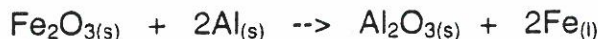


Key

# LIMITING REACTANT

## Example #1

A mixture is prepared from 25.0 g of Al and 85.0 g of Fe<sub>2</sub>O<sub>3</sub>. The reaction that occurs is described by the equation:



Which reactant is in excess and by how much and how many grams of <sup>Al<sub>2</sub>O<sub>3</sub></sup> ~~each~~ product will be made?

$$25.0 \text{ g Al} \times \frac{1 \text{ mol Al}}{27.0 \text{ g Al}} \times \frac{1 \text{ mol Al}_2\text{O}_3}{2 \text{ mol Al}} \times \frac{102.0 \text{ g Al}_2\text{O}_3}{1 \text{ mol Al}_2\text{O}_3} = \boxed{47.2 \text{ g Al}_2\text{O}_3}$$

$$85.0 \text{ g Fe}_2\text{O}_3 \times \frac{1 \text{ mol Fe}_2\text{O}_3}{159.6 \text{ g Fe}_2\text{O}_3} \times \frac{1 \text{ mol Al}_2\text{O}_3}{1 \text{ mol Fe}_2\text{O}_3} \times \frac{102.0 \text{ g Al}_2\text{O}_3}{1 \text{ mol Al}_2\text{O}_3} = 54.3 \text{ g Al}_2\text{O}_3$$

Fe<sub>2</sub>O<sub>3</sub> in excess

$$47.2 \text{ g Al}_2\text{O}_3 \times \frac{1 \text{ mol Al}_2\text{O}_3}{102.0 \text{ g Al}_2\text{O}_3} \times \frac{1 \text{ mol Fe}_2\text{O}_3}{1 \text{ mol Al}_2\text{O}_3} \times \frac{159.6 \text{ g Fe}_2\text{O}_3}{1 \text{ mol Fe}_2\text{O}_3} = 73.9 \text{ g Fe}_2\text{O}_3 \text{ used}$$

$$\therefore \text{Fe}_2\text{O}_3 \text{ in excess} \rightarrow 85.0 \text{ g} - 73.9 \text{ g} = \boxed{11.1 \text{ g Fe}_2\text{O}_3 \text{ in excess}}$$

## Example #2

Sodium hydroxide reacts with phosphoric acid to yield sodium phosphate and water. Suppose 60.0 g of sodium hydroxide is added to 20.0 g of phosphoric acid. Which reactant is in excess and by how much and many <sup>moles</sup> ~~grams~~ of products will be made?



$$60.0 \text{ g NaOH} \times \frac{1 \text{ mol NaOH}}{40.0 \text{ g NaOH}} \times \frac{1 \text{ mol Na}_3\text{PO}_4}{3 \text{ mol NaOH}} \times \frac{164.0 \text{ g Na}_3\text{PO}_4}{1 \text{ mol Na}_3\text{PO}_4} = 82.0 \text{ g Na}_3\text{PO}_4$$

$$20.0 \text{ g H}_3\text{PO}_4 \times \frac{1 \text{ mol H}_3\text{PO}_4}{98.0 \text{ g H}_3\text{PO}_4} \times \frac{1 \text{ mol Na}_3\text{PO}_4}{1 \text{ mol H}_3\text{PO}_4} \times \frac{164.0 \text{ g Na}_3\text{PO}_4}{1 \text{ mol Na}_3\text{PO}_4} = \boxed{33.5 \text{ g Na}_3\text{PO}_4}$$

$$20.0 \text{ g H}_3\text{PO}_4 \times \frac{1 \text{ mol H}_3\text{PO}_4}{98.0 \text{ g H}_3\text{PO}_4} \times \frac{3 \text{ mol H}_2\text{O}}{1 \text{ mol H}_3\text{PO}_4} \times \frac{18.0 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = \boxed{11.0 \text{ g H}_2\text{O}}$$

