How Batteries Work

Lesson Plan for Grades 6,7,8 , STEAM

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OVERVIEW & PURPOSE

Students will discuss why batteries are important in our daily life. As well, students will learn about how batteries work . Students will also create a battery to learn how batteries are made. At the same time students will identify an electrolyte solution that will best work in a battery.

Batteries are used everywhere by mostly everyone. Developing an early understanding about the mechanism and materials that go into making batteries can start a path of investigation. Batteries have gone from being used to power pocket radios to electric cars. The more we advance in understanding how this technology works, the more we will improve on it. Technology is by no means a finite science, it requires constant investigation and an improvement.

EDUCATION STANDARDS

1. 4.MD.4. Make a line plot to display a data set of measurements in fractions of a unit (1/2, 1/4, 1/8). Solve problems involving addition and subtraction of fractions by using the information presented in line plots. For example, from a line plot find and interpret the difference in length between the longest and shortest specimens in an insect collection
2. 6.SP. 5.Summarize numerical data sets in relation to their context, such as by:a.Reporting the number of observations.b.Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.c.Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.d.Relating the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered
3. Some chemical reactions release energy, others store energy. (PS1-MS-6)
4. PS3-MS-4. Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

OBJECTIVES

1. Students will determine what is the importance of using an efficient electrolyte
2. Students will describe how a battery works and its parts as conductor, anode/cathode, etc.
3. Students will create a graph charge vs. electrolyte to determine the best electrolyte for their batteries.

MATERIALS

Each group needs:

- 2 pieces aluminum foil: 8 in x 12 in (20 cm x 30 cm)
- 2 wide-mouth glass jars (must be able to hold at least 150 ml)
- 2 small paper cups (such as Dixie cups), cut at ¾ in from the cup bottom,
- 3 pieces (one: 12 in [30 cm] and two: 31.5 in [80 cm]) of non-insulated copper wire (gauge AWG 20) (available at most hardware stores); a total of 75 in (200 cm) per group. Or, if you have insulated wire, it will work if you strip the insulation off the ends.
- masking tape
- wire cutters
- marking pens
- Make copies of the Two-Cell Battery Worksheet, one per team
- Paper and Pencil for observations (Know- Want to know-Learned format) and graph

For a Battery Testing Station for the entire class to share:

- containers for the electrolyte solutions (must be able to hold at least 150 ml); wide-mouth glass jars work well
- electrolyte solutions (make in advance with water and vinegar, citrus juice [such as lemon] or salt; see Procedure section)
- a few graduated cylinders (10–25 ml) or liquid measuring cups or jars with volumes marked on the side
- 3 pairs of safety glasses or goggles
- 1 DC ammeter (to measure current in amperes) (available at most hardware or electronics shops)
- paper towels

For a Cleaning Station for the entire class to share:

- water and sink, or, if no drain is available, a large empty container to collect the used electrolyte solutions
- (optional) paper towels

ASSESSMENT

Before Video

- "Know-Want to know-" part of observations. What do you know about batteries? What would you like to know about batteries?

After video

- Students will discuss main ideas from the video.
- Add further notes on the "Know- Want to know- Learned" part of observations.

After activity

- Complete Two-Cell Battery Worksheet.
- Create graph Electrolyte vs Charge.
- Know-Want to Know-Learned.
- Final discussion and conclusion. How do batteries work? Why are batteries important? Why do you think makes a good electrolyte? What does the information in your graph and table represent?

VIDEO PRESENTATION

How a battery works (https://www.youtube.com/watch?v=9OVtk6G2TnQ)

ACTIVITY

Before the Activity

- Cut two 8 in x 12 in (20 cm x 30 cm) pieces of aluminum foil for each team.
- Cut one 12 in (30 cm) piece and two 31.5 in (80 cm) pieces of wire for each team. Note that insulated wire can be used, as long as it is stripped at the ends.
- Decide which electrolytes to use. (Suggestion: For a class of 27 students working in nine teams of three students each, use three different electrolytes [vinegar, citrus juice, salt] in three different

strengths [weak, medium, strong].)

