

## Lemon “Juice”

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

### OBJECTIVES

In this experiment, you will

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

### MATERIALS

Macintosh or IBM-compatible computer  
Serial Box Interface or ULI  
Logger *Pro*  
Vernier Voltage Probe  
2 alligator clips  
a lemon

scalpel  
graphite pencil (C)  
iron nail (Fe)  
magnesium strip (Mg)  
zinc strip (Zn)  
paper towel

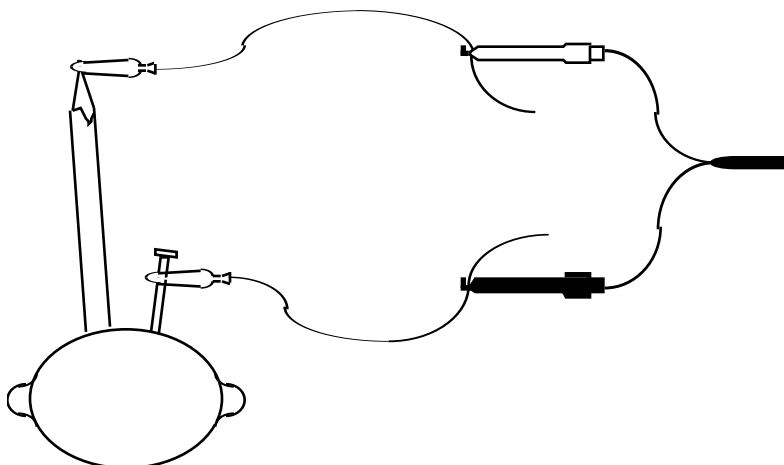


Figure 1

**PROCEDURE**

1. Use an ink 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 probe 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 voltage probe leads.
3. Prepare the computer for data collection by opening “Exp 33” from the *Physical Science with Computers* experiment files of *LoggerPro*.
4. Insert a short graphite pencil, sharpened at both ends, into one of the slots 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.
5. Record the voltage reading. Observe whether the voltage reading stays constant, rises, or drops. Record your observations.
6. Switch the positions of the alligator clips. Record the voltage reading and your observations.
7. Repeat Steps 4-6 for the other combinations listed in the Data Table. Dry the materials after each use.

**DATA**

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

## 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 - choose one.

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