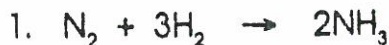
$\therefore$  NaOH is in excess

$$33.5 \text{ g Na}_3\text{PO}_4 \times \frac{1 \text{ mol Na}_3\text{PO}_4}{164.0 \text{ g Na}_3\text{PO}_4} \times \frac{3 \text{ mol NaOH}}{1 \text{ mol Na}_3\text{PO}_4} \times \frac{40.0 \text{ g NaOH}}{1 \text{ mol NaOH}} = 24.5 \text{ g NaOH used}$$

$$60.0 \text{ g NaOH} - 24.5 \text{ g NaOH} = \boxed{35.5 \text{ g NaOH in excess}}$$

# STOICHIOMETRY: LIMITING REAGENT

Name Key



How many grams of  $NH_3$  can be produced from the reaction of 28 g of  $N_2$  and 25 g of  $H_2$ ?

$$28g N_2 \times \frac{1 \text{ mol } N_2}{28.0g N_2} \times \frac{2 \text{ mol } NH_3}{1 \text{ mol } N_2} \times \frac{17g NH_3}{1 \text{ mol } NH_3} = 34.0g NH_3$$

$$25g H_2 \times \frac{1 \text{ mol } H_2}{2.0g H_2} \times \frac{2 \text{ mol } NH_3}{3 \text{ mol } H_2} \times \frac{17g NH_3}{1 \text{ mol } NH_3} = 14.1g$$

34.0 g  $NH_3$

2. How much of the excess reagent in Problem 1 is left over?

$$28.0g N_2 \times \frac{1 \text{ mol } N_2}{28.0g N_2} \times \frac{3 \text{ mol } H_2}{1 \text{ mol } N_2} \times \frac{2.0g H_2}{1 \text{ mol } H_2} = 6.0g \text{ used}$$

$$25g - 6.0g = 19.0g$$

19 g  $H_2$  excess



What volume of hydrogen at STP is produced from the reaction of 50.0 g of Mg and the equivalent of 75 g of HCl?

$$50.0g Mg \times \frac{1 \text{ mol } Mg}{24.3g Mg} \times \frac{1 \text{ mol } H_2}{1 \text{ mol } Mg} \times \frac{22.4L H_2}{1 \text{ mol } H_2} = 46.0L$$

$$75g HCl \times \frac{1 \text{ mol } HCl}{36.5g HCl} \times \frac{1 \text{ mol } H_2}{2 \text{ mol } HCl} \times \frac{22.4L}{1 \text{ mol } H_2} = 23.0L$$

23.0 L  $H_2$

4. How much of the excess reagent in Problem 3 is left over?

$$75g HCl \times \frac{1 \text{ mol } HCl}{36.5g HCl} \times \frac{1 \text{ mol } Mg}{2 \text{ mol } HCl} \times \frac{24.3g Mg}{1 \text{ mol } Mg} = 24.96 \rightarrow 25.0g Mg$$

$$50.0g - 25.0g = 25.0g Mg$$

25.0g Mg



Silver nitrate and sodium phosphate are reacted in equal amounts of 200. g each. How many grams of silver phosphate are produced?

$$200g AgNO_3 \times \frac{1 \text{ mol } AgNO_3}{169.9g AgNO_3} \times \frac{1 \text{ mol } Ag_3PO_4}{3 \text{ mol } AgNO_3} \times \frac{418.7g Ag_3PO_4}{1 \text{ mol } Ag_3PO_4} = 164.3g Ag_3PO_4$$

$$200g Na_3PO_4 \times \frac{1 \text{ mol } Na_3PO_4}{164.0g Na_3PO_4} \times \frac{1 \text{ mol } Ag_3PO_4}{1 \text{ mol } Na_3PO_4} \times \frac{418.7g Ag_3PO_4}{1 \text{ mol } Ag_3PO_4} = 164.0g Ag_3PO_4$$

164.0 g  $Ag_3PO_4$

6. How much of the excess reagent in Problem 5 is left?

$$200g AgNO_3 \times \frac{1 \text{ mol } AgNO_3}{169.9g AgNO_3} \times \frac{1 \text{ mol } Na_3PO_4}{3 \text{ mol } AgNO_3} \times \frac{164.0g Na_3PO_4}{1 \text{ mol } Na_3PO_4} = 64.4g \text{ used}$$

$$200g - 64.4g = 135.6g Na_3PO_4 \text{ in excess}$$

136 g  $Na_3PO_4$

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