CHM 1311 E **Final Exam** **Dec 9th 2010**

(Prof. S. Gambarotta)

Your Name: _____ **Student #:** _____

1. ***Deliver the entire booklet intact and stapled***
2. You must respond to **ALL** 31 exercises.
3. The questions have all the same weight.
3. Blank pages are at the end.
4. Data Sheet and Periodic Table is given at the end of the text.
5. **Please work out the answers in the blank page and transcribe on the exercise page only the ESSENTIAL text. A clean and organized answer will reduce the possibility of marking mistakes.**

Merry Christmas Everyone

1. In the reaction shown, 100.0 g $C_6H_{11}OH$ yielded 64.0 g C_6H_{10}. 1) what is the theoretical yield of the reaction, 2) what is the percent yield?, 3) what mass of $C_6H_{11}OH$ would produce 100.0g of C_6H_{10} if the percent yield is that determine in part 2?

$$C_6H_{10}OH \rightarrow C_6H_{10} - H_2O$$

2. A 99.8 mL sample of a solution that is 12.0% of KI by mass (d = 1.093 g/mL) is added to 96.7 mL of another solution that 14.0% $Pb(NO_3)_2$ by mass (d = 1.134 g/mL). How many grams of PbI_2 should form?

$$Pb(NO_3)_2 + 2KI\,(aq) \rightarrow PbI_2(s) + 2KNO_3\,(aq)$$

3. A 110.520 g sample of mineral water is analyzed for its magnesium content. The Mg^{2+} in the sample is first precipitated as $MgNH_4PO_4$ and this precipitate is converted to $Mg_2P_2O_7$ which is found to weight 0.0549 g. Express the quantity of magnesium in the sample in part per million (that is, in grams of Mg per million of grams of water).

4. A 0.4324 g sample of a potassium hydroxide-lithium hydroxide mixture requires 28.28 mL of 0.3520 M HCl for its titration to the equivalence point. What is the mass percent lithium hydroxide in this mixture?

5. At high temperatures, solid NaClO3 produces NaCl and O_2 gas. A 0.8756 g sample of impure $NaClO_3$ was heated till the production of oxygen ceased. The oxygen was collected over water and occupied a volume of 57.2 mL at 23.0 C and 734 mmHg. Calculate the mass percentage of $NaClO_3$ in the original sample. The vapor pressure of water ies 21.07 mmHg at 23 C.

6. Gas cylinder A has a volume of 48.2 L and contains N_2 at 8.35 atm at 25C. Gas cylinder B, of unknown volume, contains He at 9.50 atm and 25C. When the two cylinders are connected and the gases mixed, the pressure in each cylinder becomes 8.71. What is the volume of the cylinder B?

7. A bomb calorimetry experiment is performed with xylose $C_5H_{10}O_5$ as combustible substance. The data obtained were:

Mass of xylose burned	1.183 g
Heat capacity of calorimeter	4.728 kJ/C
Initial T	23.39C
Final calorimeter T	27.19C

(a) what is the heat of combustion of xylose in kJ/mol?
(b) (b) write the chemical equation for the complete combustion of xylose and represent the value of ΔH in this equation (Assume that ΔU~ΔH).

8. Use the Hess law to determine ΔH^0 for the reaction

$CO(g) + \frac{1}{2} O_{2(g)} \rightarrow CO_2$, given that

$C(s) + \frac{1}{2} O_2(g) \rightarrow CO(g)$ $\Delta H^0 = -110.54kJ$
$C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H^0 = -393.51kJ$

9. Use the Hess law and the following data

$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$ $\quad \Delta H^0 = -802kJ$
$CH_4(g) + CO_2(g) \rightarrow 2CO(g) + 2H_2(g)$ $\quad \Delta H^0 = +247kJ$
$CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g)$ $\quad \Delta H^0 = +206kJ$

To determine ΔH^0 for the following reaction:

$$CH_4(g) + 1/2O_2(g) \rightarrow CO(g) + 2H_2(g)$$

10. Without calculation, arrange the following electromagnetic radiation sources in order of increasing frequency.

a) Red traffic light
b) a 91.9 MHz radio transmitter
c) light with a frequency of 3.0×10^{-14} s^{-1}
d) light with a wavelength of 49 nm.

11. Use the Planck's equation to determine:

a) the energy in joules per photon of a radiation of frequency 7.39×10^{13} sec^{-1}
b) the energy in kJ/mol of a radiation of frequency 1.97×10^{14} sec^{-1}

12. What is the ground state electron configuration for each of the following elements

Te,
Cs,
Se,
Pt,
Os,
Cr

13. Which of the following species requires a resonance hybrid for its Lewis structure?: explain

CO_2, OCl , CO_3^{2-}, OH^-

14. Write plausible Lewis structure for the following odd-electron species:

CH_3, ClO_2, NO_2.

