Semester Mixed Stoichiometry Practice

Name _____

Chemistry

Date _____ Hour _____

The following set of questions is a mix of the different types of stoichiometry problems that we have encountered throughout the second semester. This includes the following types of stoichiometry problems:

Standard Stoichiometry *Solutions* *Limiting Reactants* *Gases* *Thermochemical Equations*

You may use any of the following formulas or conversion factors to solve these problems on a **separate sheet of paper**:

1 mol X = MMg X

$$M = \frac{moles\ of\ solute}{Lites\ of\ solution}$$

Celsius + 273 = Kelvin

MM = molar mass on the periodic table

1 mol X = 6.02×10^{23} particles X

PV = nRT

$$R = 0.082\ \frac{L*atm}{K*mol}$$

Particles = atoms, ions, formula units, or molecules

mol X : # mol Y

 # is the coefficient from the original chemical equation

mol X : ## kilojoules of heat

 # is the coefficient from the original chemical equation

is the amount of heat energy from the original chem equation.

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1. When ethanol (C_2H_5OH) is burned, it reacts with oxygen (O_2). It also releases 1,369 kJ of heat energy to the surroundings and produces CO_2 gas and H_2O gas.

$$C_2H_5OH(l) + 3\ O_2(g) \rightarrow 2\ CO_2(g) + 3\ H_2O(g)$$

   a. Calculate how much heat energy (in kJ) is released when 12.5 moles of ethanol burns. *-17,100 kJ*

   b. Calculate how many moles of carbon dioxide are produced if 787 kJ of heat energy are produced. *1.15 mol CO_2*

   c. Calculate how much heat energy (in kJ) is released when 124.7 grams of oxygen are reacted. *-1778 kJ*

2. A combination reaction occurs between solid magnesium metal (Mg) and diatomic oxygen gas (O_2). Solid magnesium oxide (MgO) is produced.

$$2\ Mg_{(s)} + O_{2(g)} \rightarrow 2\ MgO_{(s)}$$

   a. 17.54 moles of solid magnesium reacts completely with excess oxygen gas. Complete a BCA table.

   b. Using your BCA table and dimensional analysis, calculate the **grams** of MgO produced. *707.0 grams MgO*

3. Aqueous solutions of sulfuric acid and sodium hydroxide undergo a double-replacement reaction to form aqueous sodium sulfate and liquid water.

$$H_2SO_{4\,(aq)} + 2\ NaOH_{(aq)} \rightarrow Na_2SO_{4\,(aq)} + 2\ H_2O_{(l)}$$

   a. Complete the BCA table when 55.89 g of Na_2SO_4 is **produced** by this reaction. Remember BCA tables can only contain moles! *0.3935 mol Na_2SO_4*

   b. Calculate the number of molecules of NaOH that reacted. *4.738 x 1023 molecules NaOH*

4. Dicarbon octohydride (C_2H_8) combusts completely with excess oxygen (O_2) to form carbon dioxide (CO_2) & water (H_2O).

$$C_2H_{8\,(g)} + 4\ O_{2\,(g)} \rightarrow 2\ CO_{2\,(g)} + 4H_2O_{\,(g)}$$

   a. How many particles of CO_2 are produced if 3 moles of C_2H_8 undergo complete combustion. Complete a BCA table.

4 x 10^{24} particles CO_2

5. 10.6g of Li and 3.83g of N_2 react to form Li_3N.

$$6\ Li\ +\ N_2 \rightarrow 2\ Li_3N$$

   a. What is the maximum amount of moles of lithium nitride that can be made? *0.274 moles of Li_3N*

   b. What is the maximum amount of molecules of lithium nitride that can be made? *1.65x10^{23} molecules Li_3N*

   c. What is the limiting reactant?

   d. How many moles of limiting reactant are used? *0.137 moles N_2*

   e. How many particles of limiting reactant are used? *8.25x10^{22} molecules N_2*

   f. What is the excess reactant?

   g. How much excess reactant remains in moles? *0.708 moles of Li*

   h. How much excess reactant remains in grams? *4.91 grams of Li*

6. Calcium nitrate ($Ca(NO_3)_2$) and sodium phosphate (Na_3PO_4) undergo a double-replacement reaction according to the following balanced equation:

$$3\ Ca(NO_3)_{2\ (aq)} + 2\ Na_3PO_{4(aq)} \rightarrow Ca_3(PO_4)_{2(s)} + 6\ NaNO_{3(aq)}$$

   a. Suppose 2.75 L of 0.325M $Ca(NO_3)_2$ reacts completely with all of the Na_3PO_4. Complete a BCA table.

   b. How many grams of the precipitate will be produced in this reaction? *92.4 g $Ca_3(PO_4)_2$*

   c. If the final product contains 3.50L of aqueous $NaNO_3$, what is the molarity of the $NaNO_3$ solution? *0.511M $NaNO_3$*

   d. If the scientist was using 0.575M $Ca(NO_3)_2$ instead, what volume, in liters, would be necessary to produce the same amount of $Ca_3(PO_4)_2$ that you calculated in your BCA table. *1.55 L $Ca(NO_3)_2$*

6. Potassium chlorate decomposes into potassium chloride and oxygen gas, according to the following chemical equation:

$$2\ KClO_3(s) \rightarrow 2\ KCl(s)\ +\ 3\ O_2(g)$$

   a. What mass of potassium chlorate reacted in order to produce 3.90 L of O2 gas at 23.8℃ and 0.997 atm? *13.1 g $KClO_3$*

7. A hydrocarbon, C_2H_2, combusts according to the following chemical equation:

$$\mathbf{2}\ C_2H_{2(g)}\ +\ \mathbf{5}\ O_{2(g)} \rightarrow \mathbf{2}\ H_2O_{(g)}\ +\ \mathbf{4}\ CO_{2(g)} \qquad \textit{(760 mmHg = 1 atm)}$$

   a. How many grams of C_2H_2 are needed to produce 26.5 liters of carbon dioxide gas at 40.0℃ and 788 mmHg? *13.9 g C_2H_2*

8. Nitrogen monoxide gas and liquid water can be reacted to form oxygen gas and ammonia. In the process, 1170 kJ of heat energy are gained.

$$1170\ kJ + 4\ NO(g) + 6\ H_2O(l) \rightarrow 4\ NH_3(g) + 5\ O_2(g)$$

   a. Calculate how much heat energy (in kJ) is needed to produce 7.6 moles of ammonia. 2200 kJ

   b. Calculate the amount of heat energy required (in kJ) to react 78.98 g of nitrogen monoxide gas. *770. kJ*

   c. CHALLENGE Use dimensional analysis to calculate how many kilograms of water vapor are needed to absorb 15,980 J of heat energy. Remember: 1000 g = 1 kg and 1000 J = 1 kJ *0.001476 kg*