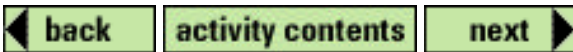


ACTIVITY CONTENTS:

Decaying Batteries

- [Introduction](#)
- [Thinking About the Question](#)
- [Materials](#)
- [Safety](#)
- [Investigation I: Making a circuit and spreadsheet](#)
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- [Investigation III: Investigating the decay of different types of batteries](#)
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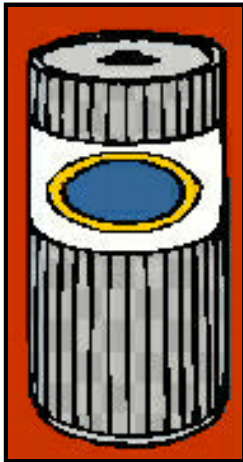
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Decaying Batteries Introduction

Discovery Question: How does voltage change as a battery is used?



This activity enables you to investigate the voltage of different batteries and how voltage changes as the battery is used up.

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Thinking About the Question

How does voltage change as a battery is used?

Have you ever been in the middle of playing with a battery-powered toy, when you noticed it beginning to move very slowly or not at all? Have you been using a calculator that simply stopped working? What happened to the power of the battery? Could you predict how long this would take to occur?

In your class you may have been making bulbs light with D-cells. As you know, there are other kinds of batteries. For example, a remote control for a television may use a 2 AAA-cells, while a portable stereo may use 2 D-cells. How are these cells different? How are they the same?

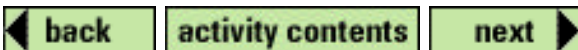
Today you will use a multimeter to measure whether and how quickly the electric current in different kinds of cells gets used up.

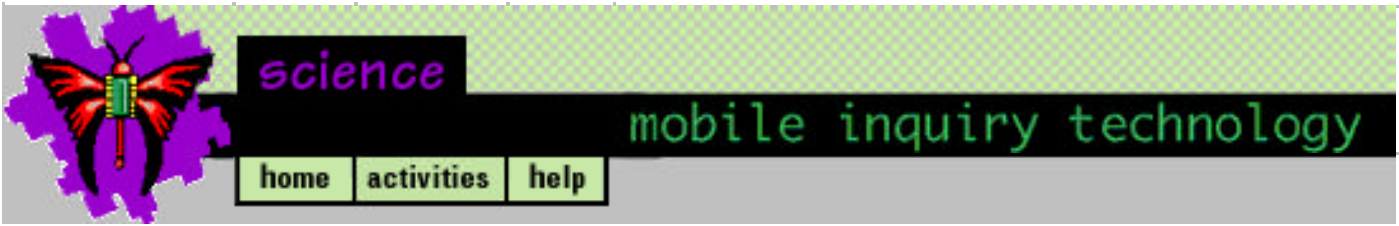
Discuss the following questions with students in your group. Write down your ideas and be prepared to present them to the class. Be sure to include the reasons behind your thinking.

You've noticed that each of your electric cells is rated at 1.5 volts. Use the multimeter to confirm the accuracy of the voltage rating.

What do you think will happen if you connected each of these cells in the same circuit for 30 minutes? What makes you think this will happen?

After you've had a chance to discuss your ideas with your class, go to "Investigating the Question" to try it out.





Decaying Batteries Materials

- multimeter with leads
- 4 different types of 1.5-volt batteries (possible types include: AAA, AA, C, D)
- 1.5-volt bulbs (several per group)
- 3-15 cm wires, stripped about 1-cm at either end
- switch
- masking tape
- optional battery charger





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Decaying Batteries Safety

Connecting leads directly between battery terminals may result in overheating and damage to the battery. Disconnect the leads if they become overheated. **Never** use larger than a 9-volt battery. Damage to the meter may result.