15. Use VSEPR to predict the geometric shapes of the following molecules and ions:

PCl_5, SO_4^{2-}, $SOCl_2$, SO_2, BrF_4

16. Describe the bond order of the diatomic carbon molecule C_2 with Lewis theory and molecular orbital theory. Explain the difference of the results.

17. Consider the molecules NO^+ and N_2^-, and use molecular orbitals:

a) write the MO configuration of each ion (ignore the 1s electron);
b) predict the bond order of each ion;
c) which of these ions is paramagnetic?
d) Which of these ions has the greater bond length?

18) A 0.682 g sample of ICl(g) is placed in a 625 mL vessel at 682K. When equilibrium is reached between the ICl(g) and I_2(g) and Cl_2(g) formed by its dissociation, 0.0383g I_2 is present. What is the Kc for this reaction?

19) Is a mixture of 0.0205 mol of $NO_2(g)$ and 0.750 mol N_2O_4 in a 5.25 L flask at 25C at the equilibrium? If not in which direction the reaction will proceed?

$$N_2O_4(g) \rightleftharpoons 2NO_2(g) \quad Kc = 4.61 \times 10^{-3} \text{ at } 25C$$

20) Cadmium metal is added to 0.350 L of an aqueous solution in which $[Cr^{3+}] = 1.00M$. What are the concentrations of the different ionic species at equilibrium? What is the minimum mass of cadmium metal required to establish this equilibrium?

$$Cr^{3+}(aq) + Cd(s) \rightleftharpoons Cr^{2+}(aq) + Cd^{2+}(aq) \text{ (unbalanced)} \quad Kc = 0.288$$

21. The acid CH_3CH_2COOH is 0.42% ionized in 0.80M solution. Calculate the value of Ka

22. How many mL of concentrated HCl(aq) (36% HCl by mass d = 1.18g/mL) are required to produce 12.5 mL of a solution with pH = 2.10?

23. A particular household ammonia solution (d = 0.97 g/mL) is 6.8% NH_3 by mass. How many milliliters of this solution should be diluted with water to produce 625 mL of a solution with pH = 11.55?

24. What concentration of NH_3 should be present in a solution with $[NH_4^+] = 0.732M$ to produce a buffer solution with pH = 9.12? For NH_3 $K_b = 1.8 \times 10^{-5}$.

25. Calculate the pH at the points of titration of 25.00 mL of 0.160M HCl when (a) 10.00 mL and (b) 15.00 mL of 0.242M KOH have been added.

26. Excess $Ca(OH)_2$ is shaken with water to produce a saturated solution. A 50.00 mL sample of the clear saturated solution is withdrawn and requires 10.7 mL of 0.1032 M HCl for its titration. What is Ksp for $Ca(OH)_2$?

27. A 25.00 mL sample of clear saturated solution of PbI_2 requires 13.3 mL of a certain $AgNO_3(aq)$ for its titration (precipitation of AgI). What is the molarity of this $AgNO_3$ (aq)? Ksp (PbI_2) = 7.1 x 10^{-9}

28. At 298K, for the reaction

$$2H^+(aq) + 2Br^-(aq) + 2NO_2(g) \rightarrow Br_2(l) + 2HNO_2(aq)$$

ΔH^o = -61.6 kJ/mol and the standard molar entropies are $H^+(aq)$ = 0 J/K; $Br^-(aq)$ = 82.4 J/K; $NO_2(g)$ = 240.1 J/K; $Br_2(l)$ = 152.2 J/K; $HNO_2(aq)$ = 135/6 J/K. Determine ΔG^o at 298K and whether the reaction proceeds spontaneously in the forward or reverse direction when reactants and products are in their standard states.

29. In the synthesis of gaseous CH_3OH from $CO(g)$ and $H_2(g)$ the following equilibrium concentrations were determined at 483K: $[CO] = 0.0911M$, $[H_2] = 0.0822M$, and $[CH_3OH]$ 0.00892M.Calculate the equilibrium constant and Gibbs energy for this reaction.

30. Assume that all reactants and products are in their standard states and use data from the table in the data sheet to predict whether a spontaneous reaction will occur in the forward direction in each case.

$Sn(s) + Pb^{2+}(aq) \rightarrow Sn^{2+}(aq) + Pb(s)$

$Cu^{+2}(aq) + 2I^{-}(aq) \rightarrow Cu(s) + I_2(s)$

$4NO_3^{-}(aq) + 4H^{+}(aq) \rightarrow 3O_2(g) + 4NO(g) + 2H_2O(l)$

$O_3(g) - Cl^{-}(aq) \rightarrow OCl^{-}(aq) + O_2(g)$ (basic solution)

31. A voltaic cell represented by the following cell diagram has $E_{cell} = 1.250V$. What must be $[Ag^+]$ in the cell?

$$Zn(s)/Zn^{2+}\ (1.00M)//Ag^{1+}(xM)/Ag(s)$$