Chemistry: Final Exam Review Trimester B

Name Beth "Key" Period

1. Chlorine gas is a very reactive substance and will combine with most metals. For example:

$2K + Cl_2 \rightarrow 2KCl$

$Ca + Cl_2 \rightarrow CaCl_2$

$2Al + 3Cl_2 \rightarrow 2AlCl_3$

Suppose individual 25.0 gram samples of these three metals are reacted with separate 50.0 gram samples of Cl_2. In each case, determine whether the metal or chlorine is the limiting reactant, and calculate the theoretical yield of metal chloride for each reaction.

$2K + Cl_2 \rightarrow 2KCl$

25.0g 50.0g

L.R.

$\frac{25.0\text{g KCl}}{39.10\text{ g/mol}} = 0.639\text{ mol K} \div 2 = 0.320$

$\frac{50.0\text{g Cl}_2}{70.90\frac{\text{g}}{\text{mol}}} = 0.705\text{ mol Cl}_2 \div 1 = 0.705$

$0.639\text{ mol K} \times \frac{2\text{ mol KCl}}{2\text{ mol K}} = 0.639\text{ mol KCl} \times 74.55\text{ g/mol} = 47.6\text{ g KCl}$

$2Al + 3Cl_2 \rightarrow 2AlCl_3$

Cl_2 = L.R.

62.7g $AlCl_3$

$Ca + Cl_2 \rightarrow CaCl_2$

Ca = L.R.

69.3g $CaCl_2$

2. Suppose you run the reaction between potassium and chlorine (with the amounts given in problem 1) and you collect 31.2 g of potassium chloride. Determine your percent yield.

$\frac{\text{EXPERIMENTAL YIELD}}{\text{THEORETICAL YIELD}} \times 100 = \%\text{ YIELD}$

$\frac{31.2\text{g KCl}}{47.6\text{ g KCl}} \times 100 = 65.6\%$

3. The following reaction is carried out at STP. How many L of $H_2(g)$ will be produced if 35.8 g of water are decomposed?

$2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$

H_2O MM = 18.02 g/mol

$\frac{35.8\text{g } H_2O}{18.02\text{g/mol}} = 1.9867\text{ mol } H_2O \times \frac{2\text{ mol } H_2}{2\text{ mol } H_2O} = 1.9867\text{ mol } H_2 \times 22.4\text{ L/mol}$

44.5 L H_2

4. Why is it so important that a chemical equation be balanced? What does it mean to say that atoms must be conserved in a balanced chemical equation?

ALL RXNS FOLLOW THE LAW OF CONSERVATION OF MASS. CONSERVED MEANS THAT ATOMS ARE NOT CREATED OR DESTROYED.

5. What is a strong electrolyte? AN IONIC COMPOUND THAT COMPLETELY BREAKS APART INTO IONS IN AQUEOUS SOLUTION. THE SOLUTION WILL CONDUCT ELECTRICITY.

6. Write equations to show the ions that form when the following ionic compounds dissolve in water.

a. NaCl $NaCl_{(s)} \xrightarrow{H_2O} Na^+_{(aq)} + Cl^-_{(aq)}$

b. $FeCl_3$ $FeCl_{3(s)} \xrightarrow{H_2O} Fe^{3+}_{(aq)} + 3Cl^-_{(aq)}$

c. $Al_2(SO_4)_3$ $Al_2(SO_4)_{3(s)} \xrightarrow{H_2O} 2Al^{3+}_{(aq)} + 3SO_4^{2-}_{(aq)}$

7 What are spectator ions?

IONS THAT DO NO PARTICIPATE IN A RXN.

8. What is a salt?

AN IONIC CMPD / METAL-NONMETAL CMPD

9. What does it mean to say a substance is soluble? Insoluble? Slightly soluble?

SOLUBLE = DISSOLVES
INSOLUBLE = DOES NOT DISSOLVE
SLIGHTLY = A FEW IONS DISSOLVE, CONSIDERED A precipitate

10. Balance each equation.

a. $2NaOH + CuSO_4 \rightarrow Cu(OH)_2 + Na_2SO_4$

b. $HI + KOH \rightarrow KI + H_2O$

c. $FeO + 2HNO_3 \rightarrow Fe(NO_3)_2 + H_2O$

d. $2C_{12}H_{26} + 37O_2 \rightarrow 24CO_2 + 26H_2O$

e. $4B + 3O_2 \rightarrow 2B_2O_3$

11. Write the molecular equation, the complete ionic and net ionic equation for the reaction that occurs between barium chloride and sodium phosphate.

