BCC, Spring 2016

Chem 1A - Final Exam Review

1. Give the systematic name of each of the following compounds:

(a) Ag_2CrO_4:_____ (b) $KMnO_4$:_____

(c) $BaCl_2 \cdot 2H_2O$:_____ (d) N_2O_5: _____

(e) $NiSO_4 \cdot 5H_2O$:_____ (f) $Pb(C_2H_3O_2)_2$:_____

(g) H_3PO_4:_____ (h) SF_4:_____

(k) $Hg_2(NO_3)_2$:_____ (j) Li_2CO_3:_____

2. Write the correct formula for each of the following compounds:

(a) Aluminum sulfate:_____ (b) Chromium(III) chloride hexahydrate: _____

(c) Acetic acid: _____ (d) Magnesium sulfate heptahydrate: _____

(e) Diboron trioxide:_____ (f) Nitric acid: _____

(g) Calcium hypochlorite: _____ (h) Sodium hydrogen phosphate:_____

(i) Hydrosulfuric acid:_____ (j) Potassium dichromate:_____

3. Complete and balance the following equation and write a balanced net ionic equation for each reaction:

(a) ___$AgNO_3(aq)$ + ___$Na_3PO_4(aq)$ $\rightarrow$ _____ + _____;

(b) ___$Pb(NO_3)_2(aq)$ + ___$KI(aq)$ $\rightarrow$ _____ + _____

(c) ___$H_2SO_4(aq)$ + ___$Al(OH)_3(aq)$ $\rightarrow$ _____ + _____

(d) ___$Ni(NO_3)_2(aq)$ + ___$NaOH(aq)$ $\rightarrow$ _____ + _____

(e) ___$CaCO_{3(s)}$ + ___$HCl_{(aq)}$ $\rightarrow$ _____ + _____ + _____

4. (a) Balance the following molecular equations using the smallest integer coefficients.:

(*i*) ___$Al_2O_{3(s)}$ + ___$HCl_{(aq)}$ $\rightarrow$ ___$AlCl_{3(aq)}$ + ___$H_2O(l)$;

(*ii*) ___$AlCl_{3(aq)}$ + ___$Na_2CO_{3(aq)}$ $\rightarrow$ ___$Al_2(CO_3)_{3(s)}$ + ___$NaCl_{(aq)}$;

(b) For each equation, write the total ionic and net ionic equations.

5. (a) Balance the following net ionic equations for redox reactions in acidic solution:

$$\_\_Cr_2O_7^{2-}(aq) + \_\_Fe^{2+}(aq) + \_\_H^+(aq) \rightarrow \_\_Cr^{3+}(aq) + \_\_Fe^{3+}(aq) + \_\_H_2O(l)$$

(b) Balance the following equation for redox reaction in basic solution:

$$\_\_\_Cr(OH)_3(s) + \_\_\_H_2O_2(aq) + \_\_\_OH^-(aq) \rightarrow \_\_\_CrO_4^{2-}(aq) + \_\_\_H_2O(l)$$

6. The following reaction is employed for the production of methanol:

$$CO(g) + 2H_2(g) \rightarrow CH_3OH(l)$$

550 L of CO gas at 45 atm and 25°C and 750 L of H_2 gas at 55 atm and 25°C are simultaneously pumped into the reactor that produce methanol. (a) Which is the limiting reactant? (b) If the limiting reactant is completely reacted and the yield is 100%, how many kilograms of methanol is produced? (c) If 23 kg of CH_3OH were produced from this reaction, calculate its percentage yield.

7. How many grams of NaOH are required to prepare 1.50 L of 0.250 *M* solution of NaCl. Briefly outline how you would prepare this solution.

8. (a) Calculate the molar mass of $CoCl_2.6H_2O$. (b) Suppose that you weigh accurately 16.45 g of pure $CoCl_2.6H_2O$ solid and transfer the solid quantitatively into a 250-mL volumetric flask; then you add about 200 mL of de-ionized water and stir the mixture to dissolve the solid. When the solid has completely dissolved, you add more de-ionized water until the total volume is 250.0 mL and shake the mixture to homogenize the solution. What is the molar concentration of $CoCl_2$ in the solution?

