

## Chemistry 106, Review for Final

### Chapter 10

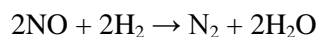
1. An aqueous solution is 27.0% LiCl (molar mass 42.4 g) by mass. The density of the solution is 1.127 g/mL. What's the molarity? ans. 7.2 M What's the molality? ans. 8.7 m
2. Arginine vasopressin is a pituitary hormone. An aqueous solution containing 21.6 mg of vasopressin in 100.0 mL of solution has 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.  $1.5 \times 10^2$  g/mole

### Chapter 11

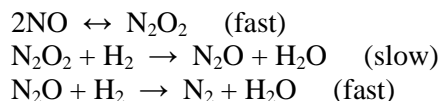
4. The decomposition of  $N_2O_5$  to  $NO_2$  and  $O_2$  is first order, with a rate constant of  $4.80 \times 10^{-4} \text{ s}^{-1}$  at 45°C.

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

- a. If the initial concentration is  $1.65 \times 10^{-2} \text{ mol/L}$  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.



A proposed mechanism is



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

6. The rate of the reaction



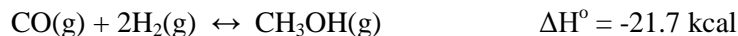
is followed by measuring the number of moles of  $Hg_2Cl_2$  that precipitate per liter per second. The following data are obtained:

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

- a. Write the rate expression for the reaction. ans.  $\text{rate} = k[HgCl_2][C_2O_4^{2-}]^2$
  - b. Calculate k for the reaction. ans.  $0.0078 \frac{L^2}{mol^2 \text{ min}}$
7. The order of a reaction with respect to some reagent is determined to be 2<sup>nd</sup> order. If the concentration of that reactant is doubled what affect will that have on the reaction rate?

## Chapter 12

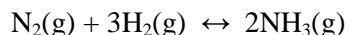
8. Consider the following reaction:



- How is the amount of  $\text{CH}_3\text{OH}$  affected by raising the temperature?
- How is the amount of  $\text{CH}_3\text{OH}$  affected by removing  $\text{H}_2\text{(g)}$ ?
- How is the amount of  $\text{CH}_3\text{OH}$  affected by decreasing the size of the container?
- How is the amount of  $\text{CH}_3\text{OH}$  affected by adding Ar?

ans. a.  $\text{CH}_3\text{OH}$  decreases b. decreases c. increases d. no change

9. Consider the following equilibrium system:



Originally the system contains only  $\text{N}_2$  at a pressure of 2.5 atm and  $\text{H}_2$  at a pressure of 7.5 atm. The equilibrium partial pressure of  $\text{NH}_3$  is found to be 0.2 atm. Calculate the pressures of  $\text{N}_2$  and  $\text{H}_2$  and equilibrium. Calculate K. ans.  $P_{\text{N}_2} = 2.4$ ,  $P_{\text{H}_2} = 7.2$ ,  $K = 4.47 \times 10^{-5}$

## Chapter 13

10. The hypochlorite ion,  $\text{ClO}^-$ , 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  $\text{ClO}^-$  in water. ans. pOH = 3.7, pH = 10.3

11. Calculate the pH of a solution containing 5.0 g of  $\text{NaHCO}_3$  (molar mass = 84.0 g) in 250. mL of  $\text{H}_2\text{O}$ .  $\text{NaHCO}_3$  is amphoteric,  $k_a = 4.7 \times 10^{-11}$ ,  $k_b = 2.3 \times 10^{-8}$ . ans. pH = 9.9

12. Predict whether aqueous solutions of the following compounds are acidic, basic, or neutral.

- $\text{NH}_4\text{Br}$
- $\text{AlCl}_3$
- $\text{Na}_3\text{PO}_4$
- $\text{K}_2\text{SO}_4$

13. Saccharin,  $\text{HC}_7\text{H}_4\text{SO}_3$ , 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.  $4.72 \times 10^{-3}$ , % ion. = 19.5 %

## Chapter 14

14. 5.4 g  $\text{HCHO}_2$  (molar mass = 46.0 g,  $K_a = 1.9 \times 10^{-4}$ ) is mixed with 3.0 g  $\text{NaCHO}_2$  (molar mass 68.0 g/mole,  $k_b = 5.3 \times 10^{-11}$ ).

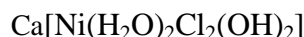
- What's the pH? ans. pH = 3.3
- What's the pH after 2.0 g NaOH (molar mass = 40.0 g) is added? ans. pH = 3.9

15. A 0.40 M solution of KOH is used to titrate 25.00 mL of 0.50 M benzoic acid ( $K_a = 6.6 \times 10^{-5}$ ).

- What volume of KOH is required to reach the equivalence point? ans. 31.25 mL
- What's the pH before any KOH is added? ans. 2.24
- What's the pH halfway to the equivalence point? ans. 4.18
- 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.