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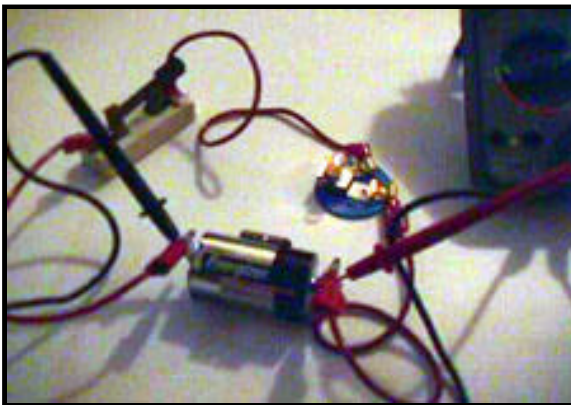
Decaying Batteries Investigation I

Making a circuit and spreadsheet

1. Obtain a battery. Note the type of battery (D-, C-, AA-, AAA-).



2. Using your spreadsheet program, make a chart to record time and voltage of your type of battery. Refer to [Technical Hints](#) to see how to make a spreadsheet.
3. Work within a group to make a circuit using one battery, one bulb, wire and a switch so that the bulb lights.



4. If necessary use masking tape to secure the wire leads of your circuit and the multimeter to the two terminals of your cell if an appropriate battery holder is not available. Make sure the leads are secure by wrapping the battery several times with the tape once the top voltage is achieved.



5. Close the switch to make sure you have a complete circuit and that your bulb works. Open the switch once the bulb is tested.
6. Connect the multimeter probe cable to your computer in the modem/printer port and open the CC DMM program. Set the collection time for 60 minutes, however you will run the program for only 30 minutes. Refer to [Technical Hints](#) to see how to use the CC DMM program.

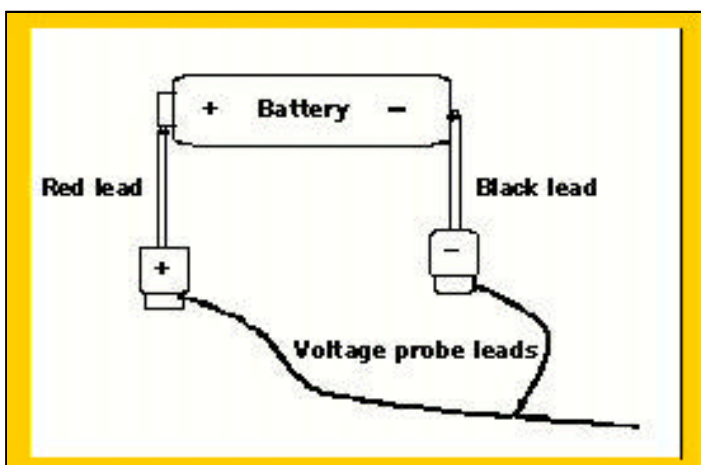
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Decaying Batteries Investigation II

Investigating the decay of a battery

1. Start the program. Close the switch and let the multimeter record for 30 minutes. If your voltage reading is appearing as a negative value, stop the program and switch the leads of the multimeter to opposite sides of the battery. The red lead should be positioned on the positive (+) terminal of the battery and the black lead on the negative (-) terminal of the battery. Click start again.
2. Once the program starts, do not move your circuit.



3. While your data is collected think about and do the following exercises with your group:
 - There are many different types of batteries. Make a chart that shows different kinds of batteries you have found in electric devices at home and in school. List size of the battery, the voltage rating and the device in which you found it. You may have multiple uses for each size battery.
 - Write down your ideas about why there are different kinds of batteries for different devices.
4. After 30 minutes stop the voltage recording and open the switch.
5. Copy the data from your voltage program into a spreadsheet. Refer to [Technical Hints](#) to see how to transfer data from the CC DMM program to the spreadsheet.
6. Use your data to make a x-y line graph. Refer to [Technical Hints](#) to see how to make an x-y line graph.
7. Answer question 1 in the "Analysis".

