Problem Set 9

1. For a galvanic cell at 298 K and made using nickel and cadmium electrodes immersed in solutions with a Ni^{2+} concentration of 0.15 M and a Cd^{2+} concentration of 0.50 M respectively:

a) Calculate the voltage for this cell if both solutions were at 1.0 M concentrations.

b) Calculate the voltage for this cell at the given solution concentrations.

c) Write the equation for the oxidation reaction that spontaneously occurs.

d) Write the equation for the reduction reaction that spontaneously occurs.

e) Write the equation for the overall reaction that spontaneously occurs.

f) Write an equation for Q for the overall reaction.

g) Calculate the change in Gibbs Free Energy for the overall reaction.

h) Determine the value of the equilibrium constant for the overall reaction.

i) Draw a diagram of the galvanic cell and show how the electrons flow, along with the reaction that occurs at each electrode.

j) Predict how the masses of each electrode change over time.

k) An Ampere (A) unit is used to measure electrical current; one Ampere represents a current flow of one Coulomb of charge per second. If a current of 10 mA flows for 30 minutes in the galvanic cell above, calculate the change in mass for each electrode.

2. Calculate the Nernst potential, in mV, for the bicarbonate ion that had extracellular and intracellular concentrations of 27 mM and 8 mM respectively. For a cell with a resting membrane potential of -70 mV, explain what would happen if a bicarbonate ion channel opened. Would this have an inhibitory or excitatory neural effect?

3. A semi-permeable membrane that is permeable to potassium ions, but not to iodide ions, separates a vessel into two compartments. KI solutions of 5.00 mM and 1.00 mM are poured into the two compartments at a temperature of 298K.

a) Calculate the voltage that develops across the membrane.

b) Draw and label a diagram that shows the two compartment concentrations and the sign of the potential gradient across the membrane.

c) Determine what occurs if the 1.00 mM solution is replaced with a 30.00 mM solution. Draw a labeled diagram.