9. A 20.00-mL sample of vinegar is diluted to 100.0 mL with de-ionized water; then a 25.00-mL portion of the dilute vinegar is transferred into a clean Erlenmeyer flask and titrated with 0.2025 *M* NaOH solution using phenolphthalein indicator. The titration was found to require 21.00 mL of the base to reach end-point. (a) Write a balanced equation for the reaction that takes place in this titration. (b) Determine the molar concentration of acetic acid, $HC_2H_3O_2$ in dilute vinegar solution. (c) What is the molarity of acetic acid in the original (undiluted) vinegar? (c) If the density of vinegar is 1.0 g/mL, what is the percentage (by mass) of acetic acid in the undiluted vinegar?

10. A balloon is filled with 454 g of helium gas at 1.00 atm and 22°C. (a) What is the volume of the balloon under this condition? (b) Suppose the balloon rises to an altitude where the atmospheric pressure and temperature are 470 torr and -5.0°C, respectively, and the balloon is made of material that allows for a volume expansion of only 5.0%, what is the final volume of the balloon and the final gas pressure?

11. 50.0 mL of 2.0 *M* NaOH and 50.0 mL of 2.0 *M* HCl solutions are reacted in a Styrofoam cup calorimeter and the temperature of solution increases from 22.0°C to 35.5°C. (a) If the density of the solution is 1.0 g/mL, calculate the heat absorbed by solution (specific heat = 4.18 J/g.°C).
(b) How much heat is absorbed by the calorimeter if its heat capacity is 10. J/°C? (c) Calculate the enthalpy change (ΔH; in kJ/mol) for the following reaction:

$$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$$

12. (a) Calculate the enthalpy change (ΔH_{rxn}) for the following reaction:

$$C_3H_8(g) + 5\ O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g);$$

[ΔH^o_f (kJ/mol): C_3H_8 = -104; $CO_{2(g)}$ = -394; $H_2O_{(g)}$ = -242]

(b) How much energy (in kJ) is produced if 1.00 g of propane gas (C_3H_8) is completely burned?

What volume of propane gas, measured at STP, must be combusted to provide enough energy to heat 1.00 L of water (density = 1.0 g/mL) from 22.0^{o}C to 100.0^{o}C? (Specific heat of water = 4.184 J/g.^{o}C)

13. Name the primary intermolecular forces found in the liquid state of each of the following substances:

(a) SiH_4:_____; (b) CH_3OH:_____

(c) CO:_____; (d) N_2H_4 :_____

(e) HCl:_____; (f) CO_2:_____

(g) CH_3CH_3:_____; (h) CH_3NH_2:_____

14. Explain the following liquid properties. How does hydrogen bonding influence these properties of water?

(a) Surface tension

(b) Capillary action

(c) Enthalpy of vaporization

15. List the following compounds in increasing order of vapor pressure:

(a) CH_4, CH_3F, CF_4, CCl_4, SiF_4; (b) HF, HCl, HBr, HI;

(c) CH_3OH, CH_3CH_2OH, H_2CO; (d) H_2O, H_2S, H_2Se, H_2Te;

16. Rank the following compounds in increasing order of boiling points:

(a) CH_4, CH_3F, CF_4, CCl_4, SiF_4; (b) HF, HCl, HBr, HI;

(c) CH_3OH, CH_3CH_2OH, H_2CO; (d) H_2O, H_2S, H_2Se, H_2Te;

17. A certain amount of ice at 0.0^{o}C is added to 100.0 g of warm water at 35.0^{o}C in a Styrofoam cup calorimeter and the final temperature of the mixture is 16.5^{o}C. What is the mass of ice? (Specific heat of water = 4.184 J/g.^{o}C; enthalpy of fusion of ice, ΔH_{fus} = 6.02 kJ/mol,)

18. The boiling point of water ar 1.00 atm is 100.ºC and its enthalpy of vaporization is 40.6 kJ/mol. (a) At what pressure would water boil at 120.ºC? (b) What is the boiling point of water in Denver, Colorado where the atmospheric pressure is 600. torr? (Assume the enthalpy of vaporization remains constant. (R = 8.314 J/mol.K)

19. Tungsten crystallizes in a body-centered cubic arrangement and the measurement of each side of the unit cell is 321 pm long. Calculate the atomic radius and the density of tungsten.
(Atomic mass of tungsten = 183.85 u; 1 *u* = 1.66 x 10^{-24} g; 1 pm = 10^{-10} cm)

