

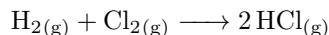
Quantities Package

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1. Calculate the following

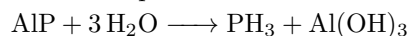
- (a) Calculate the mass of Cl_2 that combines with 2.36 g of Cl_2 (*I'm assuming this was an error and is H_2*) to form HCl in the following reaction



$$\begin{aligned} 2.36 \text{ g H}_2 * \frac{1 \text{ mol H}_2}{2 * 1.01 \text{ g H}_2} * \frac{1 \text{ mol Cl}_2}{1 \text{ mol H}_2} * \frac{2 * 35.45 \text{ g Cl}_2}{1 \text{ mol Cl}_2} \\ = 82.83 \text{ g Cl}_2 \end{aligned}$$

\therefore The mass required of Cl_2 to combine with 2.36 g of H_2 is 82.83 g.

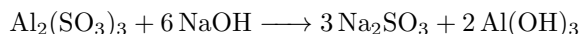
- (b) What mass of $\text{Al}(\text{OH})_3$ is formed when 7.5 g of H_2O reacts with excess of AlP ? The balanced chemical equation is



$$\begin{aligned} 7.5 \text{ g H}_2\text{O} * \frac{1 \text{ mol H}_2\text{O}}{2 * 1.01 + 16 \text{ g H}_2\text{O}} * \frac{1 \text{ mol Al}(\text{OH})_3}{3 \text{ mol H}_2\text{O}} * \frac{26.98 + (16 + 1.01) * 3 \text{ g Al}(\text{OH})_3}{1 \text{ mol Al}(\text{OH})_3} \\ = 10.82 \text{ g Al}(\text{OH})_3 \end{aligned}$$

\therefore 10.82 g of $\text{Al}(\text{OH})_3$ is formed with 2.36 g of H_2 and excess of AlP .

2. Given the following equation



- (a) If you start with 16 g of $\text{Al}_2(\text{SO}_3)_3$ and 12.5 g of NaOH , determine the limiting reagent.

What we will do is choose an arbitrary compound say, $\text{Al}_2(\text{SO}_3)_3$ and calculate the mass needed to completely react with $\text{Al}_2(\text{SO}_3)_3$ if it's less than the given mass of NaOH , then $\text{Al}_2(\text{SO}_3)_3$ is the limiting reagent, otherwise NaOH is the limiting reagent.

$$\text{Molar Mass of Al}_2(\text{SO}_3)_3 = 26.09 * 2 + (32.07 + 16 * 3) * 3 = 292.39 \text{ g/mol}$$

$$\text{Molar Mass of NaOH} = 22.99 + 16.00 + 1.01 = 40.00 \text{ g/mol}$$

$$\begin{aligned} 16 \text{ g Al}_2(\text{SO}_3)_3 * \frac{1 \text{ mol Al}_2(\text{SO}_3)_3}{292.39 \text{ g Al}_2(\text{SO}_3)_3} * \frac{6 \text{ mol NaOH}}{1 \text{ mol Al}_2(\text{SO}_3)_3} * \frac{40.00 \text{ g NaOH}}{1 \text{ mol NaOH}} \\ = 13.13 \text{ g NaOH} \end{aligned}$$

\therefore NaOH is the limiting factor as the required mass for a full reaction with $\text{Al}_2(\text{SO}_3)_3$ is greater than the given mass.

- (b) Determine the mass of Na_2SO_3 produced.

As NaOH is the limiting reagent, we must calculate the mass of Na_2SO_3 with NaOH

Molar Mass of $\text{Na}_2\text{SO}_3 = 2 * 22.99 + 32.07 + 3 * 16.00 = 126.05 \text{ g/mol}$

$$12.5 \text{ g NaOH} * \frac{1 \text{ mol NaOH}}{40.00 \text{ g NaOH}} * \frac{3 \text{ mol Na}_2\text{SO}_3}{6 \text{ mol NaOH}} * \frac{126.05 \text{ g Na}_2\text{SO}_3}{1 \text{ mol Na}_2\text{SO}_3}$$
$$= 19.70 \text{ g Na}_2\text{SO}_3$$

\therefore The mass of Na_2SO_3 produced is 19.70 grams.

