

LEAD STORAGE BATTERIES

LAB CALC.34

Two or more wet or dry cells connected in series make a battery. A car battery is generally a lead storage battery containing lead and lead oxide plates in sulfuric acid solution. In this experiment, you will construct a lead storage cell and use a direct-current power supply to charge it as shown in Figure 1. You will use a LabPro or CBL 2 interface and the voltage probe to measure the cell's voltage (see Figure 2), and then use the cell to power an electric motor.

OBJECTIVES

In this experiment, you will

- build a lead storage cell
- use a direct-current power supply to charge the cell
- use a TI Graphing Calculator, a LabPro or CBL 2 interface, and a Voltage Probe to measure the cell's voltage before and after use
- use the charged cell to power an electric motor
- make conclusions using the results of the experiment

MATERIALS

LabPro or CBL 2 interface
TI Graphing Calculator
DataMate program
Voltage Probe
2 lead strips (2 cm X 12 cm)
2 test leads

250-mL beaker
apron
2 alligator clips
sulfuric acid, H_2SO_4
clock (with second hand)
small electric motor/generator

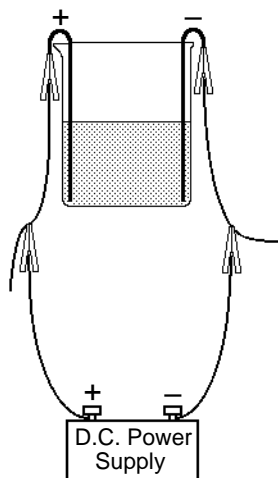


Figure 1

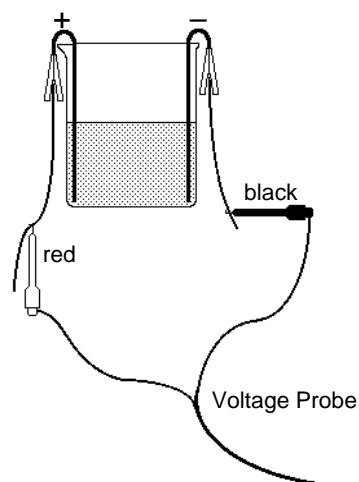


Figure 2

PROCEDURE

1. Obtain and wear goggles and an apron. **CAUTION:** The battery acid, H_2SO_4 , used in this experiment can damage eyesight and make holes in clothing!
2. Obtain two lead strips. If the strips have been used before, get one labeled (+) and one labeled (-). If the strips are not marked, label one (+) and the other (-). Bend the strips and place them in a 250-mL beaker as shown in Figure 1. Attach an alligator clip to each lead strip.
3. Add 125 mL of sulfuric acid solution, H_2SO_4 , to the beaker. Handle this strong acid with care!
4. Plug the Voltage Probe into Channel 1 of the LabPro or CBL 2 interface. Use the link cable to connect the TI Graphing Calculator to the interface. Firmly press in the cable ends.
5. Turn on the calculator and start the DATAMATE program. Press **CLEAR** to reset the program.
6. Set up the calculator and interface for the Voltage Probe.
 - a. Select SETUP from the main screen.
 - b. If the calculator displays the VOLTAGE (V) in CH 1, proceed directly to Step 7. If it does not, continue with this step to set up your sensor manually.
 - c. Press **ENTER** to select CH 1.
 - d. Select the Voltage Probe you are using from the SELECT SENSOR menu.
 - e. Select OK to return to the main screen.
7. Charge the cell using the direct-current power supply:
 - a. Attach the (-) lead from the power supply to the alligator clip on the (-) Pb electrode as shown in Figure 1.
 - b. Attach the (+) lead of the power supply to the alligator clip on the (+) Pb electrode to begin the charging process.
 - c. Time the charging process and disconnect the power supply leads after 4 minutes. Record observations during the charging process. **CAUTION:** *Make sure the lead strips do not touch each other while connected to the power supply.*
8. To measure the voltage of your lead storage cell, attach the *red clip* of the Voltage Probe to the alligator clip on the (+) electrode and the black clip to the alligator clip on the (-) electrode. After the voltage displayed on the screen stabilizes, record the value in your data table (round to the nearest 0.01 V).
9. Disconnect the black and red clips of the Voltage Probe from the cell. Use two wire leads to connect the cell to a small electric motor. Use a clock to measure the number of seconds the charged cell runs the motor. Record the results. The cell is said to be *discharging* during this process.

Lead Storage Batteries with Calculators

10. Attach the red lead of the Voltage Probe to the alligator clip on the (+) electrode and the black clip to the alligator clip on the (-) electrode. Measure the voltage of the *discharged* cell. Record this value.
11. Repeat Steps 7-10 using a 2-minute charging time.
12. Join with two other lab groups, connect your three cells, once in series and then in parallel, and measure the voltage and current produced by your battery.
13. When you are finished, select QUIT and exit the DATAMATE program..
14. Observe the two lead electrodes and record your observations. Return the H₂SO₄ solution to the "Used H₂SO₄" container supplied by your teacher. Wash and dry the beaker and the lead strips.

OBSERVATIONS

DATA TABLE

	1st Charging	2nd Charging
Voltage after charging (V)	_____	_____
Time motor ran after charging (s)	_____	_____
Voltage after discharge (V)	_____	_____
	Series	Parallel
Voltage of battery	_____	_____
Current of battery	_____	_____

PROCESSING THE DATA

1. Add the voltage after the first charging and the voltage after the second charging and then divide by 2 to calculate the average voltage of your cell when charged.
2. Cars generally have 12-volt batteries. How many lead storage cells, similar to the one you built, does a car battery contain? Explain.
3. How was the electrical energy used to power the electric motor produced?
4. The bubbles you saw produced at the (-) electrode during charging contained hydrogen gas. Why is there danger of an explosion during and after car battery charging?
5. Look up chemical equations for the charging and discharging reactions studied in this experiment. What was the substance that formed on the (+) strip during charging? Explain why “run-down” car batteries sometimes freeze up and break open in extremely cold weather.
6. Summarize what you have learned during this experiment.