Chemistry 106, Review for Final

Chapter 10

1. An aqueous solution is 27.0% LiCl (molar mass 42.4 g) by mass. The density of the solution is 1.127 g/mL. What's the molarity? ans. 7.2 M What's the molality? ans. 8.7 m

2. Arginine vasopression is a pituitary hormone. An aqueous solution containing 21.6 mg of vasopressin in 100.0 mL of solution has an osmotic pressure of 3.70 mmHg at 298 K. What's the molar mass? ans. 1085 g

3. A solution of 2.00 g of para-dichlorobenzene in 50.0 g of cyclohexane freezes at 1.05°C. What is the molar mass of para-dichlorobenzene? The freezing point of pure cyclohexane is 6.6°C and K_f for cyclohexane is 20.4°C/m. ans. 1.5 x 10^2 g/mole

Chapter 11

4. The decomposition of N_2O_5 to NO_2 and O_2 is first order, with a rate constant of 4.80 x 10^{-4} s^{-1} at 45°C.

$$\ln\frac{[A]_0}{[A]} = kt$$

a. If the initial concentration is 1.65 x 10^{-2} mol/L what is the concentration after 835 s? ans. 0.0111 mol/L
b. How long will it take for the initial concentration to decrease by 39.4%? ans. 17.4 min

5. Nitric acid can be reduced with hydrogen gas to give nitrogen and water vapor.

$2NO + 2H_2 \rightarrow N_2 + 2H_2O$

A proposed mechanism is

$2NO \leftrightarrow N_2O_2$ (fast)
$N_2O_2 + H_2 \rightarrow N_2O + H_2O$ (slow)
$N_2O + H_2 \rightarrow N_2 + H_2O$ (fast)

What rate law is predicted by this mechanism? ans. rate = $k[NO]^2[H_2]$

6. The rate of the reaction

$HgCl_2 + 1/2C_2O_4^{2-} \rightarrow Cl^- + CO_2 + 1/2Hg_2Cl_2$

is followed by measuring the number of moles of Hg_2Cl_2 that precipitate per liter per second. The following data are obtained:

$[HgCl_2]$	$[C_2O_4^{2-}]$	Initial rate (mol/L min)
0.020	0.020	6.24 x 10^{-8}
0.060	0.020	1.87 x 10^{-7}
0.020	0.040	2.49 x 10^{-7}

a. Write the rate expression for the reaction. ans. rate = $k[HgCl_2][C_2O_4^{2-}]^2$
b. Calculate k for the reaction. ans. 0.0078 $\frac{L^2}{mol^2 \min}$

7. The order of a reaction with respect to some reagent is determined to be 2nd order. If the concentration of that reactant is doubled what affect will that have on the reaction rate?

Chapter 12

8. Consider the following reaction:

$CO(g) + 2H_2(g) \leftrightarrow CH_3OH(g)$ $\Delta H^o = -21.7$ kcal

a. How is the amount of CH_3OH affected by raising the temperature?
b. How is the amount of CH_3OH affected by removing $H_2(g)$
c. How is the amount of CH_3OH affected by decreasing the size of the container?
d. How is the amount of CH_3OH affected by adding Ar?

ans. a. CH_3OH decreases b. decreases c. increases d. no change

9. Consider the following equilibrium system:

$N_2(g) + 3H_2(g) \leftrightarrow 2NH_3(g)$

Originally the system contains only N_2 at a pressure of 2.5 atm and H_2 at a pressure of 7.5 atm. The equilibrium partial pressure of NH_3 is found to be 0.2 atm. Calculate the pressures of N_2 and H_2 and equilibrium. Calculate K. ans. $P_{N2} = 2.4$, $P_{H2} = 7.2$, $K = 4.47 \times 10^{-5}$