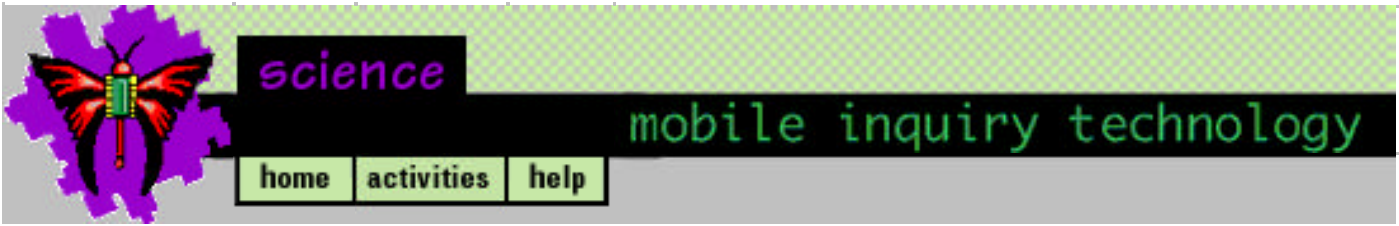


Decaying Batteries Investigation III

Investigating the decay of different types of batteries

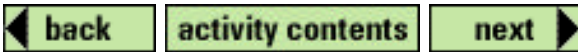
1. On your spreadsheet, add columns for other types of batteries. You will have to include an identical time column for each type of battery. Refer to [Technical Hints](#) to see how to add columns to the spreadsheet.
2. Record the data from other groups and battery types in your spreadsheet. Make a new chart that shows the data for each type of cell on the same graph. Refer to [Technical Hints](#) to see how to make a new x-y line chart.
3. Answer questions 2 and 3 in "Analysis".





Decaying Batteries Technical Hints

- [Making a spreadsheet](#)
- [Using the CC DMM program](#)
- [Transferring data from the CC DMM program to the spreadsheet](#)
- [Making an x-y line graph](#)
- [Adding columns to the spreadsheet](#)
- [Making a new x-y line graph](#)



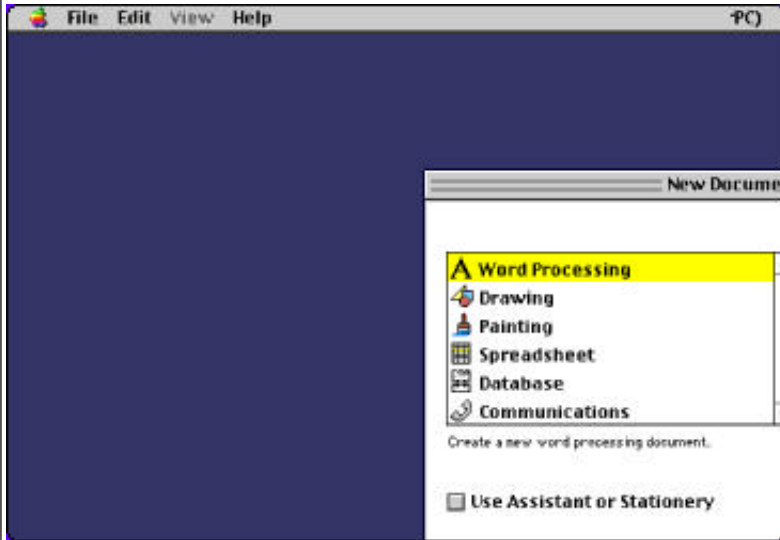


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Decaying Batteries Technical Hints

To make a spreadsheet:

1. Open the ClarisWorks spreadsheet program by selecting it from the opening menu.
2. Title the first column for Time in Seconds in Cell A1. Title the second column for your type of battery in Volts in Cell B1.