20. Calcium metal forms a cubic closest-packed lattice crystal with the unit cell edge length of 549 pm. Calculate the atomic radius of calcium in pm and its density in g/cm^3.
(1 *u* = 1.6605 x 10^{-24} g; 1 pm = 10^{-10} cm)

21. The solubility of KNO_3 is 28 g per 100 g of water at 20°C. How many grams of KNO_3 will dissolve in 225 g of water at the same temperature? (b) What is the mass percent of KNO_3 in the saturated solution at 20°C? (c) Calculate the *molal* concentration of KNO_3 in the saturated solution at 20°C.

22. The Henry's law constant for O_2 gas in fresh water at 20°C is 1.3 x 10^{-3} mol/L-atm. (a) Calculate the concentration of O_2 in a fresh water lake at 20°C when the partial pressure of oxygen over the water is 0.21 atm. (b) What is the concentration of O_2 in ppm? (Assume the density of water = 1.0 g/mL)

23. Benzene (C_6H_6) and toluene (C_7H_8) form an ideal solution in any proportion. The vapor pressure of pure benzene and pure toluene at 25°C are 95.1 torr and 28.4 torr, respectively. (a) Calculate the mole fraction of benzene and toluene, respectively, in a mixture composed of 275 g benzene and 275 g toluene. (b) What is the total vapor pressure above the solution at 25°C? (c) What is the mole percent of toluene in the vapor at 25°C?

24. A radiator fluid is prepared by mixing 1.00 L of water (density = 1.00 g/mL) and 1.00 L of ethylene glycol (EG = $HOCH_2CH_2OH$; density = 1.12 g/mL). Calculate the molal concentration of EG, the freezing and the boiling point of the solution? (For water, K_f = 1.86^{o}C/*m*, and K_b = 0.512^{o}C/*m*)

25. A 0.638-g sample of an organic compound is dissolved in 20.0 mL of cyclohexane (density = 0.779 g/mL) and the freezing point of the solution is found to be 2.40^{o}C. The freezing point of pure cyclohexane is 7.00^{o}C and its freezing point depression constant, K_f = 20.5^{o}C/*m*. (a) Determine the molar mass of the organic compound. (b) If the empirical formula is CH, calculate the molecular formula of the compound.

26. A 50.0-mL solution containing 0.525 g of polymer in carbon tetrachloride has an osmotic pressure of 34.0 torr at 25°C. Calculate the molar mass of the polymer.
(R = 0.08206 L.atm/mol.K)

Answers:

1. (a) Silver chromate; (b) Potassium permanganate;
   (c) Barium chloride dehydrate; (d) Dinitrogen pentoxide;
   (e) Nickel(II) sulfate hexahydrate; (f) Lead(II) acetate
   (g) Phosphoric acid (h) Sulfur tetrafluoride

2. (a) $Al_2(SO_4)_3$; (b) $CrCl_3.6H_2O$; (c) $HC_2H_3O_2$; (d) $MgSO_4.7H_2O$
   (e) B_2O_3 (f) HNO_3 (g) $Ca(OCl)_2$; (h) Na_2HPO_4;
   (*i*) HF (j) $K_2Cr_2O_7$.

3. (a) **3** $AgNO_3(aq)$ + $Na_3PO_4(aq)$ → $\mathbf{Ag_3PO_4(s)}$ + **3** $\mathbf{NaNO_3(aq)}$;
   (b) $Pb(NO_3)_2(aq)$ + 2 $KI(aq)$ → $\mathbf{PbI_2(s)}$ + **2** $\mathbf{KNO_3(aq)}$
   (c) **3** $H_2SO_4(aq)$ + **2** $Al(OH)_3(aq)$ → $\mathbf{Al_2(SO_4)_3(aq)}$ + **3** $\mathbf{H_2O(\mathit{l})}$
   (d) $Ni(NO_3)_2(aq)$ + **2** $NaOH(aq)$ → $\mathbf{Ni(OH)_2(s)}$ + **2** $\mathbf{NaNO_3(aq)}$
   (e) $CaCO_{3(s)}$ + **2** $HCl_{(aq)}$ → $\mathbf{CaCl_2(aq)}$ + $\mathbf{H_2O(\mathit{l})}$ + $\mathbf{CO_2(g)}$

