Name:_____Date:_____Block:____

Chapter 4 – Electrochemistry: Redox and Galvanic Cells

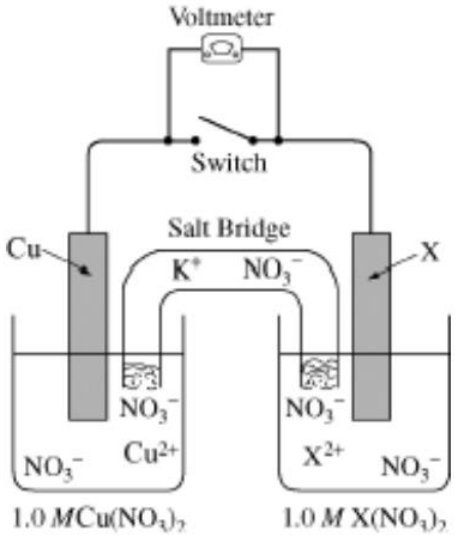
Super Problem

Answer the following questions below, which relate to reactions involving copper, Cu and copper(II) ion, Cu^{2+}.

A standard voltaic cell is constructed using copper and metal X. The standard reduction potential for Cu is given below.

$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$	$E^\circ = 0.34$ V

Immediately after closing the switch, the voltmeter shows a reading of 0.47 V. Several minutes later it was noted that small flakes were adhering to the Cu electrode.



(a) Which metal, Cu or X, is the anode? Justify your answer.

(b) In the diagram of the cell shown above, label the
- (i) cathode
- (ii) direction of electron flow

(c) Which substance is being oxidized, Cu or X? Explain.

(d) Determine the standard reduction potential for the X^{2+}/X half-cell.

(e) Using the information provided, select the metal that was used for the X electrode. Explain your choice.

$Ag^{+}(aq) + e^{-} \rightarrow Ag(s)$	$E^{\circ} = 0.80$ V
$Pb^{2+}(aq) + 2e^{-} \rightarrow Pb(s)$	$E^{\circ} = -0.13$ V
$Sn^{2+}(aq) + 2e^{-} \rightarrow Sn(s)$	$E^{\circ} = -0.14$ V

(f) Write a balanced net ionic equation for this electrochemical cell.

(g) This galvanic cell has a salt bridge that is filled with a saturated solution of KNO_3.

(i) As the cell operates, describe what happens in the salt bridge.

(ii) Describe what you would observe in the anode half-cell if the salt bridge contained a saturated solution of KCl instead of KNO_3.

(h) In the original galvanic cell, if the [Cu^{2+}] is changed from 1.0 M to 0.1 M, would the new cell potential, E_{cell}, at 25°C, increase, decreased, or remain the same? Justify your answer.

(i) For the original reaction in the galvanic cell above, indicate whether

(i) ΔG is positive or negative. Justify your choice.

(ii) the equilibrium constant, K, is greater than one or less than one. Justify your choice.

In another experiment, a 1.019 gram piece of Cu was cut from the electrode used above and added to 250. mL of 0.25 M nitric acid, HNO_3. An oxidation-reduction reaction between the copper and the nitrate ion occurs as indicated below.

$$Cu + NO_3^- \rightarrow Cu^{2+} + NO$$

(j) Write a complete and balanced net ionic equation for this redox reaction. Show work to support your answer.

(k) Identify the limiting reactant. Show work to support your answer.

(l) On the basis of the limiting reactant identified above, calculate the value of the concentration of Cu^{2+} ions after the reaction is complete.