



# Determination of the Charge on an Electron

Topical Unit of Instruction: Atomic Structure

Teacher's Edition

Rehab  
the  
LAB

## Introduction

There are no chemical consumables in this lab. The  $\text{ZnSO}_4$  can be reused from year to year indefinitely. After several years, it may no longer appear very pure, but it will still yield excellent results. The electrodes are also good for many years. To prolong battery life up to several years, they can be kept in the refrigerator or freezer. Recharging or recycling batteries will help keep batteries out of the landfills.

## Time

50 minutes for data collection

50 minutes for final balance readings and processing data

## Objectives

1. To determine the charge on an electron.
2. To gain experience setting up a circuit.

## Preparation

1. Use tin snips to cut electrodes from zinc sheet.
2. Place 228 g  $\text{ZnSO}_4 \cdot 7 \text{H}_2\text{O}$  in one-liter volumetric flask. Dissolve in about  $\frac{3}{4}$  L distilled  $\text{H}_2\text{O}$ . Dilute to volume. Solution will not be clear.

## Typical Results

1. a.  $\sim .70$  amperes  
b. 25 min.  $\times 60$  sec/min = 1500 sec  
c.  $0.70$  amp  $\times 1500$  sec =  $1.050 \times 10^3$  amp-sec
2.  $\sim .35$  g each, "+" electrode should lose mass and "-" electrode should gain mass
3.  $\sim [0.35\text{g} / (1.09 \times 10^{-22} \text{ g/Zn atom})] = 3.2 \times 10^{21}$  Zn atoms  
You will have to give students the mass of a Zn atom if you have not yet taught Avagadro's Number and moles!
4.  $\sim [(1.05 \times 10^3 \text{ amp-sec}) / (3.2 \times 10^{21} \text{ Zn atoms})] = 3.3 \times 10^{-19}$  [(amp-sec)/Zn atom]
5.  $\sim [(3.3 \times 10^{-19} \text{ [(amp-sec)/Zn atom]} / 2(\text{electrons/Zn atom}))] = 1.7 \times 10^{-19}$  (amp-sec)/electron =  $1.7 \times 10^{-19}$  (coulomb/electron)
6. % error =  $1(1.60 \times 10^{-19}) - (1.7 \times 10^{-19}) / (1.6 \times 10^{-19}) = 6.3\%$

## Materials

(For a class of 32 students working in pairs)

- 32 zinc electrodes ( $\sim 3 \times 10$  cm)
- 1 package steel wool (from hardware store)
- balances (sensitive to 0.01 g)
- 16 250 mL beakers
- $\sim 3.5$  L of 1.0 M  $\text{ZnSO}_4$
- 48 wire leads with alligator clips
- 16 battery holders – Frey (vendor) has great ones!
- 64 "D" batteries
- 16 ammeters (borrow from physics teacher)
- 8 squirt bottles with distilled  $\text{H}_2\text{O}$
- clock with second hand



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### Hints

1. It is imperative that you do this experiment before you have students do it! Although this should be standard practice for all science teachers introducing new labs into their curriculum, it is especially important for this activity.
2. Maintaining the current at 0.70 amps is not always an easy task. If it is too high, try bypassing a battery by placing the alligator clip on the aluminum post between the last two batteries on one end. If it is too low, try toggling the aluminum posts between the batteries or moving the electrodes in the beaker a little closer together. If your batteries are more than a couple of years old, check to make sure they still work the day before you intend to have students do the lab.
3. If your ammeters have more than one positive terminal, remind students to use the one that will allow them to read 0.70 amperes. Also, remind them to not let the electrodes touch each other. This may include some “fiddling” around with alligator clips during set-up.
4. Make sure you check each set-up before students add  $\text{ZnSO}_4$ . If you disconnect the “-“ terminal on the ammeter, they can pour the  $\text{ZnSO}_4$  in the beaker and easily reconnect the “-“ terminal without disrupting the rest of the circuit.
5. Although the mass change in the 2 electrodes should be similar (the amount lost by the “+” should be about the same as the mass gained by the “-“), the data from the “-“ electrode is usually more reliable. The Zn plated onto the “-“ electrode is usually fairly pure, whereas the mass lost from the “+” electrode may contain some impurities.
6. Students must use the same balance for all mass measurements. You may wish to number or label your balances to ensure that this happens.
7. If ammeters are in short supply, have students work in groups of three instead of pairs.
8. The calculations for this lab are not easy for some students, particularly if you choose to teach atomic structure before you teach moles. Working on the calculations together as a class will lower the anxiety of the less math-able students.