- (c) Determine the mass of the excess reagent left over.

To calculate the mass of the excess reagent, we can calculate the mass used in the reaction with the limiting reagent.

$$12.5 \text{ g NaOH} * \frac{1 \text{ mol NaOH}}{40.00 \text{ g NaOH}} * \frac{1 \text{ mol Al}_2(\text{SO}_3)_3}{6 \text{ mol NaOH}} * \frac{292.39 \text{ g Al}_2(\text{SO}_3)_3}{1 \text{ mol NaOH}}$$
$$= 15.23 \text{ g Al}_2(\text{SO}_3)_3$$

Mass of excess reagent left over = $16 - 15.23 = 0.77 \text{ g Al}_2(\text{SO}_3)_3$

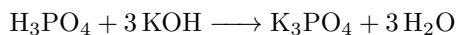
\therefore The mass of excess reagent left over is 0.77 g of $\text{Al}_2(\text{SO}_3)_3$

- (d) What is the percentage yield if 4.45 g of Na_2SO_3 was actually produced?

$$\text{Percentage Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} * 100\%$$
$$= \frac{4.45 \text{ g Na}_2\text{SO}_3}{19.70 \text{ g Na}_2\text{SO}_3} * 100\%$$
$$= 23\%$$

\therefore The percentage yield is 23% if 4.45 g of Na_2SO_3 was actually produced.

3. A student conducts an experiment involving the following balanced chemical equation



What is the percentage yield if the student obtains 49.0 g of K_3PO_4 when she combines 67.0 g of H_3PO_4 with 62.0 g of KOH ?

Molar Mass of $\text{H}_3\text{PO}_4 = 3 * 1.01 + 30.97 + 4 * 16.00 = 98.00 \text{ g/mol}$

Molar Mass of $\text{KOH} = 39.10 + 16.00 + 1.01 = 56.11 \text{ g/mol}$

Molar Mass of $\text{K}_3\text{PO}_4 = 3 * 39.10 + 30.97 + 4 * 16.00 = 212.27 \text{ g/mol}$

We must first find the limiting factor, then we can use the limiting reagent to calculate the theoretical yield, which will be used to calculate the percentage yield.

Using a different method than 2a), we can calculate the limiting factor by calculating the mole of each compound, and whichever is less is the limiting factor.

$$67.0 \text{ g H}_3\text{PO}_4 * \frac{1 \text{ mol H}_3\text{PO}_4}{98.00 \text{ g H}_3\text{PO}_4} * \frac{1 \text{ mol K}_3\text{PO}_4}{1 \text{ mol H}_3\text{PO}_4} = 0.68 \text{ mol K}_3\text{PO}_4$$

$$62.0 \text{ g KOH} * \frac{1 \text{ mol KOH}}{56.11 \text{ g KOH}} * \frac{1 \text{ mol K}_3\text{PO}_4}{3 \text{ mol KOH}} = 0.37 \text{ mol K}_3\text{PO}_4$$

∴ The limiting reagent is KOH and we will calculate the theoretical yield with KOH
As we already know 62 g of KOH is 0.37 mol of K₃PO₄ we will continue from there.

$$0.37 \text{ mol K}_3\text{PO}_4 * \frac{212.28 \text{ g K}_3\text{PO}_4}{1 \text{ mol K}_3\text{PO}_4} = 78.54 \text{ g K}_3\text{PO}_4$$

∴ The theoretical yield is 78.54 g of K₃PO₄

$$\text{Percentage Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} * 100\%$$

$$= \frac{49.0 \text{ g K}_3\text{PO}_4}{78.54 \text{ g K}_3\text{PO}_4} * 100\%$$

$$= 62\%$$

∴ The student's percentage yield is 62.