Chapter 13

10. The hypochlorite ion, ClO^-, is the active ingredient in household bleach. It is a weak base with a $K_b = 3.3 \times 10^{-7}$. Calculate the pH and pOH of a 0.12 M solution of ClO^- in water. ans. pOH = 3.7, pH = 10.3

11. Calculate the pH of a solution containing 5.0 g of $NaHCO_3$ (molar mass = 84.0 g) in 250. mL of H_2O. $NaHCO_3$ is amphiprotic, $k_a = 4.7 \times 10^{-11}$, $k_b = 2.3 \times 10^{-8}$. ans. pH = 9.9

12. Predict whether aqueous solutions of the following compounds are acidic, basic, or neutral.
a. NH_4Br
b. $AlCl_3$
c. Na_3PO_4
d. K_2SO_4

13. Saccharin, $\boldsymbol{H}NC_7H_4SO_3$, a sugar substitute, is a weak acid. A 0.10 M solution of saccharin has a pH of 1.71. Calculate the K_a and the percent ionization for saccharin. ans. 4.72×10^{-3}, % ion. = 19.5 %

Chapter 14

14. 5.4 g $HCHO_2$ (molar mass = 46.0 g, $K_a = 1.9 \times 10^{-4}$) is mixed with 3.0 g $NaCHO_2$ (molar mass 68.0 g/mole, $k_b = 5.3 \times 10^{-11}$).
a. What's the pH? ans. pH = 3.3
b. What's the pH after 2.0 g NaOH (molar mass = 40.0 g) is added? ans. pH = 3.9

15. A 0.40 M solution of KOH is used to titrate 25.00 mL of 0.50 M benzoic acid ($K_a = 6.6 \times 10^{-5}$).
a. What volume of KOH is required to reach the equivalence point? ans. 31.25 mL
b. What's the pH before any KOH is added? ans. 2.24
c. What's the pH halfway to the equivalence point? ans. 4.18
d. What's the pH of the solution at the equivalence point? ans. 8.76

Chapter 15

16. For the following coordination compound give the formulas for the counter ion, complex ion, ligands, central metal cation, coordination number, and predicted geometry.

$Ca[Ni(H_2O)_2Cl_2(OH)_2]$

ans. Ca^{2+}, $[Ni(H_2O)_2Cl_2(OH)_2]^{2-}$, H_2O, Cl^{1-}, OH^{1-}, Ni^{2+}, six, octahedral

Chapter 16

17. Calculate the solubility of LaF_3 in moles per liter in a 0.025 M KF solution. Ksp for $LaF_3 = 2 \times 10^{-19}$.
ans. 1.28×10^{-14} mole/L

18. Will Ag_2SO_4 precipitate when 100 mL of 0.050 M $AgNO_3$ is mixed with 10 mL of 0.01 M Na_2SO_4 solution? Ksp for $Ag_2SO_4 = 1.5 \times 10^{-5}$. ans. P = 1.9×10^{-6}, no precipitate forms

19. Which of the following is/are more soluble in an acidic solution than in pure water?
$MnSO_3$
$BiCl_3$
$Ba_3(PO_4)_2$

Chapter 17

20. For the following process calculate ΔS^o, ΔH^o and ΔG^o at 25°C (298 K).

$P_4O_{10}(s) + 6H_2O(l) \rightarrow 4H_3PO_4(aq)$

	ΔH_f^o	S^o
$P_4O_{10}(s)$	-2675.2 kJ/mol	228.9 J/K
$H_2O(l)$	-237.13 kJ/mol	69.9 J/K
$H_3PO_4(aq)$	-1142.6kJ/mol	158.2 J/K

ans. ΔS^o = -15.56 J/K, ΔH^o = -472.42 KJ, ΔG^o = -467.8 KJ

21. Consider the following reaction.

$2POCl_3(g) \rightarrow 2PCl_3(g) + O_2(g)$

At 25°C, ΔH^o = 572 kJ and ΔS^o = 179 J/K

This reaction is not spontaneous under standard conditions at 25°C. At what temperature will the reaction become spontaneous? ans. 2923°C

