TLC
Teaching and Learning Center
UNIVERSITY OF WASHINGTON TACOMA

Stoichiometry Worksheet

1. In the combustion reaction of pentane with gaseous oxygen, CO_2 and water vapor are produced.

Ex: $CH_3CH_2CH_2CH_2CH_{3\,(l)} + 8O_{2\,(g)} \longrightarrow 5CO_{2\,(g)} + 6H_2O_{(g)}$

If you are given 31.125g of pentane to burn, how many grams of CO_2 gas will be produced (assuming $O_{2\,(g)}$ is in excess)?

-the first step in a stoichiometry problem is to determine the number of moles of our reactants. We know that O_2 is in excess, so we only need to convert pentane to moles. First we must find the molecular weight (MW) of pentane:

MW of pentane: 72.15 grams/mole

Now that we know the MW we can find the moles of pentane.

$$\frac{\text{Grams of pentane}}{\text{MW of pentane}} = \frac{31.125\text{g}}{72.15\text{ g/mole}} = \boxed{0.4314 \text{ moles pentane}}$$

Next, we will use the molar ratios to determine the moles of CO_2 produced.

$CH_3CH_2CH_2CH_2CH_{3\,(l)} + 8O_{2\,(g)} \longrightarrow 5CO_{2\,(g)} + 6H_2O_{(g)}$

Comparing the moles of pentane to that of CO_2, it can be seen that the **molar ratio** is 1:5 pentane:carbon dioxide.

-Multiply moles of pentane by the **molar ratio** to calculate the moles of CO_2.

$$\frac{0.4314\ \text{~~moles pentane~~} * 5\text{ moles }CO_2}{1\ \text{~~moles pentane~~}} = \boxed{2.157\text{ moles }CO_2}$$

-Lastly, the moles of CO_2 must be converted to grams, this can be done through the use of the MW of CO_2 = 44.01 g/mole.

2.157 moles of CO_2 * MW of CO_2 44.01 g/mole = $\boxed{94.93\text{ grams of }CO_2\text{ produced}}$

2. a) If you react 19.8 g of lead(II) nitrate with 12.4 g of sodium iodide, how much lead(II) iodide is formed?

-Because we were given two amounts of our reactants, we know this is a limiting reactant problem and must first determine which reactant is limiting. First we need to write out the balanced chemical reaction:

$Pb(NO_3)_2 + 2\,NaI \longrightarrow PbI_2 + 2NaNO_3$

We now see the molar ratios between our reactants and products, but we still need to convert our products into moles before determining the limiting reactant.

First find the MW of each reactant. Divide the number of grams by the MW to determine the number of moles for each reactant.

$$\frac{19.8\text{ g of }Pb(NO_3)_2}{331.2\text{ g/mole of }Pb(NO_3)_2} = \boxed{0.0598\text{ moles of }Pb(NO_3)_2}$$

$\frac{12.4 \text{ g of NaI}}{149.89 \text{ g/mole of NaI}}$ = **0.0827 moles of NaI**

We can't determine the limiting reactant from these amounts. We must use molar ratios to determine how many moles of lead(II) iodide will be formed in this reaction. First, let's calculate how many moles of PbI_2 is formed if we assume $Pb(NO_3)_2$ is the limiting reactant:

$0.0598 \text{ } \cancel{\text{moles of } Pb(NO_3)_2} * \frac{(1 \text{ mole of } PbI_2)}{(1 \text{ } \cancel{\text{mole of } Pb(NO_3)_2})}$ = **0.0598 moles of PbI_2**

Now, let's assume NaI is the limiting reactant:

$0.0827 \text{ } \cancel{\text{moles of NaI}} * \frac{(1 \text{ mole of } PbI_2)}{(2 \text{ } \cancel{\text{moles of NaI}})}$ = **0.0414 moles of PbI_2**

Which reactant produces the least amount of product? Lead (II) Nitrate produces 0.0598 moles of PbI_2, while NaI only produces 0.0414 moles of PbI_2, therefore NaI is our limiting reactant. Now we can convert moles of PbI_2 into grams by multiplying by the MW of PbI_2:

0.0414 moles of PbI_2 * 461.01 g/mole of PbI_2 = **19.1 g of PbI_2 will be produced**

b) How much of the excess reactant is leftover after the reaction has completed?

If NaI is our limiting reactant, we know that $Pb(NO_2)_3$ is our excess reactant. We also know how many moles of each reactant we have and the molar ratio between the two reactants. For every two moles of NaI, we need one mole of $Pb(NO_2)_3$:

$0.0827 \text{ } \cancel{\text{moles of NaI}} * \frac{(1 \text{ mole of } Pb(NO_2)_3)}{(2 \text{ } \cancel{\text{moles of NaI}})}$ = **0.0414 moles of $Pb(NO_2)_3$ used up**

We were given 0.0598 moles of $Pb(NO_2)_3$, so we can subtract 0.0414 from the original amount to find out how much $Pb(NO_2)_3$ remains.

0.0598 moles – 0.0414 moles used up = 0.0184 moles remain. We can convert this to grams by multiplying the remaining moles by the MW of $Pb(NO_2)_3$:

0.0184 moles * 331.2 g/mol = **6.09 g of $Pb(NO_2)_3$ remain**

c) You conduct the above reaction using the amount given. The reaction yields 12.4 g of PbI_2. What was your percent yield?

To determine percent yield you divide your actual yield by your theoretical yield. Remember, that we calculate the theoretical yield of PbI_2 in part a (19.1 g of PbI_2). You will then divide that number by the thoretical yield and multiply by 100:

$\frac{12.4\text{g}}{19.1 \text{ g}} * 100$ = **64.9 % yield of PbI_2**