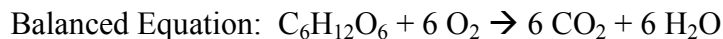


Student Name: _____ Pd. _____ Date: _____

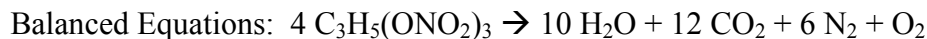
Stoichiometry Word Problems 2 SOLUTIONS

1. Cellular respiration occurs in animal cells, a reaction that is essentially the combustion of a sugar called glucose, $C_6H_{12}O_6$. If the average human uses 550 liters of oxygen when breathing, how many grams of glucose are used by this process?



$$\left(\frac{550 L O_2}{1}\right)\left(\frac{1 mol O_2}{22.4 L O_2}\right)\left(\frac{1 mol C_6H_{12}O_6}{6 mol O_2}\right)\left(\frac{180 g C_6H_{12}O_6}{1 mol C_6H_{12}O_6}\right) = 736.61 g C_6H_{12}O_6$$

2. Nitroglycerin, $C_3H_5(ONO_2)_3$, was invented in 1846 by an Italian chemist named Ascanio Sobrero. Nitroglycerine contains both an oxidant and a fuel. When it detonates, it decomposes to form carbon dioxide, water, nitrogen, and oxygen, all in a gaseous state. Every mole of the explosive that decomposes in this way generates a tremendous amount of energy – approximately 1.5 MJ (1 MJ = 1 megajoule = 1×10^6 J = 1 MJ).
- a. If 1.135 kilograms of nitroglycerin detonates, how many total liters of gas (assuming STP) are produced?

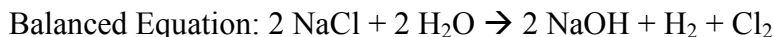


$$\left(\frac{1.135 kg \text{ nitro}}{1}\right)\left(\frac{1000 g \text{ nitro}}{1 kg \text{ nitro}}\right)\left(\frac{1 mol \text{ nitro}}{227 g \text{ nitro}}\right)\left(\frac{29 mol \text{ gas}}{4 mol \text{ nitro}}\right)\left(\frac{22.4 L \text{ gas}}{1 mol \text{ gas}}\right) = 812 L C_3H_5(ONO_2)_3$$

- b. How much energy is produced by the explosion?

$$\left(\frac{1.135 kg \text{ nitro}}{1}\right)\left(\frac{1000 g \text{ nitro}}{1 kg \text{ nitro}}\right)\left(\frac{1 mol \text{ nitro}}{227 g \text{ nitro}}\right)\left(\frac{1 MJ \text{ energy}}{1 mol \text{ nitro}}\right) = 7.5 MJ$$

3. Sodium hydroxide is a strong, inexpensive base used commonly in many industrial chemical processes. It is manufactured by creating a strong aqueous brine (NaCl) solution and applying an intense electrical current. The sodium ions react with the water to generate sodium hydroxide, hydrogen gas, and chlorine gas. If 2345 g of salt is mixed with 4562 g of water:
- a. Which reactant is limiting?



$$\left(\frac{2345 g NaCl}{1}\right)\left(\frac{1 mol NaCl}{58.5 g NaCl}\right)\left(\frac{2 mol H_2O}{2 mol NaCl}\right)\left(\frac{18 g H_2O}{1 mol H_2O}\right) = 721.54 g H_2O$$

Since the amount of H_2O required is less than the amount provided (4562 g), it is in excess, so NaCl is the limiting reagent.

b. How much base is produced?

Use the limiting reactant (NaCl):

$$\left(\frac{2345 \text{ g NaCl}}{1}\right)\left(\frac{1 \text{ mol NaCl}}{58.5 \text{ g NaCl}}\right)\left(\frac{2 \text{ mol NaOH}}{2 \text{ mol NaCl}}\right)\left(\frac{40 \text{ g NaOH}}{1 \text{ mol NaOH}}\right) = 1603.42 \text{ g NaOH}$$

c. How much of the excess reactant is left over?

From part (a), 721.54 g of water were consumed. Subtract this from the given (4562 – 721.54 = 3840 g H₂O are left over.