MOLECULAR: $3BaCl_{2(aq)} + 2Na_3PO_{4(aq)} \Rightarrow Ba_3(PO_4)_{2(s)} + 6NaCl_{(aq)}$

Complete: $3Ba^{2+}_{(aq)} + 6Cl^-_{(aq)} + 6Na^+_{(aq)} + 2PO_4^{3-}_{(aq)} \rightarrow Ba_3(PO_4)_{2(s)} + 6Na^+_{(aq)} + 6Cl^-_{(aq)}$

NET: $3Ba^{2+}_{(aq)} + 2PO_4^{3-}_{(aq)} \rightarrow Ba_3(PO_4)_{2(s)}$

12. A mystery metal is placed into an aqueous solution of Chromium (III) Nitrate. The metal reacts. Consult the activity series on your gold sheet and circle all of the metals below which could possibly be the mystery metal.

(Ba) (Mg) Au Fe (Rb) Sn (Zn)

17. Calculate the following and indicate if the solution is an acid, base or neutral.

a) The pH of a 4.58×10^{-6}M HCl

$pH = -\log(4.58 \times 10^{-6})$ **pH = 5.339**

) The pH of 7.95×10^{-5}M NaOH

$pOH = -\log(7.95 \times 10^{-5})$ $14 - pOH = pH$ **pH = 9.990**

c) The $[H^+]$ of a solution with a pH of 3.45

$[H^+] = 10^{-3.45}$ **$[H^+] = 3.5 \times 10^{-4}$**

) The $[H^+]$ of a NaOH solution that is 4.61×10^{-4}M

$pOH = -\log(4.61 \times 10^{-4}) = 3.336$

$14 - pOH = pH$ $14 - 3.336 = 10.664 = pH$

$[H^+] = 10^{-pH}$ $[H^+] = 10^{-10.664} =$ **2.17×10^{-11}M**

18. A titration is carried out and it is found that 35.00mL of a 0.780M HCl solution neutralize 51.35 mL of NaOH solution of unknown concentration. Write the balanced molecular equation and net ionic equation for the neutralization reaction.

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

Net: $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

Calculate the concentration of NaOH. ← Base

$M_aV_a = M_bV_b$

$(0.780M)(35.00mL) = M_b(51.35mL)$

$M_b = 0.532M$

19. A titration is carried out and it is found that 12.36mL of 0.780M HCl solution neutralize 22.45 mL of $Mg(OH)_2$ of unknown concentration. Write the balanced molecular equation and net ionic equation for the neutralization reaction.

$2HCl(aq) + Mg(OH)_2(aq) \rightarrow MgCl_2(aq) + 2H_2O(l)$

$2H^+(aq) + 2OH^-(aq) \rightarrow 2H_2O(l)$

Calculate the concentration (molarity) of $Mg(OH)_2$.

$Mg(OH)_2 \xrightarrow{H_2O} Mg^{2+}(aq) + 2OH^-(aq)$

$(0.780MHCl)(12.36mL) = M_{(OH)}(22.45mL)$

$M_{OH^-} = 0.429M \times \frac{1\,Mg(OH)_2}{2\,OH^-} =$ **0.215M**

13. Write a balanced equation for the reaction that takes place between potassium metal and nickel (II) nitrate. Write the equations for the half-reactions for oxidation and reduction for this reaction.

$$2K^{0}_{(s)} + Ni(NO_3)_{2\,(aq)} \rightarrow 2KNO_{3\,(aq)} + Ni^{0}_{(s)}$$

OXIDATION: $2K_{(s)} \longrightarrow 2K^{+}_{(aq)} + 2e^{-}$

REDUCTION $Ni^{2+}_{(aq)} + 2e^{-} \rightarrow Ni_{(s)}$

14. Sodium reacts with water as follows.

$$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g) + 325\ kJ$$

a. 1.15 g of sodium is allowed to react completely with water. The resulting solution is diluted to 250 cm^3. Calculate the molarity (M) of the resulting sodium hydroxide solution.

$$\frac{1.15\,g\,Na}{22.99\,g/mol} = 0.0500\,mol\,Na \times \frac{2\,mol\,NaOH}{2\,mol\,Na} = 0.0500\,mol\,NaOH$$

$$\frac{0.0500\,mol\,NaOH}{0.250\,L\,soln} = 0.200\,M$$

b. What are kJ?

Units of energy

c. Is this reaction exothermic or endothermic?