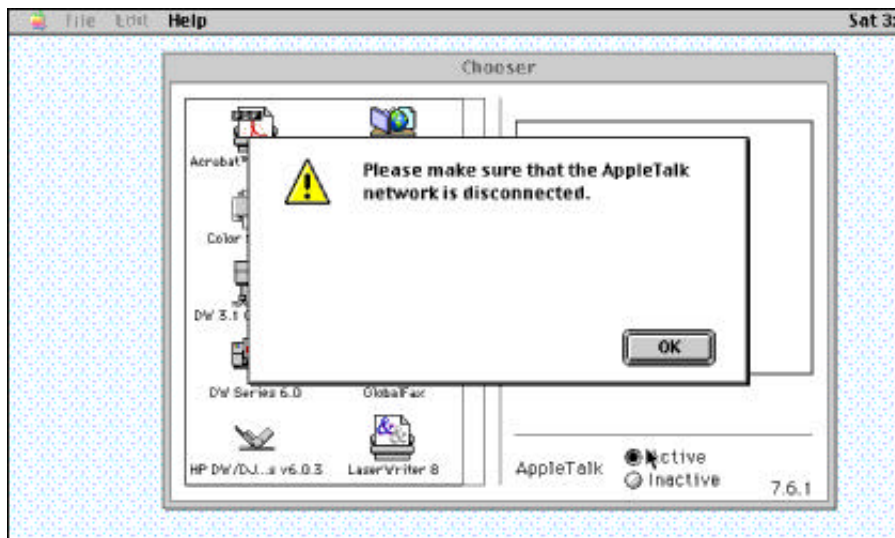


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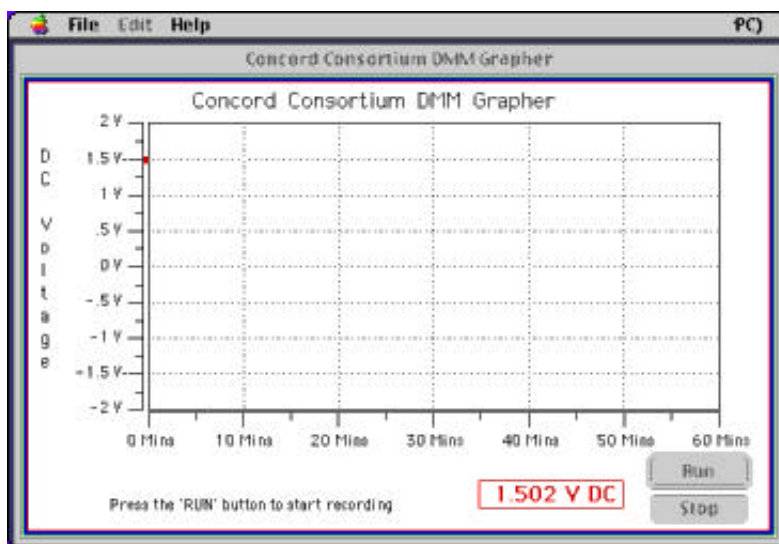
Decaying Batteries Technical Hints

To use the CC DMM program:

1. Before opening the software, attach the serial cord to the serial port at the back of the computer.
2. Open the Chooser from under the Apple menu. Make sure AppleTalk is inactive.



3. Set the knob on the multimeter to the 2 V (in yellow region) scale.
4. Turn on the multimeter.
5. Open the Concord Consortium Digital MultiMeter (CC DMM) program. Select 60 minute from the Collection Time. You will need to stop the program at 30 minutes. The multimeter will automatically collect data every 10 seconds.



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Decaying Batteries Technical Hints

To transfer data from the CC DMM program to the spreadsheet:

1. To transfer data from the CC DMM, end the collection at 30 minutes by clicking on the Stop button. Select Copy data to Clipboard from the Edit menu.
2. Open your spreadsheet and select a place away from your titled columns. Choose Paste from the Edit menu. The data automatically transferred is more than is needed for this activity. Highlight just the time and voltage data and select Copy from the Edit menu. Click in Cell A1. Choose Paste from the Edit menu. Highlight the original transfer and press delete on your keyboard.

| | A | B | C | D | E | F | G |
|----|---|---|---|------------------------------|-------|---|---|
| 7 | | | | DC Voltage. Range is 2 Volts | | | |
| 8 | | | | Seconds | Volts | | |
| 9 | | | | 0 | 1.501 | | |
| 10 | | | | 10 | 1.501 | | |
| 11 | | | | 20 | 1.501 | | |
| 12 | | | | 30 | 1.501 | | |
| 13 | | | | 40 | 1.501 | | |
| 14 | | | | 50 | 1.501 | | |
| 15 | | | | 60 | 1.5 | | |
| 16 | | | | 70 | 1.5 | | |
| 17 | | | | 80 | 1.501 | | |
| 18 | | | | 90 | 1.501 | | |
| 19 | | | | 100 | 1.501 | | |
| 20 | | | | 110 | 1.501 | | |
| 21 | | | | 120 | 1.5 | | |
| 22 | | | | 130 | 1.5 | | |
| 23 | | | | 140 | 1.5 | | |
| 24 | | | | 150 | 1.5 | | |
| 25 | | | | 160 | 1.5 | | |

