RDCH 702   Last Name:_____
Quiz 5
Assigned 2 December 15   First Name:_____
Due 9 November 15
Post questions to the blog (http://rdch702.blogspot.com/2015/12/fall-2015-rdch-702-quiz-5.html)

Quiz Topics
Lecture 9 Separations
Lecture 10 In reactor chemistry

Use the lecture notes, chart of the nuclides, table of the isotopes, and web links to answer the following questions.

1. (30 Points) An experiment is performed with ^{241}Am. Data from the experiment is below. In this study the extraction of Am into an organic phase is examined. The ligand (L) is a protonated organic soluble ligand; it is only present only in the organic phase. At the start of the experiment all the Am is in 1 mL of aqueous phase, listed as Am aq Initial (Bq/mL) in the table. A 1 mL organic phase containing the ligand L at different concentrations is added to the aqueous phase and mixed for 5 minutes. After phase separation a 100 µL sample is removed and analyzed by scintillation counting, with the results listed as Am org (Bq/mL).

   1.1. Complete the data table below. Am aq final (Bq/mL) is the equilibrium Am concentration in the aqueous phase. Ignore any error in the values.

Am aq Initial (Bq/mL)	[L] M	Am org (Bq/mL)	Am aq final (Bq/mL)	K_d
1000	7.50E-04	572	_____	_____
1000	1.00E-03	760	_____	_____
1000	2.50E-03	980	_____	_____
1000	5.00E-03	997	_____	_____

   1.2. The extracted Am species is AmL_x. What is the value of x? _____

   1.3. What type of solvent extraction mechanism is responsible for the Am extraction?

_____

2. (20 Points) The separation of Pu from U in PUREX is achieved by reduction.

2.1. What is the reduced metal ion that is backextracted from the organic phase to the aqueous

phase? _____

2.2. Select a suitable reductant that can be used in the PUREX process.

☐ H_2 ☐ $[Fe(CN)_6]^{4-}$ ☐ $NH_3OH^+NO_3^-$ ☐ Na   ☐ U^{4+} ☐ $Fe(H_2NO_3S)_2$

2.3. What is a suitable nitric acid concentration for the initial extraction of U and Pu into the organic

phase? _____

2.4. What is the organic ligand in the PUREX process? _____

2.5. What is the oxidation state of initially extracted uranium? _____

3. (30 Points) Consider an oxide fuel in a reactor that has 100 % UO_2 at the beginning of life. Assume
the initial charge of the uranium is 1000 g/ kg of metal. This means uranium is 100 % of the metal in
the fuel at the beginning of life. As the fuel fissions actinides and fission products build in. Answer
the following.

3.1. What percentage of the uranium remains after a burnup of 52.0 MWd/kg HM?

_____ %

3.2. How much Pu is in the fuel after a burnup of 39.0 MWd/kg HM?

_____ g/kg of metal

3.3. At a burnup of 39.0 MWd/kg HM which fission product has the highest concentration in g/kg of
metal?

_____

3.4. Would you expect to find more Zr or Mo in used nuclear fuel?

_____

3.5. Estimate the percentage of remaining uranium at 100 MWd/kg HM.

_____%

3.6. Estimate the necessary burnup that results in the removal of 50 % of the uranium.

_____ MWd/kg HM

4. (10 Points) Provide a route for the separation of uranium from plutonium with a strong base anion exchange resin using a nitric acid aqueous phase.

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5. (10 Points) What is the basic premise for separation by pyroprocessing.

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