EXOTHERMIC

15. A solution is made by dissolving 15 grams of NaCl in 225 g of water. What is the mass percent of this solution?

$$\frac{15\,g}{(15\,g + 225\,g)} \times 100 = 6.3\%$$

16. A solution is 18% NaCl and has a density of 1.15 g/mL. What is the molarity of this NaCl solution?

$$\frac{1.15\,g\,soln}{1\,mL} \times \frac{18}{100} = \frac{0.207\,g\,NaCl}{1\,mL\,soln} \times \frac{1000\,mL}{1\,L} = \frac{207\,g\,NaCl}{L\,soln}$$

$$MM\,NaCl = 58.44\,g/mol \qquad \frac{207\,g\,NaCl}{58.44\,g/mol} = \frac{3.54\,mol}{1\,L} = 3.54\,M$$

23. On hot days, you may have noticed that potato chip bags seem to "inflate", even though they have not been opened. I have a 250. mL bag at a temperature of 19°C, and I leave it in my car which has a temperature of 60.°C, what will be the new volume of the bag?

$19°C + 273 = 292K$

$60.°C + 273 = 333K$

P will remain constant - the bag is under atmospheric Pressure!

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\quad \frac{250.mL}{292K} = \frac{V_2}{333K}$

$V_2 = 285mL$

24. You have an unknown quantity of oxygen (O_2) gas held at a temperature of 95°C in a container with a volume of 250. milliliters and a pressure of 800. mm Hg. How many grams of oxygen gas do I have?

$95° + 273 = 368K$ $\quad PV = nRT$

$250.mL \times \frac{1L}{1000mL} = 0.250L$ $\quad \frac{PV}{RT} = n$

$800.mmHg \times \frac{1atm}{760.mmHg} = 1.05atm$

$\frac{(1.05atm)(0.250L)}{(0.08206\frac{atm \cdot L}{K \cdot mol})(368K)} = 8.69216 \times 10^{-3} mol\ O_2$

$8.69216 \times 10^{-3} mol\ O_2 \times 32.00g/mol = 0.278g\ O_2$

25. If I initially have a gas at a pressure of 12 atm, a volume of 23 liters, and a temperature of 200. K, and then I raise the pressure to 14 atm and increase the temperature to 300. K, what is the new volume of the gas?

$\frac{T_2 P_1 V_1}{P_2 T_1} = \frac{P_2 V_2 T_2}{T_2 P_2}$

$\frac{T_2 P_1 V_1}{P_2 T_1} = V_2$ $\quad V_2 = \frac{(300K)(12atm)(23L)}{(14atm)(200K)} = 30.L$

26. A gas takes up a volume of 17 liters, has a pressure of 2.3 atm, and a temperature of 299 K. If I raise the temperature to 350 K and lower the pressure to 1.5 atm, what is the new volume of the gas?

$\frac{T_2 P_1 V_1}{P_2 T_1} = \frac{P_2 V_2 T_2}{T_2 P_2}$ $\quad \frac{T_2 P_1 V_1}{P_2 T_1} = V_2$

$\frac{(350K)(2.3atm)(17L)}{(1.5atm)(299K)} = V_2$

$V_2 = 31L$

20. Using the following equation:

MM $LiNO_3$ = 68.95 g/mol
MM Li_2SO_4 = 109.94 g/mol

$$Pb(SO_4)_2 + 4\ LiNO_3 \rightarrow Pb(NO_3)_4 + 2\ Li_2SO_4$$

How many grams of lithium nitrate will be needed to have a yield of 250. grams of lithium sulfate, assuming that you have an adequate amount of lead (IV) sulfate to do the reaction?

$$\frac{250.\ g\ Li_2SO_4}{109.94\ g/mol} = 2.27397\ mol\ Li_2SO_4 \times \frac{4\ mol\ LiNO_3}{2\ mol\ Li_2SO_4} = 4.5479\ mol\ LiNO_3$$

$$4.5479\ mol \times 68.95\ g/mol$$

314 g $LiNO_3$

What would be the percent yield for this reaction if it were carried out in the laboratory and the yield is only 219 grams of lithium sulfate?

LAB YIELD → 219 g / 314 g (Calculated Yield (Theoretical)) × 100 = **69.8%**

21. Using the following equation:

$$2\ NaOH + H_2SO_4 \rightarrow 2\ H_2O + Na_2SO_4$$

How many grams of sodium sulfate will be formed if you start with 200. grams of sodium hydroxide and you have an excess of sulfuric acid?