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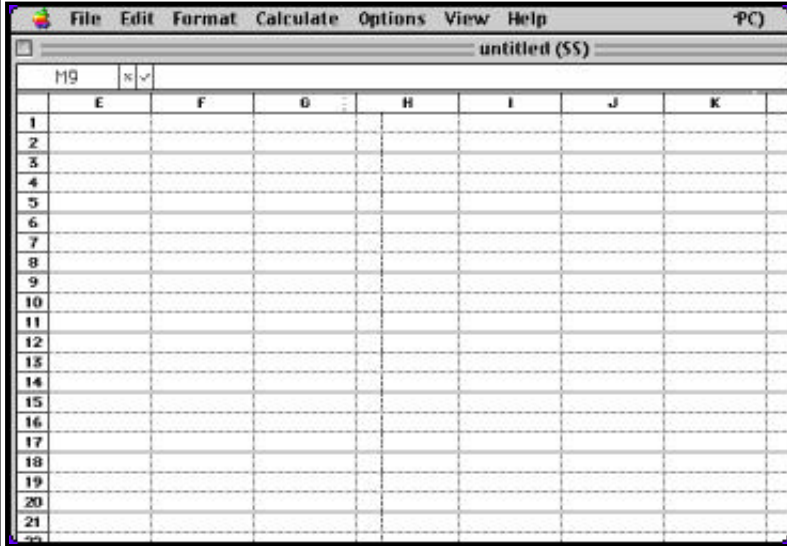


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Decaying Batteries Technical Hints

To make an x-y line graph:

1. Highlight your data starting with Cell A1.
2. Select Make Chart from the Options menu. Click on x-y Line graph. If you want to title the graph, double click on the chart and select the Label button. Type D-cell Voltage Over Time.



3. To change from x marks the spot to solid circles, double click on the graph and select series. Choose the solid circle.

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Decaying Batteries Technical Hints

To add columns to the spreadsheet:

1. On your spreadsheet, add columns for other types of cells. You will have to include an identical time column for each type of battery.
2. Share data between groups by adding the data from each group that used another kind of battery to your spreadsheet. Ask your teacher how to make the transfer.

| | A | B | C | D | E | F | G |
|----|------------|----------------|------------|----------------|---|---|---|
| 1 | Time (sec) | D-cell (Volts) | Time (sec) | C-cell (Volts) | | | |
| 2 | 0 | 1.501 | | | | | |
| 3 | 10 | 1.501 | | | | | |
| 4 | 20 | 1.501 | | | | | |
| 5 | 30 | 1.501 | | | | | |
| 6 | 40 | 1.501 | | | | | |
| 7 | 50 | 1.501 | | | | | |
| 8 | 60 | 1.5 | | | | | |
| 9 | 70 | 1.5 | | | | | |
| 10 | 80 | 1.501 | | | | | |
| 11 | 90 | 1.501 | | | | | |
| 12 | 100 | 1.501 | | | | | |
| 13 | 110 | 1.501 | | | | | |
| 14 | 120 | 1.5 | | | | | |
| 15 | 130 | 1.5 | | | | | |
| 16 | 140 | 1.5 | | | | | |
| 17 | 150 | 1.5 | | | | | |
| 18 | 160 | 1.5 | | | | | |
| 19 | 170 | 1.5 | | | | | |
| 20 | 180 | 1.5 | | | | | |
| 21 | 190 | 1.5 | | | | | |





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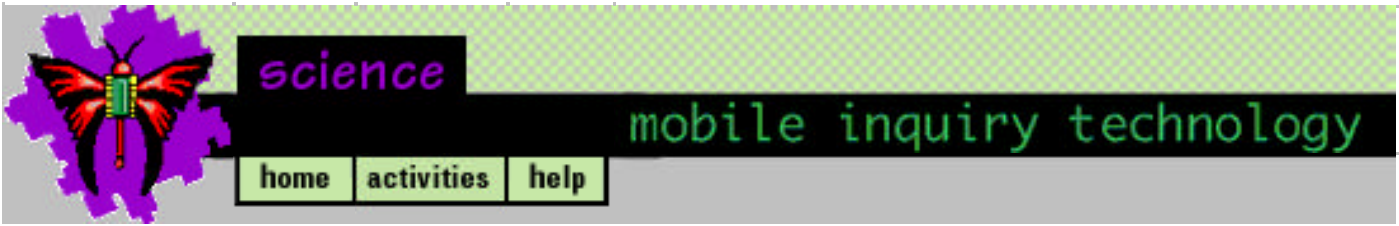
Decaying Batteries Technical Hints

