Chem1B, General Chemistry II

1.) Radium-226 undergoes radioactive α-decay.

a.) Write the **balanced** nuclear reaction.

b.) If the half-life of radium-226 is 1.25×10^9 years, calculate the amount of radium-226 remaining in a rock that is 1.5×10^9 years old and originally 15 kg.

c.) Based on your answer from (b), how many kg of the produced element in (a) by decay are present after 1.5×10^9 years?

2.) A solution of 0.10 M $CuSO_4(aq)$ is electrolyzed for 1.00 hours by a current of 1.62 A. Calculate the amount of Cu(s), in g, deposited at the cathode.

3.) Consider the following equilibrium at 298K:

$$Cu^+(aq) + Ag^+(aq) \rightleftharpoons Cu^{2+}(aq) + Ag(s)$$

Calculate the reduction potential (E°_{red}) for $Cu^{2+}(aq) + e^- \rightarrow Cu^+(aq)$, given that $Ag^+ + 1\ e^- \rightarrow Ag(s)$ has a reduction potential of +1.98 V and the equilibrium constant (K_{eq}) is 6.29×10^{30}.

4.) Consider the following equilibrium:

$$2\ CO(g) + O_2(g) \rightleftharpoons 2\ CO_2(g) \qquad \text{At 533 K, } K_p = 4.56 \times 10^8$$

a.) Calculate ΔG° at 533 K, in kJ/mol, at equilibrium.

b.) Calculate ΔS_{rxn}, given that ΔS° CO = 197.7 J/K, ΔS° O_2 = 205.1 J/K, and ΔS° CO_2 = 213.7 J/K.

c.) Calculate the heat of formation of $CO_2(g)$ in kJ/mol, given that for CO, ΔH_f = -110.5 kJ/mol.

5.) Given the following:

$Cd^{2+}(aq) + 2\ e^- \longrightarrow Cd(s)$ $\qquad E^\circ_{red} = -0.403$ V
$Au^{3+}(aq) + 3\ e^- \rightarrow Au(s)$ $\qquad E^\circ_{red} = +1.52$ V

a.) Identify the **anode**. _____
b.) Identify the **cathode.** _____
c.) Write the **balanced** overall redox reaction between Cd and Au.

d.) Calculate E°_{cell}, in V.

e.) Calculate ΔG° in kJ/mol for the above reaction.

6.) Consider a radioactive atom of uranium-238 (mass: 238.0289 amu).

a.) Write the **balanced** nuclear equation for the α-decay of uranium-238.

b.) Calculate the energy change, in J, associated with this nuclear reaction (the elemental product weighs 232.0381 amu and the decayed particle weighs 4.00150 amu, m_e = 5.48580×10^{-4} amu, m_n = 1.00866 amu, m_p = 1.00728 amu).

c.) Uranium-238 can undergo sequential radioactive decay. Using your answer from (1), determine the final product when the product of (1) undergoes a further **two** β-decay reactions.

7.) Consider the following equilibrium:

$N_2(g) + 2\ O_2(g) \rightleftharpoons 2\ NO_2(g)$ ΔG° = +102.6 kJ/mol, ΔH° = -67.68 kJ/mol, ΔS° = -120.6 J/K

a.) Calculate the equilibrium constant (K_p) for this reaction.

b.) Calculate the temperature, in K, at which this equilibrium will begin to be spontaneous.

c.) Using your answer from (b), find the partial pressure of $NO_2(g)$ when the system is at equilibrium at that temperature if all the partial pressures are equal.