MM $NaOH$ = 40.00 g/mol
MM Na_2SO_4 = 142.04 g/mol

$$\frac{200.\ g\ NaOH}{40.00\ g/mol} = 5.0000\ mol\ NaOH \times \frac{1\ mol\ Na_2SO_4}{2\ mol\ NaOH} = 2.5000\ mol\ Na_2SO_4$$

$$2.5000\ mol\ Na_2SO_4 \times 142.04\ g/mol$$

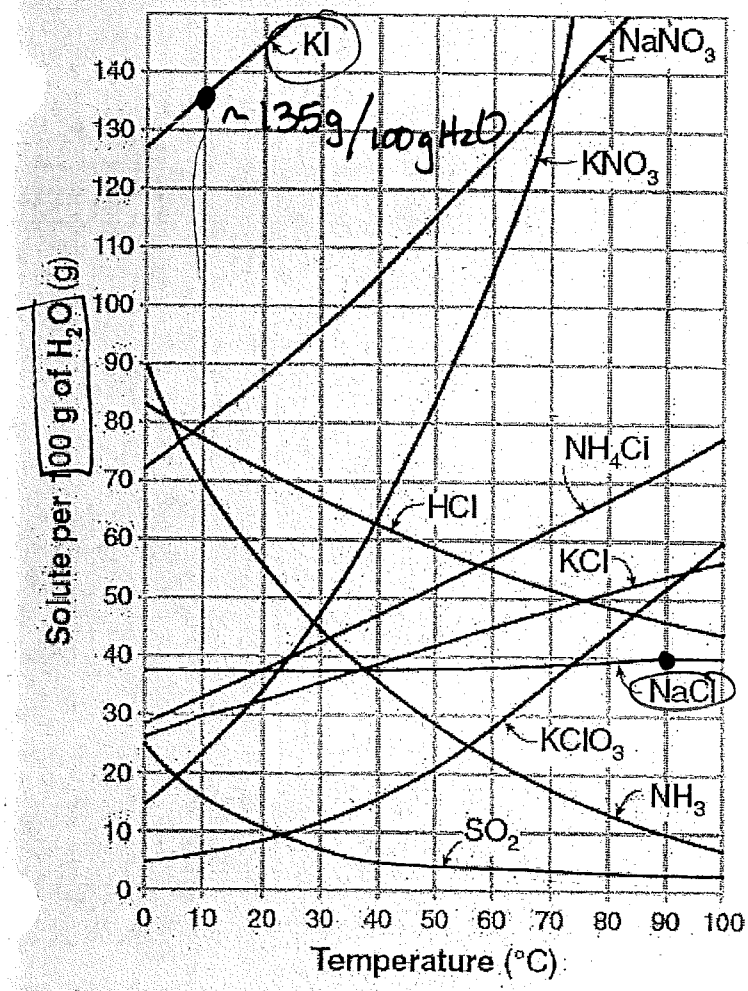
355 g Na_2SO_4

22. In a thermonuclear device, the pressure of 0.050 liters of gas within the bomb casing reaches 4.0 x 10^6 atm. When the bomb casing is destroyed by the explosion, the gas is released into the atmosphere where it reaches a pressure of 1.00 atm. Assuming temperature remains constant, what is the volume of the gas after the explosion?

$$P_1V_1 = P_2V_2 \qquad \frac{P_1V_1}{P_2} = V_2$$

$$\frac{(4.0 \times 10^6\ atm)(0.050\ L)}{1.00\ atm} = \mathbf{2.0 \times 10^5\ L}$$

Solubility Curves



27. SO_2 and NH_3 found on the solubility graph to the left are gases. KNO_3 and KCl are solids. Based on these curves what can we conclude about the solubility of solids in water as temperature increases?

SOLUBILITY INCREASES

What can we conclude about th solubility of gases in water as temperature increases?

SOLUBILITY DECREASES

28. AKI solution is formed by dissolving 65 grams of KI in 50. grams of water at 10°C. Is this solution unsaturated, saturated, or supersaturated?

$$\frac{135g}{100g\,H_2O} = \frac{x\ g}{50g\,H_2O}$$ $x = 67.5g$ = saturation

65g is unsaturated

29. How many grams of NaCl can be dissolved in 435 grams of water at 90°C?

$$\frac{40\ g\ NaCl}{100g\,H_2O} = \frac{x\ g\ NaCl}{435g\,H_2O}$$

$x = 174g$ NaCl at 90°C