4. Prior to World War II, ammonia was produced by a process called dry distillation, by which ammonium chloride and quicklime (calcium oxide) react to form calcium chloride, calcium hydroxide, and ammonia. The reaction looks like this:



If 75.6 g of ammonium chloride is allowed to react with 52.8 g of quicklime:

a. How many grams of the excess reactant are left over?

$$\left(\frac{75.6 \text{ g NH}_4\text{Cl}}{1}\right)\left(\frac{1 \text{ mol NH}_4\text{Cl}}{43.5 \text{ g NH}_4\text{Cl}}\right)\left(\frac{2 \text{ mol CaO}}{2 \text{ mol NH}_4\text{Cl}}\right)\left(\frac{56.1 \text{ g CaO}}{1 \text{ mol CaO}}\right) = 97.50 \text{ g CaO}$$

Since more quicklime is needed than is provided, quicklime is the limiting reactant. Therefore:

$$\left(\frac{52.8 \text{ g CaO}}{1}\right)\left(\frac{1 \text{ mol CaO}}{56.1 \text{ g CaO}}\right)\left(\frac{2 \text{ mol NH}_4\text{Cl}}{2 \text{ mol CaO}}\right)\left(\frac{43.5 \text{ g NH}_4\text{Cl}}{1 \text{ mol NH}_4\text{Cl}}\right) = 40.94 \text{ g NH}_4\text{Cl}$$

75.6 – 40.4 = 35.2 grams of NH₄Cl are left over.

b. How many grams of ammonia are formed?

Use the limiting reactant:

$$\left(\frac{52.8 \text{ g CaO}}{1}\right)\left(\frac{1 \text{ mol CaO}}{56.1 \text{ g CaO}}\right)\left(\frac{2 \text{ mol NH}_3}{2 \text{ mol CaO}}\right)\left(\frac{17.0 \text{ g NH}_3}{1 \text{ mol NH}_3}\right) = 16.0 \text{ g NH}_3$$

5. Hydrochloric acid reacts with zinc metal to form zinc chloride and hydrogen gas. If 345.2 g of zinc metal reacts with 231.6 grams of acid. How many liters of hydrogen gas are produced? How many moles of zinc chloride are produced?



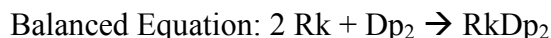
$$\left(\frac{231.6 \text{ g HCl}}{1} \right) \left(\frac{1 \text{ mol HCl}}{36.5 \text{ g HCl}} \right) \left(\frac{1 \text{ mol Zn}}{2 \text{ mol HCl}} \right) \left(\frac{65.4 \text{ g Zn}}{1 \text{ mol Zn}} \right) = 207.49 \text{ g Zn}$$

HCl is limiting,

$$\left(\frac{231.6 \text{ g HCl}}{1} \right) \left(\frac{1 \text{ mol HCl}}{36.5 \text{ g HCl}} \right) \left(\frac{1 \text{ mol H}_2}{2 \text{ mol HCl}} \right) \left(\frac{2.0 \text{ g H}_2}{1 \text{ mol H}_2} \right) = 6.35 \text{ g H}_2$$

$$\left(\frac{231.6 \text{ g HCl}}{1} \right) \left(\frac{1 \text{ mol HCl}}{36.5 \text{ g HCl}} \right) \left(\frac{1 \text{ mol ZnCl}_2}{2 \text{ mol HCl}} \right) \left(\frac{100.9 \text{ g ZnCl}_2}{1 \text{ mol ZnCl}_2} \right) = 320.12 \text{ g ZnCl}_2$$

6. Dappolonium gas (Dp_2 mw=5 g/mol) and Rockthehosium (Rk, mw=7 g/mol) combine to form Dapphousium (RkDp_2), an amazingly hard material with transdimensional properties. If 17 grams of Dp_2 and 32 grams of Rk combine, which is the limiting reactant? How many grams of Dapphousium is formed?



$$\left(\frac{17 \text{ g Dp}_2}{1} \right) \left(\frac{1 \text{ mol Dp}_2}{5 \text{ g Dp}_2} \right) \left(\frac{2 \text{ mol Rk}}{1 \text{ mol Dp}_2} \right) \left(\frac{7 \text{ g Rk}}{1 \text{ mol Rk}} \right) = 47.6 \text{ g Rk}$$

Rockthehosium is limiting.

$$\left(\frac{32 \text{ g Rk}}{1} \right) \left(\frac{1 \text{ mol Rk}}{7 \text{ g Rk}} \right) \left(\frac{1 \text{ mol RkDp}_2}{2 \text{ mol Rk}} \right) \left(\frac{12 \text{ g RkDp}_2}{1 \text{ mol RkDp}_2} \right) = 27.43 \text{ g RkDp}_2$$