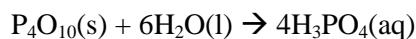
ans.  $\text{Ca}^{2+}$ ,  $[\text{Ni}(\text{H}_2\text{O})_2\text{Cl}_2(\text{OH})_2]^{2-}$ ,  $\text{H}_2\text{O}$ ,  $\text{Cl}^-$ ,  $\text{OH}^-$ ,  $\text{Ni}^{2+}$ , six, octahedral

## Chapter 16

17. Calculate the solubility of  $\text{LaF}_3$  in moles per liter in a 0.025 M KF solution.  $K_{sp}$  for  $\text{LaF}_3 = 2 \times 10^{-19}$ .  
ans.  $1.28 \times 10^{-14}$  mole/L
18. Will  $\text{Ag}_2\text{SO}_4$  precipitate when 100 mL of 0.050 M  $\text{AgNO}_3$  is mixed with 10 mL of 0.01 M  $\text{Na}_2\text{SO}_4$  solution?  
 $K_{sp}$  for  $\text{Ag}_2\text{SO}_4 = 1.5 \times 10^{-5}$ . ans.  $P = 1.9 \times 10^{-6}$ , no precipitate forms
19. Which of the following is/are more soluble in an acidic solution than in pure water?  
 $\text{MnSO}_3$   
 $\text{BiCl}_3$   
 $\text{Ba}_3(\text{PO}_4)_2$

## Chapter 17

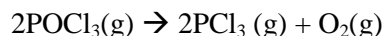
20. For the following process calculate  $\Delta S^\circ$ ,  $\Delta H^\circ$  and  $\Delta G^\circ$  at  $25^\circ\text{C}$  (298 K).



	$\Delta H_f^\circ$	$S^\circ$
$\text{P}_4\text{O}_{10}(\text{s})$	-2675.2 kJ/mol	228.9 J/K
$\text{H}_2\text{O}(\text{l})$	-237.13 kJ/mol	69.9 J/K
$\text{H}_3\text{PO}_4(\text{aq})$	-1142.6 kJ/mol	158.2 J/K

ans.  $\Delta S^\circ = -15.56$  J/K,  $\Delta H^\circ = -472.42$  KJ,  $\Delta G^\circ = -467.8$  KJ

21. Consider the following reaction.



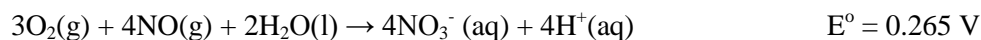
At  $25^\circ\text{C}$ ,  $\Delta H^\circ = 572$  kJ and  $\Delta S^\circ = 179$  J/K

This reaction is not spontaneous under standard conditions at  $25^\circ\text{C}$ . At what temperature will the reaction become spontaneous? ans.  $2923^\circ\text{C}$

## Chapter 18

22. Draw a voltaic cell diagram for the following reaction. Also, write the abbreviated cell notation.  
 $\text{Fe}(\text{s}) + 2\text{H}^+ \rightarrow \text{Fe}^{2+} + \text{H}_2(\text{g})$
23. For the following cell reaction write the balanced half reactions and the overall balanced chemical equation  
 $\text{Pt}|\text{Cl}_2|\text{ClO}_3^-||\text{O}_2|\text{H}_2\text{O}|\text{Pt}$
- Also, calculate  $E^\circ$  for this cell.  
ans.  $4\text{H}_2\text{O} + 4\text{Cl}_2 + 10 \text{O}_2 \rightarrow 8\text{ClO}_3^- + 8\text{H}^+$ ,  $E^\circ = -0.229\text{V}$
24. Using standard potentials and showing your work decide whether  $\text{Fe}(\text{s})$  will be oxidized to  $\text{Fe}^{2+}$  by treatment with HCl at standard conditions. ans.  $E^\circ = +0.409$  V,  $\text{Fe}(\text{s})$  will be oxidized
25. Arrange the following reducing agents in order (from left to right) of increasing strength.  
 $\text{Zn}$ ,  $\text{Cl}^-$ ,  $\text{Cu}^+$
- ans.  $\text{Cl}^- < \text{Cu}^+ < \text{Zn}$
26. Arrange the following oxidizing agents in order (from left to right) of increasing strength.  
 $\text{Sn}^{2+}$ ,  $\text{PbSO}_4$ ,  $\text{Cl}_2$
- ans.  $\text{PbSO}_4 < \text{Sn}^{2+} < \text{Cl}_2$

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



Calculate E under the following conditions.

$$T = 298 \text{ K}$$

$$[\text{NO}_3^-] = 0.750 \text{ M}$$

$$\text{pH} = 2.85$$

$$P_{\text{NO}} = 0.993 \text{ atm}$$

$$P_{\text{O}_2} = 0.515 \text{ atm}$$

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

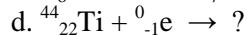
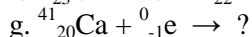
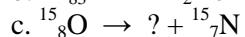
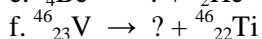
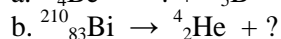
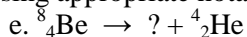
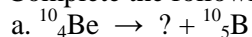
$$F = 9.648 \times 10^4 \text{ J/mole V}$$

$$R = 8.31 \text{ J/mole K}$$

$$\text{ans. } 0.319 \text{ V}$$

### Chapter 19

28. Complete the following equations, using appropriate notations and formulas:



$$\text{ans. a. } {}^0_{-1}\text{e} \quad \text{b. } {}^{206}_{81}\text{Tl} \quad \text{c. } {}^0_{-1}\text{e} \quad \text{d. } {}^{44}_{21}\text{Sc} \quad \text{e. } {}^4_2\text{He} \quad \text{f. } {}^0_{-1}\text{e} \quad \text{g. } {}^{41}_{19}\text{K}$$

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  ${}^{14}_6\text{C}$ .

$$\text{proton} = 1.00728 \text{ amu}$$

$$\text{neutron} = 1.00867 \text{ amu}$$

$${}^{14}_6\text{C} = 13.99995 \text{ amu}$$

$$c = 3.00 \times 10^8 \text{ m/s}$$

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

### 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.