EXPLORATIONS

Activity 4

Voltage from Dry Cells

Objectives

- To understand the relationship between dry cell size and voltage

Materials

- TI-73
- Unit-to-unit cable
- CBL 2™
- Voltage sensor
- New AAA, AA, C, and D dry cells
- Battery holders
- Alligator clips
- Data Collection and Analysis pages (p. 36 – 38)

In this activity you will

- Use a CBL 2™ with a voltage sensor to measure the voltage produced by new dry cells of each size.
- Determine whether there is a relationship between dry cell size and voltage.

Problem

Does voltage vary with the size of AAA, AA, C, and D dry cells?

Introduction

Fruits and vegetables will create one wet cell as opposed to a battery that is made from a series of cells. An example of a dry cell is a AAA cell. A 9-volt is a true battery: it contains six 1.5 volt cells. All 1.5 volt dry cells contain the same voltage, regardless of size.

Hypothesis

Before testing, answer the questions on the **Data Collection and Analysis** page to predict the effect of dry cell size on voltage. Also answer the questions in the **Experimental Design** section.

Procedure: Collecting the Data

1. Collect new dry cells in different sizes and put them into battery holders.
2. Plug the voltage sensor into Channel 1 (**CH 1**) on the CBL 2.
3. Start the DATAMATE program.
4. The Main Screen is displayed. **CH 1:VOLTAGE(V)** is displayed.

5. Select **1:SETUP**.
6. Select **MODE** by pressing ▼ to highlight **MODE** and pressing ENTER. Then select **3:EVENTS WITH ENTRY**.
7. Select **1:OK** to return to the Main Screen.
8. Attach the black and red leads to the positive and negative terminals on the battery holder. Alligator clips make this easier.
9. When you are ready to begin, select **2:START**. The screen displays **PRESS ENTER TO COLLECT OR STO TO STOP**.
10. When the voltage reading is ready, press ENTER.
11. The program asks you to enter a value. This value is the number of your dry cell size, NOT the voltage reading. Type the number for this dry cell (for example, if this is your first dry cell, type **1**) and press ENTER. Record the dry cell size beside the number in the table on the **Data Collection and Analysis** page. The program returns to the data collection screen, ready for you next dry cell.
12. Repeat steps 8 through 11 for each sample, using the number for the dry cell size when the program asks for a value after you have the voltage. After you enter the first dry cell number, the last number you used is displayed at the bottom of the screen.
13. After you have collected the voltage reading for the last dry cell, press STO▶. A scatter plot is displayed showing the voltage reading for all of the dry cells. Use ▶ and ◀ to move to each data point and record the values in the table on the **Data Collection and Analysis** page.
14. To exit from the DATAMATE program, press ENTER to return to the Main Screen. Select **6:QUIT** and press ENTER.
15. To display the lists showing the results, press LIST. The dry cell numbers are stored in **L1**. The voltage readings are stored in **L2**.
16. To change the sample numbers in **L1** to the sizes of the dry cells:
    a. Highlight the first element in the list.
    b. Press 2nd [TEXT]. Press the arrow keys to move to the letters in the name, pressing ENTER after each one. The first name must be enclosed in quotation marks.
    c. When the name is finished, move to **Done** and press ENTER.
    d. Press ENTER again to paste the name in the list.
    e. When you finish working with the lists, press 2nd [QUIT] to return to the home screen.
17. Use the TI-73 and the data from all of the lab groups to find the average voltage for each dry cell size.

Procedure: Graphing the Data

Create a bar graph to display the voltage reading for each dry cell size.

Bar Graph

The bar graph has a limit of seven bars.

1. Press [2nd] [PLOT] **4:PlotsOff** [ENTER] to turn off all stat plots.
2. Press [2nd] [PLOT] [ENTER] to select **Plot1**.
3. Press [ENTER] to select **On** (to turn on **Plot1**).
4. Select (the bar graph) for **Type**.
5. Plot **L1** (dry cell numbers) as the categorical list and **L2** as data list 1 (voltage readings).
6. Press [ZOOM] **7:ZoomStat** to set the window and display the graph.
7. Press [TRACE] to display the dry cell numbers with their voltage readings.

Data Analysis

Using the data you collected and the bar graph, answer the questions on the **Data Collection and Analysis** page to analyze your results.

Extension

- Test new 9-volt and 6-volt lantern batteries to find their voltage. Based on the voltage measured for each dry cell in this lab, how many dry cells make up each 9-volt battery? 6-volt battery?
- Gather a selection of used dry cells. Take voltage readings for each one. Compare the readings to the voltages you found for new dry cells. Calculate the percentage of energy remaining from each original dry cell.

