acting as the conductor
  - there is a relationship between resistance and current; e.g., if the resistance doubles, the current is reduced by one-half
  - heat increases with resistance
  - additional principles such as voltage, amperes, Ohm's Law, etc. may be discussed if so desired

  Principles related to thermal energy such as friction and heat, kinetic energy, and thermodynamics

- Secondary ideas

  Review of graphing/plotting

  Measurement of temperature, various temperature scales

Teacher Activities:

- Assemble/organize all materials needed for activity.
- Present background material to students.
- Depending on the size of the class, the teacher may wish to divide the class into groups of 2-4 students. Each student in the group should have a specific task in the exercise. For example, one student should be responsible for recording data, another using a stopwatch to monitor time, another actually reading the thermometer, etc.
- Issue instructions to students regarding experiment.
- Distribute Activity Sheets to students and give instructions on how to complete them.
- Review graphing procedures.
- Stress lab safety. (broken glass hazard, etc.)
- Monitor/assist students as needed during exercises.
- After students complete exercises and assemble back into a group, allow students to show their work and describe their observations.
- After students have shared their work, engage students in post-activity discussion. Stress main points of lesson during discussion.

Student Activities:

- Listen to background information given by teacher.
- Obtain all materials needed to complete the exercise (refer to Activity Sheet).
- Record preliminary data on Activity Sheets.
- Construct miniature heaters as directed in Activity Sheets.
- Observe, record, and plot data on graph paper.
- Interpret/analyze data and share it with other students.
- Participate in post-activity discussion.

Evaluation:

- Activity sheets
- Direct observation
- Oral reports from students

Extension/Enrichment:

- Have students utilize multimeter to measure current and resistance of same lengths of wires and plot data.
- Use a variety of materials for insulation in activity and measure temperature differences.
- Use data to apply Ohm's Law; use Ohm's Law to measure resistance in a light bulb.
- Use a regulated power source to vary voltages in experiment.
- Discuss the use of resistors in electronics; then build circuits utilizing resistors.
- Vary wire composition and note differences in resistance.
- Discuss thermal resistance, insulation, and heat flow.

Safety Considerations:

- Use alcohol filled thermometers rather than mercury.
- Use high quality borosilicate glass test tubes that can withstand heat.
- Caution students to handle glass equipment with care to prevent breakage.
- Monitor students carefully to insure that they use only the 6 volt lantern battery as a power source.

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ACTIVITY SHEET ONE

(READ THIS ENTIRE SHEET BEFORE BEGINNING THE EXERCISE)

Introduction

In this lab activity, you will experiment with passing electrical current through wires of varying diameters and monitoring heat production. You are actually constructing miniature water heaters made of test tubes wrapped by wire and insulated with electrical tape. The exercise will require close observation and measurement of temperature changes over time.

Hopefully, you will be able to denote a relationship between wire diameter, heat, and resistance as discussed prior to the laboratory exercise. Follow the directions on this Activity Sheet and record your data carefully and accurately as you will be called upon to relay your findings to the rest of the class after the lab is completed.

Procedure

Obtain the following materials as directed by your instructor:

- Three lengths of bare wire, each of a different diameter
- Roll of electrical tape
- Thermometer - BE CAREFUL!!!
- 6 Volt Lantern Battery
- Stopwatch (or watch with second hand)
- Graph paper
- 3 sets of short lengths of very thin diameter wire, each set of a different composition
- Pencil
- Distilled water
- Volumetric pipet (1 to 5 mL)

- Take the medium diameter length of wire and wrap it around the outside of the test tube as shown in Figure 1.

- Wrap electrical tape around wire and tube to serve as insulation and keep wire in place around tube.

- Use the volumetric pipet to place 2.5 mL of distilled water in the test tube.

- Measure the temperature of the water in the tube; record the initial temperature on the data chart (see Table 1).

- Connect one end of the wire to the positive terminal of the battery and the other end of the wire to the negative terminal; start the stopwatch.

- Observe and record the temperature of the water every thirty seconds until it reaches a maximum temperature (the temperature stops rising).

- Plot the data on graph paper (time on X axis and temperature on Y axis).

- Repeat the procedure for the other two diameters of wire; be certain to start with a new test tube and fresh distilled water, both at room temperature.

- Analyze your data and answer the questions on Activity Sheet 2.

