

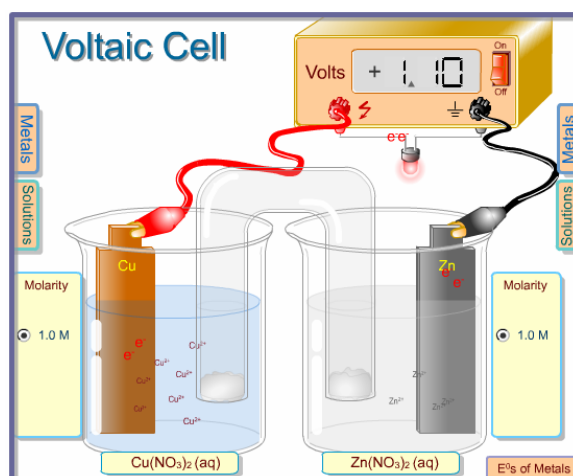
# Variation of Cell E.M.F. with Concentration

## Student Handout

**Purpose:** To investigate the effect of changes in ionic concentration on the e.m.f. of a cell.

### Introduction

In this activity, you will use a computer simulation to construct a zinc-copper electrochemical cell using  $\text{Zn}^{2+}(\text{aq})$  and  $\text{Cu}^{2+}(\text{aq})$  solutions. The concentration of copper ions is varied, keeping the zinc ion concentration constant, and the cell e.m.f. for each concentration of copper ions is measured. The procedure is then repeated, keeping the copper ion concentration constant and varying the zinc ion concentration.



### Tasks

1. Start the computer simulation by entering the URL below in a web browser equipped with Macromedia Shockwave Player and Flash Player.  
<http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/flashfiles/electroChem/voltaicCellEMF.html>
2. Construct an electrochemical cell with 1.0 M  $\text{Zn}(\text{NO}_3)_2(\text{aq})$  in the zinc half-cell and using each of the  $\text{Cu}(\text{NO}_3)_2(\text{aq})$  in turn. If the reading on the voltmeter is negative, reverse the connections to obtain a positive reading. Record your results in the table below.
3. Repeat step (2), using 1.0 M  $\text{Cu}(\text{NO}_3)_2(\text{aq})$  in the copper half-cell and using each of the  $\text{Zn}(\text{NO}_3)_2(\text{aq})$  in turn. Remember to “turn off” the voltmeter before each reconstruction.

| $[\text{Zn}^{2+}(\text{aq})]/\text{M}$ | $[\text{Cu}^{2+}(\text{aq})]/\text{M}$ | Cell e.m.f./V |
|----------------------------------------|----------------------------------------|---------------|
| 1                                      | 1                                      |               |
| 1                                      | 0.1                                    |               |
| 1                                      | 0.01                                   |               |
| 1                                      | 0.001                                  |               |
| 0.1                                    | 1                                      |               |
| 0.01                                   | 1                                      |               |
| 0.001                                  | 1                                      |               |

**Discussion Questions**

1. Write the overall equation for the reaction occurring in the cell.

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2. Account for the change in the e.m.f. of the cell as  $\text{Cu}(\text{NO}_3)_2(\text{aq})$  becomes more dilute.

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3. Account for the change in the e.m.f. of the cell as  $\text{Zn}(\text{NO}_3)_2(\text{aq})$  becomes more dilute.

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4. Does the e.m.f. variation with ion concentration in the simulation follow the predictions made by applying principle of chemical equilibrium to the above metal-metal ions systems?

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5. Use the Nernst equation to explain your answers to questions 2 and 3.

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6. Using the simulation, construct two electrochemical cells with e.m.f. greater than +1.10 V. Before doing the simulation, predict the e.m.f. of the cells. Write the chemical equation that represents the reaction occurring in these cells.

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