**LEAD STORAGE BATTERIES**

**LAB LQ 34**

 From *Chemistry with Vernier*

Two or more wet or dry cells connected 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 build a lead storage cell and use the interface box to charge it. You will measure the cell’s voltage, and use the cell to power an electric motor.

# OBJECTIVES

In this experiment, you will

* build a lead storage cell
* use an interface box to charge the cell
* 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



# *Figure 1*

# MATERIALS

LabQuest 9 V battery

250 mL beaker 9 V battery clip

Voltage Probe clock (with second hand)

small electric motor sulfuric acid solution, H2SO4

2 test leads 2 lead strips (2 cm × 12 cm)

# PROCEDURE

1. Obtain and wear goggles.
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. DANGER: Solid lead, Pb: Do not eat or drink when using this product—harmful if swallowed or inhaled. Avoid breathing dust and fumes. May damage fertility or the unborn child. Inorganic lead compounds are probable human carcinogens. Do not handle until all safety precautions have been understood.
3. Add 125 mL of sulfuric acid solution, H2SO4, to the beaker. DANGER: Sulfuric acid, concentrated, H2SO4: Causes severe skin burns and eye damage. Do not breathe mist, vapors, or spray. Maybe be harmful if inhaled. Harmful to aquatic life. Considerable heat generated when diluted with water.
4. Connect the Voltage Probe to LabQuest and choose New from the File menu.
5. Charge the cell using the 9 V battery:
	1. Connect the 9 V battery clip to the battery if they are not yet connected.
	2. Use a test lead to connect the (–) terminal of the 9 V battery to the cell’s (–) Pb electrode, as shown in Figure 1.
	3. Use a second test lead to connect the (+) terminal of the 9 V battery to the alligator clip on the cell’s (+) Pb electrode to begin the charging process.
	4. Charge the lead storage battery for 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.
6. To measure the voltage of your cell, attach the red clip of the Voltage Probe to the test lead connected to the (+) lead strip and the black clip to the test lead connected to the (–) lead strip. After the voltage displayed in the meter stabilizes, record the value in your data table.
7. Disconnect the Voltage Probe clips from the wire leads. Use the 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.
8. Connect the Voltage Probe’s red clip to the wire lead on the (+) electrode and its black clip to the wire lead on the (–) electrode. Measure the voltage of the discharged cell. Record this value.
9. Repeat Steps 5–8 using a 2 minute charging time.
10. Observe the two lead electrodes and record your observations.
11. Return the H2SO4 solution to the “Used H2SO4” container supplied by your teacher. Wash and dry the beaker and the lead strips.

Processing the data

1. From the voltage values for the 1st and 2nd charging, calculate the average voltage of your cell when charged.
2. Cars generally have 12 V batteries. How many lead storage cells, similar to the one you built, does a car battery contain? Explain.
3. Using a Table of Standard Reduction Potentials, write the chemical equations occurring at the anode and cathode when the battery was discharging and behaving as a voltaic (electrochemical) cell. Write the standard potential value, E°, in the blank following the equation. In the third blank, write the net equation for the reaction by combining the two half-reactions. Find the E°total (or E°cell) by adding the E° values for the two half-reactions.
4. Find the percent error for the cell potential by comparing your experimental voltage value in Step 1 of Processing the Data with the accepted E°total value in Step 3.
5. What was the gas you saw being produced at the (–) electrode, during charging? What was the gas being produced at the (+) electrode? Account for the danger of an explosion after car battery charging.
6. Explain why “run-down” car batteries sometimes freeze up and break open in extremely cold weather. Hint: Examine the equation for the net reaction in the Data and Calculations table below.
7. When you charged and discharged the battery in this experiment, which process was electrolytic? Which was electrochemical (voltaic)? Explain.

|  |  |  |
| --- | --- | --- |
|   | 1st charging | 2nd charging |
| Voltage after charging | \_\_\_\_\_\_\_\_ V | \_\_\_\_\_\_\_\_ V |
| Time motor ran after charging | \_\_\_\_\_\_\_\_ s | \_\_\_\_\_\_\_\_ s |
| Voltage after discharge | \_\_\_\_\_\_\_\_ V | \_\_\_\_\_\_\_\_ V |

|  |
| --- |
| Average potential of charged cellV |
|                                                                         E°Equation Anode (–)   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_ VCathode (+)     \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_       \_\_\_\_\_\_\_ VNet reaction    \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_       \_\_\_\_\_\_\_\_ V |
| Percent error% |