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Experiment
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Lemon “Juice”

“Juice” is a slang term sometimes used for electricity. Batteries are made up of one or more cells. Cells often consist of two different materials in a solution that are connected to each other by a wire. In this experiment, you will study some basic principles of cells using the juice of a lemon as the cell solution. You will place small pieces of two different materials into the lemon, and a calculator will be used to measure and display the voltages produced.

OBJECTIVES

In this experiment, you will

- build several cells
- measure and display cell voltages
- discover which combinations produce a voltage
- decide which combination makes the “best” battery

MATERIALS

LabPro or CBL 2 interface
TI Graphing Calculator
DataMate or EasyData App.
Voltage Probe
2 alligator clips
a lemon
scalpel
graphite pencil (C)
iron nail (Fe)
magnesium strip (Mg)
zinc strip (Zn)
paper towel

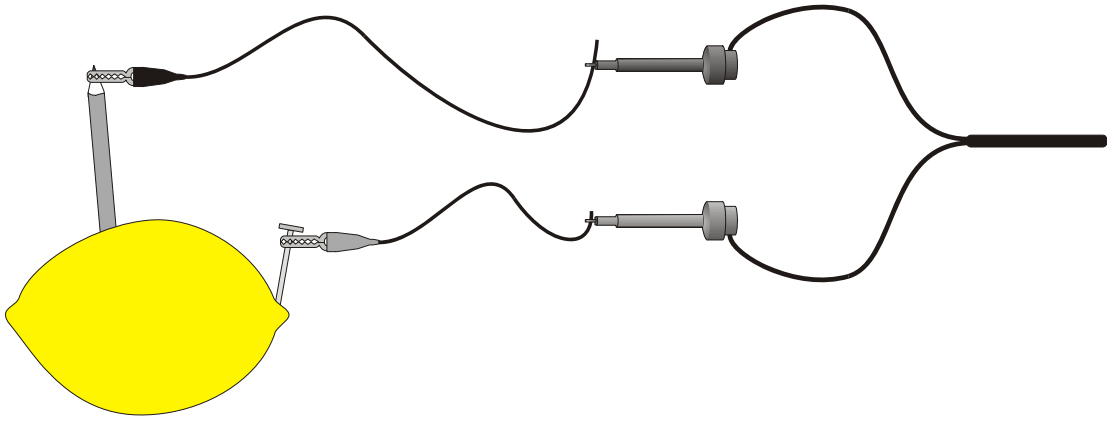

Figure 1

PROCEDURE

1. Use a pen to make two parallel marks 1 cm long and 2 cm apart on a lemon. Use a scalpel to cut 2 slits in the lemon peel at the marks.

2. Attach the red Voltage Probe lead to one alligator clip and the black lead to a second alligator clip as shown in Figure 1. You will be attaching the alligator clips to the test materials during this experiment in order to prevent corrosion of the probe leads.

3. 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.

4. Turn on the calculator and start the DATAMATE program. Press CLEAR to reset the program.

5. Insert a short graphite pencil, sharpened at both ends, into one of the slits and an iron nail into the other. Hook the alligator clip attached to the red probe lead to the pencil. Hook the alligator clip attached to the black probe lead to the iron nail.

6. Record the voltage reading. Observe whether the voltage reading stays constant, rises, or drops. Record your observations. Note: If the two leads of the voltage probe are not connected to a cell, a meaningless reading of about 2 volts is displayed.

7. Switch the positions of the alligator clips. Record the voltage reading and your observations.

8. Repeat Steps 5-7 for the other combinations listed in the Data table. Dry the materials after each use.

DATA

Probe lead		Voltage (V)	Observations	Probe lead		Voltage (V)	Observations
Red	Black			Red	Black		
C	Fe			Fe	C		
C	Mg			Mg	C		
C	Zn			Zn	C		
Fe	Mg			Mg	Fe		
Fe	Zn			Zn	Fe		
Mg	Zn			Zn	Mg		

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PROCESSING THE DATA

1. What happens to the voltage reading if a cell is hooked up backwards?

2. Which combination gives the highest voltage?

3. Which combination(s) gives the steadiest voltage?

4. Which combination would make the best battery? Explain.

5. The chemical activity of metal is shown by the size of the voltage reading when the metal is paired with carbon in a cell. A high voltage indicates high chemical activity. Rank the three metals (Fe, Mg, and Zn) according to chemical activity, from highest to lowest.

EXTENSIONS

1. Measure the voltage of "lemon cells" connected in series and in parallel.
2. Try the experiment using other fruits and vegetables.
3. Do the experiment using other metals, such as aluminum, copper, and lead.