PRACTICE EXAM #3

Chem20, Elementary Chemistry

1.) Dimethylhydrazine ($C_2H_8N_2$) is commonly used as rocket fuel in space shuttles. It combusts according to the following **UNBALANCED** chemical reaction: (23 pts)

$$C_2H_8N_2\ (l) + O_2\ (g) \rightarrow N_2\ (g) + CO_2\ (g) + H_2O\ (l) \qquad \Delta H_{rxn} = -393.54\ kJ/mol$$

a.) Is this reaction exothermic or endothermic? __**exothermic (-ΔH_{rxn})**________

b.) Balance the chemical reaction.

$$\_\_\_\_ C_2H_8N_2\ (l) + \underline{\ \mathbf{4}\ }\ O_2\ (g) \rightarrow \_\_\_\_\ N_2\ (g) + \underline{\ \mathbf{2}\ }\ CO_2\ (g) + \underline{\ \mathbf{4}\ }\ H_2O\ (l)$$

c.) How much heat (in kJ) would be produced from the combustion of 125.6 g of $C_2H_8N_2$? (The molecular weight (MW) for $C_2H_8N_2$ is 60.10 g/mol)

Convert g $C_2H_8N_2$ → mols $C_2H_8N_2$ (molecular weight) → kJ heat (ΔH_{rxn})

$$125.6\ g\ C_2H_8N_2 \times \frac{1\ mol\ C_2H_8N_2}{60.10\ g\ C_2H_8N_2} \times \frac{-393.54\ kJ}{1\ mol\ C_2H_8N_2} = -822.\underline{4}396672 \rightarrow \mathbf{-822.4\ kJ\ (lost)}$$

2.) A wave of electromagnetic radiation has a frequency, ν, of 7.64×10^{18} Hz. (12 pts)

a.) Calculate the energy, E, for this wave in Joules ($h = 6.626 \times 10^{-34}$ J·s).

Use $E = h\nu$

$$E = (6.626 \times 10^{-34}\ J \cdot s)(7.64 \times 10^{18}\ s^{-1}) = 5.0\underline{6}2264 \times 10^{-15} \rightarrow \mathbf{5.06 \times 10^{-15}\ J}$$

b.) Calculate the wavelength, λ, for this radiation in meters ($c = 2.998 \times 10^{8}$ m/s).

Use $c = \nu\lambda$, where $\lambda = (c/\nu)$

$$\lambda = (2.998 \times 10^{8}\ m/s)/(7.64 \times 10^{18}\ s^{-1}) = 3.9\underline{2}408377 \times 10^{-11} \rightarrow \mathbf{3.92 \times 10^{-11}\ m}$$

3.) Predict the products for the following pairs of ionic compounds if a double displacement reaction were to occur. Write the balanced molecular, complete (total) ionic, and net ionic equations for each successful reaction. Indicate the spectator ions in each. If no reaction occurs, write **NO REACTION.** (12 pts)

a.) lithium sulfate and calcium chloride → lithium chloride + calcium sulfate

MOLECULAR: $Li_2SO_4(aq) + CaCl_2(aq) \rightarrow 2\ LiCl(aq) + CaSO_4(s)$

TOTAL IONIC: $2\ Li^+(aq) + SO_4^{-2}(aq) + Ca^{+2}(aq) + 2\ Cl^-(aq) \rightarrow 2\ Li^+(aq) + 2\ Cl^-(aq) + CaSO_4(s)$

NET IONIC: $SO_4^{-2}(aq) + Ca^{+2}(aq) \rightarrow CaSO_4(s)$

SPECTATOR IONS: $Li^+(aq)$, $Cl^-(aq)$

b.) sodium hydroxide and copper(II) chloride → sodium chloride + copper(II) hydroxide

MOLECULAR: $2\ NaOH(aq) + CuCl_2(aq) \rightarrow 2\ NaCl(aq) + Cu(OH)_2(s)$

TOTAL IONIC: $2\ Na^+(aq) + 2\ OH^-(aq) + Cu^{+2}(aq) + 2\ Cl^-(aq) \rightarrow 2\ Na^+(aq) + 2\ Cl^-(aq) + Cu(OH)_2(s)$