Chapter 18

22. Draw a voltaic cell diagram for the following reaction. Also, write the abbreviated cell notation.
$Fe(s) + 2H^+ \rightarrow Fe^{2+} + H_2(g)$

23. For the following cell reaction write the balanced half reactions and the overall balanced chemical equation

$Pt|Cl_2|ClO_3^-||O_2|H_2O|Pt$

Also, calculate E^o for this cell.
ans. $4H_2O + 4Cl_2 + 10\ O_2 \rightarrow 8ClO_3^- + 8H^+$, E^o = -0.229V

24. Using standard potentials and showing your work decide whether Fe(s) will be oxidized to Fe^{2+} by treatment with HCl at standard conditions. ans. E^o = +0.409 V, Fe(s) will be oxidized

25. Arrange the following reducing agents in order (from left to right) of increasing strength.
Zn, Cl^-, Cu^+

ans. $Cl^- < Cu+ < Zn$

26. Arrange the following oxidizing agents in order (from left to right) of increasing strength.
Sn^{2+}, $PbSO_4$, Cl_2

ans. $PbSO_4 < Sn^{2+} < Cl_2$

27. Consider a voltaic cell in which the following reaction takes place.

$3O_2(g) + 4NO(g) + 2H_2O(l) \rightarrow 4NO_3^-(aq) + 4H^+(aq)$ $\quad E^o = 0.265$ V

Calculate E under the following conditions.
T = 298 K
$[NO_3^-] = 0.750$ M
pH = 2.85
$P_{NO} = 0.993$ atm
$P_{O2} = 0.515$ atm

$$E = E^o - \frac{RT}{nF}\ln Q$$

F= 9.648×10^4 J/mole V
R = 8.31 J/mole K

ans. 0.319 V

Chapter 19
28. Complete the following equations, using appropriate notations and formulas:
a. $^{10}_{4}Be \rightarrow ? + ^{10}_{5}B$
b. $^{210}_{83}Bi \rightarrow ^{4}_{2}He + ?$
c. $^{15}_{8}O \rightarrow ? + ^{15}_{7}N$
d. $^{44}_{22}Ti + ^{0}_{-1}e \rightarrow ?$
e. $^{8}_{4}Be \rightarrow ? + ^{4}_{2}He$
f. $^{46}_{23}V \rightarrow ? + ^{46}_{22}Ti$
g. $^{41}_{20}Ca + ^{0}_{-1}e \rightarrow ?$

ans. a. $^{0}_{-1}e$ b. $^{206}_{81}Tl$ c. $^{0}_{1}e$ d. $^{44}_{21}Sc$ e. $^{4}_{2}He$ f. $^{0}_{1}e$ g. $^{41}_{19}K$

29. Carbon from a cypress beam obtained from an ancient tomb gave 9.2 disintegrations/minute/ g C. Carbon from living material gives 15.3 disintegrations/minute/ g C. Carbon-14 has a half-life of 5730 y. How old is the beam? ans. 4204 y

30. Calculate the mass defect, binding energy (J/mole), and binding energy per nucleon (J/mole·nucleon) for $^{14}_{6}C$.

proton = 1.00728 amu
neutron = 1.00867 amu
$^{14}_{6}C = 13.99995$ amu
$c = 3.00 \times 10^8$ m/s

ans. $\Delta m = -0.1131$ g/mole, $E = 1.02 \times 10^{13}$ J/mole, E/nucleon = 7.29×10^{11} J/mole·nucleon

Other stuff:
Know terms from the chapter on electrochemistry.

Review the electroplating problems from the chapter on electrochemistry.

Know the information in the table for types of radiation.

Explain what affect the following has on the nucleus of an atom:
Beta emission
K-electron capture
positron emission
gamma ray emission

Draw and label a diagram form a nuclear power plant.