Data Collection and Analysis

Name _____

Date _____

Activity 4: Voltage from Dry Cells

Problem

Does voltage vary with the size of AAA, AA, C, and D dry cells?

Hypothesis

1. Before testing, complete the table below to predict the rank of the new dry cells by voltage (1 = greatest voltage).

Dry Cell Size	**Predicted Rank by Voltage** (Greatest to Least)

2. If the size of a dry cell increases, the voltage _____ .

Experimental Design

1. Independent Variable: We are changing _____ .
2. Dependent Variable: We are measuring _____

   in _____ (units).
3. Constants: Which variables stay the same for each trial?

   _____

   _____
4. Number of Trials: _____

Data Collection

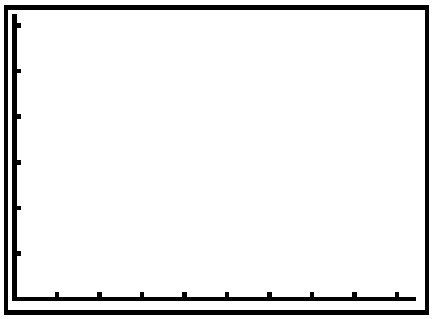
1. After you test the dry cells, use the scatter plot to fill in the voltages on the table below. Then rank the dry cells from greatest to least voltage (1 = greatest).

Sample Number	**Dry Cell Size**	**Actual Voltage** (Volts)	**Actual Rank by Voltage** (Greatest to Least)
1			
2			
3			
4			

2. Record the voltage that is the average of all the lab groups in the table below.

Dry Cell Size	**Actual Voltage Average** (Volts)
AAA	
AA	
C	
D	

3. Sketch your bar graph or print it on the computer and attach it to this page. Label the bars and insert a scale for voltage.



Data Analysis

1. Compare the actual results from the table and graph to your prediction. Discuss any surprises or differences you find.

   _____

   _____

   _____

   _____

2. How are dry cell size and voltage related?

   _____

   _____

   _____

3. What is the mean voltage from your lab group? _____ .

   What is the median voltage from your lab group? _____ .
   How do the mean and median voltages compare?

   _____

   _____

   _____

4. Why might the mean or median voltage be different from the labeled voltage on the dry cell?

   _____

   _____

   _____

5. Why do you think there are differently sized dry cells?

   _____

   _____

   _____

Conclusions

1. As dry cell size increases, the voltage _____ .
2. There is a (positive / negative / no) correlation in dry cells between size and voltage. (Circle the correct response.)

Teacher Notes

Activity 4

Voltage from Dry Cells

Objectives

- To understand the relationship between dry cell size and voltage

NSES Standards

- Physical Science: Properties and changes of properties in matter
- Physical Science: Transfer of energy
- Science as Inquiry: Abilities necessary to do scientific inquiry

Preparation

- Provide new AAA, AA, C, and D dry cells and battery holders for each lab group. In a pinch, use plastic rulers with a "v"-shaped ridge in the middle. (See ruler description in CBL 2™ *Getting Started*.)
- Alligator clips may be used to save wear on the voltage sensor leads. These can break off if handled roughly.

Management

- Ask students to sketch the lab setup before starting the lab and label with key terms. Students learn vocabulary in context and seem less confused by the procedure.
- Explain that the fruits and vegetables will create one wet cell as opposed to a battery that is made from a series of cells. An example of a dry cell is a AAA; a 9-volt is a true battery since it contains six 1.5 volt cells. All 1.5 volt dry cells contain the same voltage, regardless of size.
- Assign these student jobs for this lab:
  - Materials/setup person (sets up samples, sensor)
  - Tech person (operates CBL 2 and TI-73)
  - Data recorder (reads voltage readings from the CBL 2 at each collection interval)
  - Runner (brings CBL 2 and TI-73 to the computer to print out graphs with TI-GRAPH LINK™ or TI™ Connect and brings **Data Collection and Analysis** pages to the teacher)

Selected Answers

Experimental Design

1. Independent Variable: *We are changing the size of the dry cell.*
2. Dependent Variable: *We are changing the voltage in volts.*
3. Constants: *Age and number of dry cells, CBL 2 and voltage sensor, battery holders*
4. Number of Trials: ——

Conclusions

1. As dry cell size increases, the voltage *remains constant at about 1.5 v for new dry cells*.
2. There is *no* correlation in dry cells between size and voltage.