NET IONIC: $2\ OH^-(aq) + Cu^{+2}(aq) \rightarrow Cu(OH)_2(s)$

SPECTATOR IONS: $Na^+(aq)$, $Cl^-(aq)$

4.) Write the complete electronic configuration for the following elements (with or without noble gas configuration is acceptable). (9 pts)

a.) Be ___ $[He]2s^2$ OR $1s^22s^2$ ___
b.) S ___ $[Ne]3s^23p^4$ OR $1s^22s^22p^63s^23p^4$ ___
c.) Pt ___ $[Xe]6s^24f^{14}5d^8$ OR $1s^22s^22p^63s^33p^64s^23d^{10}4p^65s^24d^{10}5p^66s^24f^{14}5d^8$ ___

5.) Identify the following elements based on their electronic configuration. (9 pts)

a.) $[Ar]4s^23d^3$ ___ V, vanadium ___
b.) $[Ne]3s^23p^1$ ___ Al, aluminum ___
c.) $[Xe]6s^1$ ___ Cs, cesium ___

6.) In a vessel, 12.1 g of aqueous hydrochloric acid and 10.6 grams of solid calcium hydroxide are mixed and an acid-base neutralization reaction is observed. (35 pts)

a.) Write the **balanced** chemical equation for this reaction.

$2\ HCl(aq) + Ca(OH)_2(s) \rightarrow 2\ H_2O(l) + CaCl_2(aq)$

b.) Classify this reaction in as many ways as possible.

acid-base neutralization, double displacement

c.) Which is the **limiting reactant**? Calculate the **theoretical yield** of salt that forms, in g. (MW for hydrochloric acid is 36.46 g/mol, and for calcium hydroxide, 74.09 g/mol)

$CaCl_2$: (1)(40.08 g/mol) + (2)(35.45 g/mol) = 110.9$\underline{8}$ g/mol

$$12.1\text{ g HCl} \times \frac{1\text{ mol HCl}}{36.46\text{ g HCl}} \times \frac{1\text{ mol CaCl}_2}{2\text{ mols HCl}} \times \frac{110.98\text{ g CaCl}_2}{1\text{ mol CaCl}_2} = 18.\underline{4}1549643\text{ g CaCl}_2$$

$$10.6\text{ g Ca(OH)}_2 \times \frac{1\text{ mol Ca(OH)}_2}{74.09\text{ g Ca(OH)}_2} \times \frac{1\text{ mol CaCl}_2}{1\text{ mol Ca(OH)}_2} \times \frac{110.98\text{ g CaCl}_2}{1\text{ mol CaCl}_2} = 15.\underline{8}7782427\text{ g CaCl}_2$$

Limiting Reactant: $Ca(OH)_2$, calcium hydroxide
Theoretical Yield: 15.9 g $CaCl_2$

d.) How many grams of the reactant in excess are left over after the reaction is complete?

$$15.9\text{ g CaCl}_2 \times \frac{1\text{ mol CaCl}_2}{110.98\text{ g CaCl}_2} \times \frac{2\text{ mols HCl}}{1\text{ mol CaCl}_2} \times \frac{36.46\text{ g HCl}}{1\text{ mol HCl}} = 10.\underline{4}4717967\text{ g HCl used}$$

12.1 g HCl initial – 10.$\underline{4}$ g HCl used = 1.$\underline{6}$52820328 g → **1.7 g HCl in excess**

e.) The reaction was performed in a laboratory and the percent yield of the produced salt was calculated to be 60.5%. What was the actual yield of this salt, in grams?

$$60.5\ \% = \frac{x}{15.9\text{ g CaCl}_2} \times 100\%$$

x = (15.9 g $CaCl_2$)(0.60$\underline{5}$) = 9.6$\underline{1}$95 → **9.62 g $CaCl_2$ actual yield**