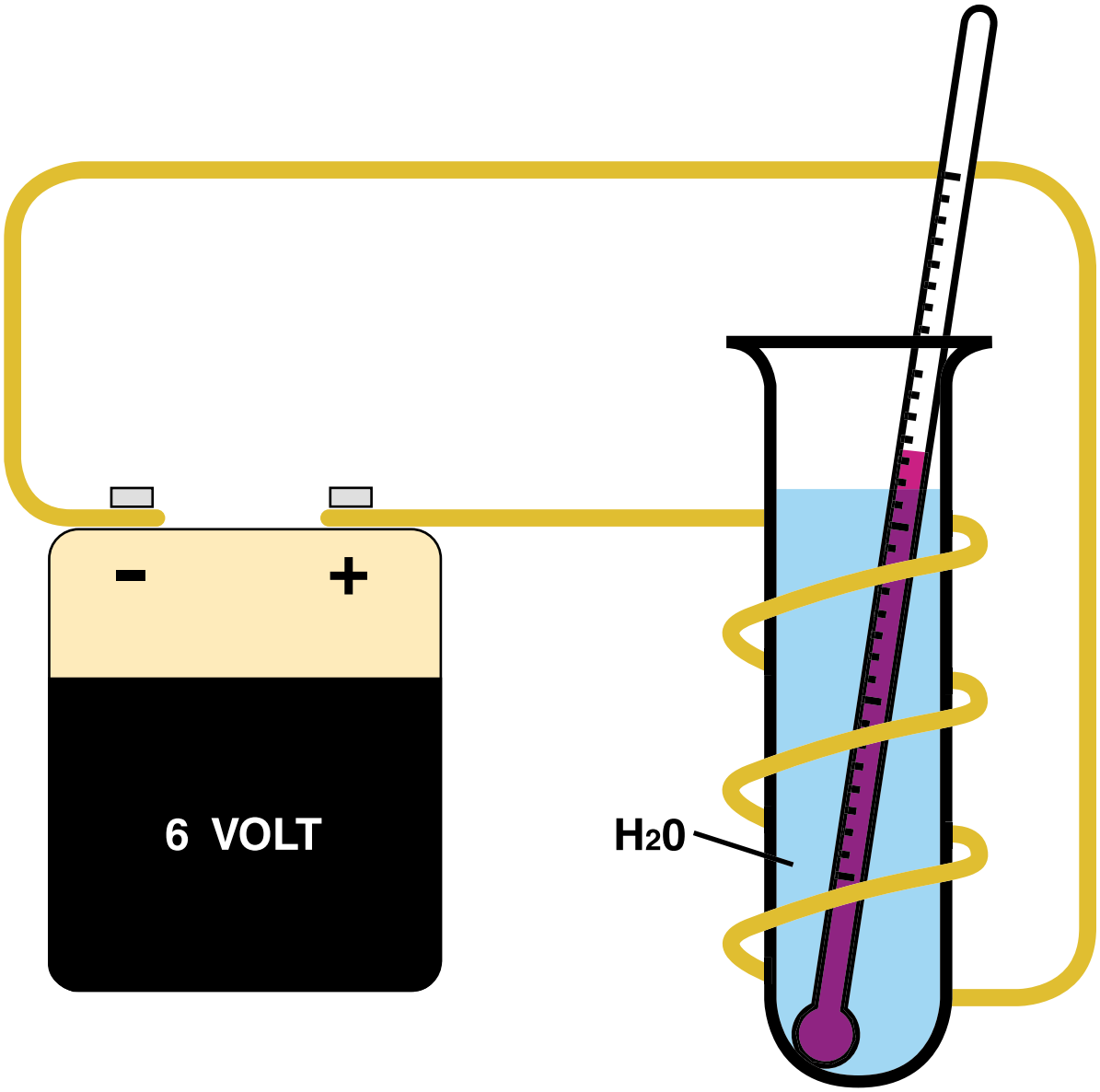

Figure 1

WIRE DIAMETER	INITIAL TEMP.	30” TEMP.	1’ TEMP.	1’30” TEMP.	2’ TEMP.	2’30” TEMP.	3’ TEMP.	3’30” TEMP.	4’ TEMP.	4’30” TEMP.
Medium										
Thick										
Thin										

Add additional columns to your table if needed.

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ACTIVITY SHEET TWO

After completing your experiment, plot data from the chart on graph paper. Compare the results you get for each different diameter of wire. Analyze the data and answer the following questions:

1. Is there a relationship between wire diameter and heat production? If so, explain that relationship.

2. Is there a relationship between resistance and heat production? If so, what is that relationship?

3. Which of the wires tested produced the greatest amount of heat? Why do you think it produced the most heat?

4. Compare your results (e.g., graphs) to those obtained by others in your class. Are your results the same or different? Why?

5. List some ways to modify the experiment to cause greater heat production.

6. What would happen if you repeated the experiment with no insulation?

7. What are some other materials that might be used for insulation?

8. Why do you think the instructions require distilled water rather than tap water?