9-3 Limiting Reactants and Percent Yield

Limiting Reactant – the reactant that limits the amount of products formed and reactants used (Also called Limiting Reagent)

The limiting reactant is what runs out first.

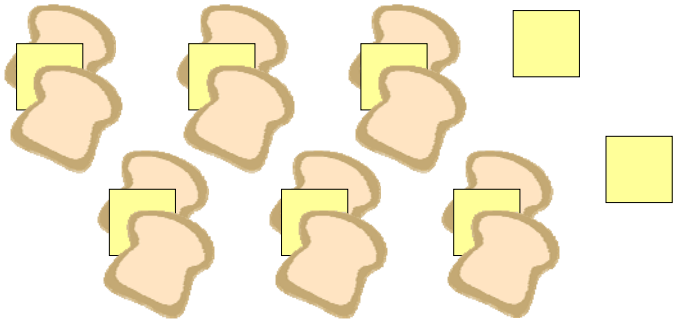
Excess Reactant – any reactant that does not completely react due to having an excess quantity

Some common excess reactants are water and oxygen.

9-3 Limiting Reactants and Percent Yield

Example:

A recipe for a cheese sandwich calls for 2 slices of bread and 1 slice of cheese. How many sandwiches can we make with 12 slices of bread and 8 slices of cheese? What is the limiting ingredient? What is the excess ingredient? How many extra slices do we have?



9-3 Limiting Reactants and Percent Yield

46g of sodium metal is added to 100g of water. What is the limiting reactant? What is the excess reactant? How much is excess?

$$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$$

Case 1 (How much H_2O is needed?)

$$46\ \cancel{g\ Na}\left[\frac{1\ mol\ \cancel{Na}}{23.0\ \cancel{g\ Na}}\right]\left[\frac{2\ \cancel{H_2O}}{2\ \cancel{Na}}\right]\left[\frac{18.0\ g\ H_2O}{1\ \cancel{mol\ H_2O}}\right] = 36\ g\ H_2O\ needed$$

Water is the excess reactant because we only need 36g and we have 100g. Sodium is the limiting reactant.

Determine the amount of excess.

100g – 36g = 64g of excess water

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$$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$$

Case 2 (How much Na is needed?)

$$100\ g\ \cancel{H_2O}\left[\frac{1\ mol\ \cancel{H_2O}}{18.0\ g\ \cancel{H_2O}}\right]\left[\frac{2\ \cancel{Na}}{2\ \cancel{H_2O}}\right]\left[\frac{23.0\ g\ Na}{1\ \cancel{mol\ Na}}\right] = 127.8\ g\ Na\ needed$$

Since more sodium is needed, it is the limiting reactant. Case 2 does not provide enough info to determine the amount of excess.

Tip – Guessing the correct limiting reactant can save you time because you will not need to do both cases for more information.

9-3 Limiting Reactants and Percent Yield

Theoretical Yield – the maximum amount of product that can be produced in a reaction from a given reactant

This is what you expect if everything goes perfect

Actual Yield – the measured amount of product from a reaction

This is what you really get

Percent Yield – the ratio of actual yield to theoretical yield

This is a percetange of how close you were to the perfect value.

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

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9-3 Limiting Reactants and Percent Yield

Example:

A birthday party for a friend had 80 invitations given out. There was a total of 68 people who showed up. What is the percent yield of attendance?

$$\% \text{ Yield} = \frac{A}{T} \times 100 =$$

$$\frac{68 \text{ showed up}}{80 \text{ invited}} \times 100 = 85\%$$

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9-3 Limiting Reactants and Percent Yield

If 75.0g of CO reacts to produce 68.4g CH_3OH (methanol), what is the percent yield of CH_3OH?

$$CO(g) + 2H_2(g) \xrightarrow{\text{catalyst}} CH_3OH(l)$$

1) Find the Theoretical Yield

$$75.0 \text{ g CO} \left(\frac{1 \text{ mol CO}}{28.0 \text{ g CO}}\right)\left(\frac{1 \text{ CH}_3\text{OH}}{1 \text{ CO}}\right)\left(\frac{32.0 \text{ g CH}_3\text{OH}}{1 \text{ mol CH}_3\text{OH}}\right) = 85.7 \text{ g } CH_3OH$$

2) Calculate the Percent Yield

$$\% \text{ Yield} = \frac{A}{T} \times 100 = \frac{68.4\text{g}}{85.7\text{g}} \times 100 = 79.8\%$$

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