RDCH 702   Name:_____
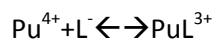Quiz 2
Assigned 10 October 12, Due 17 October 12

Quiz Topics: Speciation, Kinetics, Thermodynamics; Nuclear Reactions
Use the lecture notes, chart of the nuclides, table of the isotopes, and web links to answer the following
questions.

1. (30 Points) Consider the complexation of Pu^{4+} with a monoprotic ligand (LH). The reaction is:

$Pu^{4+}+L^{-}\leftarrow\rightarrow PuL^{3+}$

You measure the Pu and ligand speciation as a function of temperature at equilibrium. The equilibrium
data are below:

Table 1. Concentration of Pu and ligands species as a function of temperature (K)

T (K)	[PuL] M	$[L^{-}]_f$ M	$[Pu^{4+}]_f$ M
298	9.74E-07	5.26E-07	2.64E-08
298	9.54E-07	2.96E-07	4.59E-08
298	8.88E-07	1.12E-07	1.12E-07
283	9.28E-07	7.24E-08	7.24E-08
325	7.82E-07	2.18E-07	2.18E-07
335	7.32E-07	2.68E-07	2.68E-07
345	6.77E-07	3.23E-07	3.23E-07
355	6.19E-07	3.81E-07	3.81E-07
365	5.57E-07	4.43E-07	4.43E-07

Please provide the following. Ignore activities for this question.
   a. ΔG_{298}
   b.   The equilibrium constant at 298 K
   c. ΔH over the experimental range
   d. ΔS over the experimental range
   e.   Using the complexation constant calculate the speciation of Pu at 298 K for 1 mM ligand and 1
        M Pu.

2. (15 Points) Using CHESS, provide speciation data for the following conditions. You should show the graphs of % species against the condition.   Discuss the speciation of U and Pu as a function of concentration and Eh for the 5 conditions below. Provide dominant species for each evaluated condition.

    a.   1E-6 M/L Pu^{4+} from pH 2 to pH 12
    b.   1E-6 M/L UO_2^{2+} from pH 2 to pH 12
    c.   1E-3 M/L UO_2^{2+} from pH 2 to pH 12 at 200 mV Eh
    d.   1 mmol/L Pu^4+ from 200 mV to 1250 mV Eh at pH 2

3. (15 Points) Determine the number of atoms and activity of ^{88}Rb produced from the exposure of 1 g of Rb metal to a neutron flux of 10^{14} n/cm^2/sec

      a. 300 seconds

      b. 1 hour

4. (10 Points) Find the Q value, threshold energy, and Coulomb barrier for the following. You can use http://www.nndc.bnl.gov/qcalc/ for the Q value.

      a. The reaction of ^{59}Co and an alpha particle that produces a neutron and the product nuclei

      b. The reaction of a proton and ^{209}Bi to produce ^{206}Pb

5. (10 Points) Set up the equations to describe the speciation of uranyl, uranyl monocarbonate, and the uranyl dicarbonate using the complexation constants. This equation should show the total uranyl concentration as a function of free uranyl, free carbonate, and the complexation constants.

6. (10 Points) Describe the s-process in nucleosynthesis. What isotope range is produced through this process?

7. (10 Points) Identify which isotopes from the list below would be produced during the r-process
    a. ^{100}Ru
    b. ^{100}Mo
    c. ^{124}Te
    d. ^{130}Te
    e. ^{128}Te
    f. ^{112}Sn
    g. ^{115}Sn
    h. ^{122}Sn
    i. ^{124}Sn
    j. ^{209}Bi
    k. ^{238}U
    l. ^{244}Pu