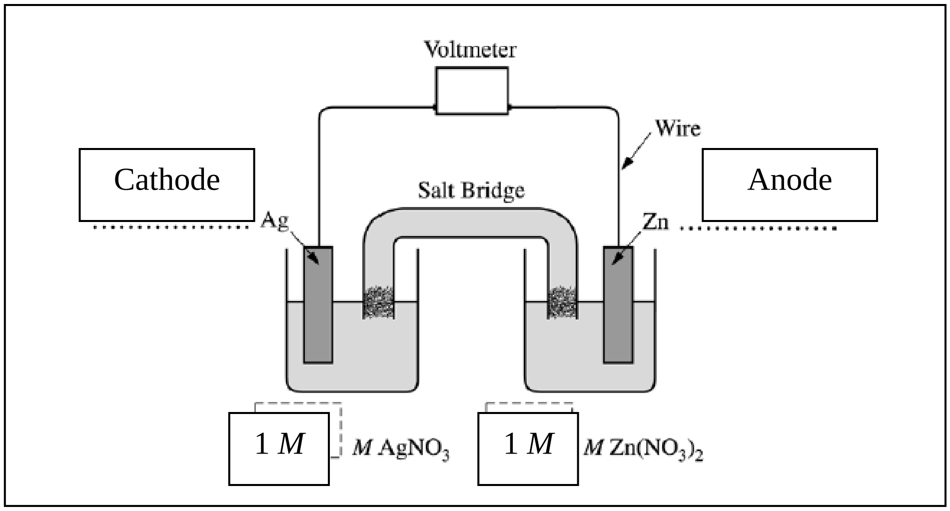
AP CHEMISTRY

TOPIC 11: ELECTROCHEMISTRY, REVIEW, PART I

Day 129:

A calculator is not needed to work these problems, from the free response questions that did not allow a calculator.



1. The following questions refer to the electrochemical cell shown in the diagram above.

(a) Write a balanced ionic equation for the spontaneous reaction that place in the cell.

Zn^{+2} (aq) + 2 e^{-1} → Zn (s) E^0 = – 0.76 V (flip this equation – for an oxidation reaction)

Ag^{+1} (aq) + e^{-1} → Ag (s) E^0 = + 0.80 V

Zn (s) + 2 Ag^{+1} (aq) → Zn^{+2} + 2 Ag (s)

(b) Calculate the standard cell potential, E^0, for the reaction in part (a).

Zn (s) → Zn^{+2} (aq) + 2 e^{-1} E^0 = + 0.76 V

Ag^{+1} (aq) + e^{-1} → Ag (s) E^0 = + 0.80 V

E^0_{cell} = (+ 0.76 V + + 0.80 V) = + 1.56 V

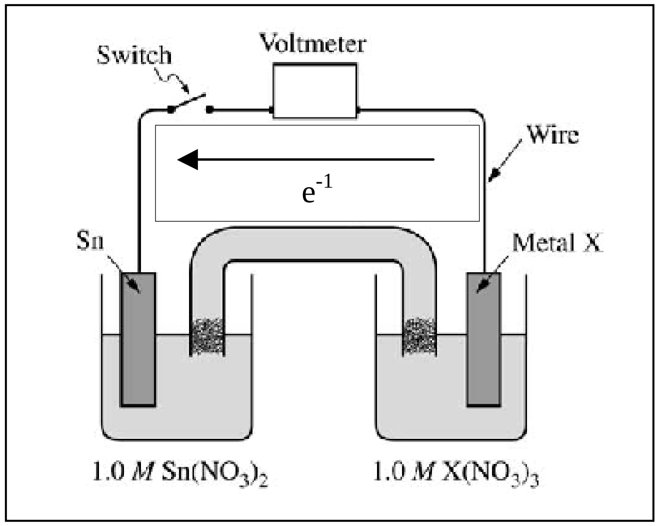
(c) In the diagram above,

(i) label the anode and cathode on the dotted lines provided, and

(ii) indicate, in the boxes below the half-cells, the concentrations of $AgNO_3$ and the concentration of $Zn(NO_3)_2$ that are needed to generate E^0.

(d) How will the cell potential be affected if KI is added to the silver half-cell? Justify your answer.

A precipitate will form as I^{-1} ions react with Ag^{+1} ions in solution in the cathode compartment. [Ag^{+1}] will be reduced, causing the cell potential to decrease.



2. An electrochemical cell is constructed with an open switch, as shown in the diagram above. A strip of Sn and a strip of an unknown metal, X, are used as electrodes. When the switch is closed, the mass of the Sn electrode increases. The half-reactions are shown below.

$$Sn^{+2}\,(aq) + 2\,e^{-1} \rightarrow Sn\,(s) \qquad E^0 = -\,0.14\text{ V}$$

$$X^{+3}\,(aq) + 3\,e^{-1} \rightarrow X\,(s) \qquad E^0 = ?$$

(a) In the diagram above, label the electrode that is the cathode. Justify your answer.

The Sn (tin) electrode is the cathode.

The INCREASE in mass indicates that reduction occurs at the Sn electrode.

$$Sn^{+2}\,(aq) + 2\,e^{-1} \rightarrow Sn\,(s)$$

(b) In the diagram above, draw an arrow indicating the direction of the electron flow in the external circuit when the switch is closed.

Electrons flow from Metal X to Sn – see arrow on diagram

(c) If the standard cell potential, E_{cell} , is + 0.60 V, what is the standard reduction potential, in volts, for the X^{+3} / X electrode?

Metal X (anode – oxidation) + Sn (cathode - reduction) = + 0.60 V

Metal X (+ 0.74 V) + Sn (- 0.15 V) = + 0.60 V

(d) Identify metal X.

Chromium

$$Cr\,(s) \rightarrow Cr^{+3}\,(aq) + 3\,e^{-1} \quad (+\,0.74\text{ V})$$

(e) Write a balanced net-ionic equation for the overall reaction occurring in the cell.

$$3\,Sn^{+2} + 2\,Cr \rightarrow 3\,Sn + 2\,Cr^{+3}$$

(f) In the cell, the concentration of Sn^{+2} is changed from 1.0 *M* to 0.50 *M*, and the concentration of X^{+3} is changed from 1.0 *M* to 0.10 *M*.

(i) Substitute all the appropriate values for determining the cell potential, E_{cell}, into the Nernst equation. (Do <u>not</u> do any calculations.)

$$E_{cell} = E^0_{cell} - \frac{0.0592}{n} \log \frac{[Cr^{+3}]^2}{[Sn^{+2}]^3}$$

$$E_{cell} = +0.60\ V - \frac{0.0592}{6} \log \frac{[0.10]^2}{[0.50]^3}$$

(ii) On the basis of your response in part (f) (i), will the cell potential, E_{cell}, be greater than, less than, or equal to the orginal E_{cell} ? Justify your answer.

E_{cell} will be greater (more positive). Since the Q ratio is a number less than 1, the log of the ratio will be negative. A negative times a negative is positive. Thus E_{cell} will increase.