- Prepare the electrolyte solutions, making about 400 mL of each solution. Make sure to label them. The whole class can use the same type of solution at different strengths, or different teams can have different types of solutions at a range of strengths (see examples below):
- *Weak solution*: 5 ml (~1 teaspoon) of [vinegar or citrus juice or salt] for every 100 ml water
- *Medium solution*: 15 ml (~1 tablespoon) of [vinegar or citrus juice or salt] for every 100 ml water
- *Strong solution*: 40 ml (~2.5 tablespoon) of [vinegar or citrus juice or salt] for every 100 ml water

If the number of teams is not a multiple of three (one team using the weak solution, one using the medium solution, and one using the strong solution), prepare more electrolyte solutions for the remaining teams, making them incrementally stronger.

- Prepare a Battery Testing Station for the entire class to use: 3 pairs of goggles, a DC ammeter, graduated cylinders, all the containers of prepared electrolyte and paper towels.
- Set up a Cleaning Station.

With the Students

Have each team construct its two-cell battery at a desk. After all the groups have finished, gather the class around the battery testing station to observe what happens when electrolyte is added to each team's battery.

Constructing the Battery:

1. Put a piece of tape on each glass container. Label one container A and the other B.
2. Have students roll each piece of foil so the long side of the roll is about 12 in (30 cm). Crumple about 1/4 of one end on each roll.
3. Place one aluminum foil roll in each container, placing the crumpled end on the bottom of the container. Carefully flatten the rolled part of the foil against the side of each container.
4. Place a paper cup bottom on top of the crumpled foil in each container; the aluminum foil column should go up and around the side of the paper cup .
5. Carefully wind one end of the 12 in (30 cm) piece of copper wire around the top of the foil roll in container A. Make a couple winds with the wire to get a good connection. Leave the other end of the wire free.
6. Coil about 22-24 in (55-60 cm) of the 31.5 in (80 cm) piece of wire into a ball. Place this ball on top of the paper cup bottom in container B. Make sure the copper wire is not touching the aluminum foil.
7. Coil about 22-24 in (55-60 cm) of the second 31.5 in (80 cm) piece of wire into a ball. Place this ball on top of the paper cup bottom in container A. Make sure the copper wire is not touching the aluminum foil.
8. Carefully wind the free end of the third piece of copper wire (the 31.5 in wire in container A)

around the top of the foil roll in container B. Again, make a couple winds with the wire to get a good connection.

Testing the Battery. Repeat steps 9–15 for each team.

9. Have students wear goggles when they test their batteries.
10. Connect the free end of the wire from container A to one of the ammeter connections.
11. Connect the free end of the wire from container B to the other ammeter connection.
12. Obtain an electrolyte solution. Pour about 50 ml of the electrolyte solution into container A and about 50 ml of the same solution into container B. The solution should cover the wire coils in both containers completely; if not, carefully add more of the solution.
13. Measure the current produced by the battery using a DC ammeter. Have one student from each team record the electrolyte concentration and current.
14. Disconnect the wires from the ammeter.
15. Pour the electrolyte solution back into its correct source container.
16. After all students have tested their batteries, have teams disassemble their batteries. Have one member of each team take its materials to the Cleaning Station. Students should gently rinse containers A and B with a small amount of water. Pour this water in the sink or into a container provided for this purpose.
17. Have teams report the electrolyte concentration and current produced by their batteries on the classroom board.
18. In teams, have students complete the Two-Cell Battery Worksheet.
19. As a math exercise, using the chart on the Two-Cell Battery Worksheet, have students construct graphs charge vs. electrolyte to determine a pattern or relationship between both.

References

"Hands-on Activity: Two-Cell Battery".
https://www.teachengineering.org/activities/view/cub_electricity_lesson03_activity2

Idaho Department of Education. Idaho Content Standards. http://www.sde.idaho.gov/academic/standards/