4. (a) (*i*) $Al_2O_3(s)$ + **6** $HCl(aq)$ → **2** $AlCl_3(aq)$ + **3** $H_2O(l)$;
   (*ii*) **2** $AlCl_3(aq)$ + **3** $Na_2CO_3(aq)$ → $Al_2(CO_3)_3(s)$ + **6** $NaCl(aq)$;
   (b) (*i*) t.i.e.: $Al_2O_3(s)$ + **6** $H^+(aq)$ + **6** $Cl^-(aq)$ → **2** $Al^{3+}(aq)$ + **6** $Cl^-(aq)$ + **3** $H_2O(l)$;
   n.i.e.: $Al_2O_3(s)$ + **6** $H^+(aq)$ → **2** $Al^{3+}(aq)$ + **3** $H_2O(l)$;
   (*ii*) t.i.e.: **2** $Al^{3+}(aq)$ + **6** $Cl^-(aq)$ + **6** $Na^+(aq)$ + **3** $CO_3^{2-}(aq)$ → $Al_2(CO_3)_3(s)$ + **6** $Na^+(aq)$ + **6** $Cl^-(aq)$;
   n.i.e.: **2** $Al^{3+}(aq)$ + **3** $CO_3^{2-}(aq)$ → $Al_2(CO_3)_3(s)$;

5. (a) $Cr_2O_7^{2-}(aq)$ + **6** $Fe^{2+}(aq)$ + **14** $H^+(aq)$ → **2** $Cr^{3+}(aq)$ + **6** $Fe^{3+}(aq)$ + **7** $H_2O(l)$
   (b) **2** $Cr(OH)_3(s)$ + **3** $H_2O_2(aq)$ + **4** $OH^-(aq)$ → **2** $CrO_4^{2-}(aq)$ + **8** $H_2O(l)$

6. (a) limiting reactant is H_2; (b) 27 kg; (c) 85%
7. 15.0 g
8. (a) 237.94 g/mol; (b) 0.2765 *M*
9. (a) 0.1701 *M*; (b) 0.8505 *M*; (c) 5.1%
10. (a) 2.75 x 10^3 L; (b) 658 torr
11. (a) 5.64 x 10^3 J; (b) 135 J; (c) (ΔH = –58 kJ/mol
12. (a) ΔH = -2046 kJ/mol; (b) 46.4 kJ/g; (c) 3.6 L
13. (a) London Dispersion; (b) Hydrogen bonding (c) Dipole-dipole
    (d) Hydrogen bonding; (e) Dipole-dipole; (f) London Dispersion
    (g) London dispersion (h) Hydrogen bonding
15. (a) $CCl_4 < SiF_4 < CF_4 < CH_3F < CH_4$; (b) $HF < HI < HBr < HCl$;
    (c) $CH_3CH_2OH < CH_3OH < H_2CO$; (d) $H_2O < H_2Te < H_2Se < H_2S$
16. (a) $CH_4 < CH_3F < CF_4 < SiF_4 < CCl_4$; (b) $HCl < HBr < HI < HF$;
    (c) $H_2CO < CH_3OH < CH_3CH_2OH$; (d) $H_2S < H_2Se < H_2Te < H_2O$;

17. 19.2 g
18. (a) 1.95 atm; (b) 93.4^{o}C
19. Atomic radius = 139 pm; density = 18.4 g/cm^3
20. Atomic radius = 194 pm; density = 1.61 g/cm^3
21. (a) 63 g; (b) 22%; (c) *molality* = 2.8 *m*
22. (a) 2.8 x 10^{-4} mol/L; (b) 9.0 ppm
23. (a) X_{Bz} = 0.541; X_{Tol} = 0.459; (b) P_{Bz} = 51.4 torr; P_{Tol} = 13.0 torr; P_T = 64.4 torr; (c) 20.2% tol in vapor
24. *molality* = 18.0 *m*; T_f = –33.6^{o}C; T_b = 109.2^{o}C
25. (a) Molar mass = 182 g/mol; (b) Empirical formula = $C_{14}H_{14}$
26. Molar mass = 5740 g/mol