To make a new x-y line graph:

1. Share data between groups by adding the data from each group that used another kind of battery to your spreadsheet. Ask your teacher how to make the transfer.
2. Open your spreadsheet and select a place away from your titled columns. Choose Paste from the Edit menu. The data that will be copied tells you interesting but extra data. Highlight just the time and voltage data and select Copy from the Edit menu. Place this data in the appropriate column based on the type of battery.
3. Highlight all of the data starting with Cell A1.
4. Select Make Chart from the Options menu. Click on x-y Line graph. To change from x marks the spot to solid circles, double click on the graph and select series. Choose the solid circle.

| | A | B | C | D | E | F | G |
|----|-----|-------|-----|-------|---|---|---|
| 45 | 430 | 1.499 | 430 | 1.506 | | | |
| 46 | 440 | 1.499 | 440 | 1.505 | | | |
| 47 | 450 | 1.5 | 450 | 1.506 | | | |
| 48 | 460 | 1.5 | 460 | 1.506 | | | |
| 49 | 470 | 1.499 | 470 | 1.503 | | | |
| 50 | 480 | 1.499 | 480 | 1.503 | | | |
| 51 | 490 | 1.499 | 490 | 1.502 | | | |
| 52 | 500 | 1.499 | 500 | 1.503 | | | |
| 53 | 510 | 1.499 | 510 | 1.503 | | | |
| 54 | 520 | 1.499 | 520 | 1.502 | | | |
| 55 | 530 | 1.499 | 530 | 1.502 | | | |
| 56 | 540 | 1.499 | 540 | 1.501 | | | |
| 57 | 550 | 1.499 | 550 | 1.501 | | | |
| 58 | 560 | 1.499 | 560 | 1.501 | | | |
| 59 | 570 | 1.499 | 570 | 1.5 | | | |
| 60 | 580 | 1.499 | 580 | 1.5 | | | |
| 61 | 590 | 1.499 | 590 | 1.5 | | | |
| 62 | 600 | 1.499 | 600 | 1.499 | | | |
| 63 | 610 | 1.499 | 610 | 1.499 | | | |
| 64 | 620 | 1.499 | 620 | 1.499 | | | |
| 65 | 630 | 1.499 | 630 | 1.499 | | | |
| 66 | 640 | 1.499 | 640 | 1.499 | | | |

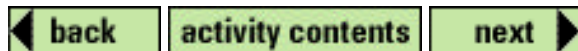
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Decaying Batteries Analysis

Answer the following questions on paper:

1. You have collected voltage data and made observations of one kind of cell in a circuit over a 30-minute period. Look at all the data that you have collected. Write a paragraph about what information the data gives you about what happen over the 30-minute period. Be sure to include in your description, information such as:
 - the beginning and final voltage readings
 - the range of the voltage data
 - the patterns in the data
2. You now have data from each type of cell on a graph. Compare the change in voltage for each type of cell? Write a paragraph about your observations. Include both description in words (one type decreased more or faster than another) and numerical description (one decreased by 0.8 volts while another decreased by 0.2 volts).
3. Now think about the data you collected about the size of cells in battery-powered electric devices. Write a paragraph describing your ideas about why devices that use the same number of 1.5-volt cells need different size batteries.





Decaying Batteries Further Investigation

- Compare the cost of different kinds of cells and how long they last in a circuit. Decide which cell would be the most economical to use.
- Design a way to test the D-cell battery while the flashlight is operating. Record the voltage change of the D-cell until it is depleted. Study the graph of the discharging battery.
- Recharge a depleted rechargeable battery. Test its voltage before and after the charge. Did the battery return to its labeled voltage?

