Chem 11 Name: Key Block:

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# LIMITING REACTANT

**Example #1**

A mixture is prepared from 25.0 g of Al and 85.0 g of Fe2O3. The reaction that occurs is described by the equation:

$$Fe_2O_{3(s)} + 2Al_{(s)} \rightarrow Al_2O_{3(s)} + 2Fe_{(l)}$$

Which reactant is in excess and by how much and how many grams of ~~each~~ $Al_2O_3$ product will be made?

2Al = 54.0
3O = 48.0

$$25.0\,g\,Al \times \frac{1\,mol\,Al}{27.0\,g\,Al} \times \frac{1\,mol\,Al_2O_3}{2\,mol\,Al} \times \frac{102.0\,g\,Al_2O_3}{1\,mol\,Al_2O_3} = \boxed{47.2\,g\,Al_2O_3}$$

2Fe = 111.6
3O = 48.0
159.6

$$85.0\,g\,Fe_2O_3 \times \frac{1\,mol\,Fe_2O_3}{159.6\,g\,Fe_2O_3} \times \frac{1\,mol\,Al_2O_3}{1\,mol\,Fe_2O_3} \times \frac{102.0\,g\,Al_2O_3}{1\,mol\,Al_2O_3} = 54.3\,g\,Al_2O_3$$

$Fe_2O_3$ in excess

$$47.2\,g\,Al_2O_3 \times \frac{1\,mol\,Al_2O_3}{102.0\,g\,Al_2O_3} \times \frac{1\,mol\,Fe_2O_3}{1\,mol\,Al_2O_3} \times \frac{159.6\,g\,Fe_2O_3}{1\,mol\,Fe_2O_3} = 73.9\,g\,Fe_2O_3 \text{ used}$$

$\therefore Fe_2O_3$ in excess $\rightarrow$ 85.0 g − 73.9 g = $\boxed{11.1\,g\,Fe_2O_3 \text{ in excess}}$

**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 ~~moles~~ grams of products will be made?

$$3NaOH + H_3PO_4 \longrightarrow Na_3PO_4 + 3H_2O$$

$$60.0\,g\,NaOH \times \frac{1\,mol\,NaOH}{40.0\,g\,NaOH} \times \frac{1\,mol\,Na_3PO_4}{3\,mol\,NaOH} \times \frac{164.0\,g\,Na_3PO_4}{1\,mol\,Na_3PO_4} = 82.0\,g\,Na_3PO_4$$

$$20.0\,g\,H_3PO_4 \times \frac{1\,mol\,H_3PO_4}{98.0\,g\,H_3PO_4} \times \frac{1\,mol\,Na_3PO_4}{1\,mol\,H_3PO_4} \times \frac{164.0\,g\,Na_3PO_4}{1\,mol\,Na_3PO_4} = \boxed{33.5\,g\,Na_3PO_4}$$

$$20.0\,g\,H_3PO_4 \times \frac{1\,mol\,H_3PO_4}{98.0\,g\,H_3PO_4} \times \frac{3\,mol\,H_2O}{1\,mol\,H_3PO_4} \times \frac{18.0\,g\,H_2O}{1\,mol\,H_2O} = \boxed{11.0\,g\,H_2O}$$

$\therefore$ NaOH is in excess

$$33.5\,g\,Na_3PO_4 \times \frac{1\,mol\,Na_3PO_4}{164.0\,g\,Na_3PO_4} \times \frac{3\,mol\,NaOH}{1\,mol\,Na_3PO_4} \times \frac{40.0\,g\,NaOH}{1\,mol\,NaOH} = 24.5\,g\,NaOH \text{ used}$$

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

K

# STOICHIOMETRY: LIMITING REAGENT

Name Key

1. $N_2 + 3H_2 \rightarrow 2NH_3$

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

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

$25g\,H_2 \times \frac{1\,mol\,H_2}{2.0g\,H_2} \times \frac{2\,mol\,NH_3}{3\,mol\,H_2} \times \frac{17g\,NH_3}{1\,mol\,NH_3} = 141.7g$

**34 g $NH_3$**

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

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

$25g - 6.0g = 19.0g$

**19 g $H_2$ excess**

3. $Mg + 2HCl \rightarrow MgCl_2 + H_2$

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?

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

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

**23. L $H_2$**

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

$75g\,HCl \times \frac{1\,mol\,HCl}{36.5g\,HCl} \times \frac{1\,mol\,Mg}{2\,mol\,HCl} \times \frac{24.3g\,Mg}{1\,mol\,Mg} = 24.9g \rightarrow 25.0g\,Mg$

$50.0g - 25.0g = 25.0g\,Mg$

**25.0g Mg**

5. $3AgNO_3 + Na_3PO_4 \rightarrow Ag_3PO_4 + 3NaNO_3$

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

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

$200g\,Na_3PO_4 \times \frac{1\,mol\,Na_3PO_4}{164.0g\,Na_3PO_4} \times \frac{1\,mol\,Ag_3PO_4}{1\,mol\,Na_3PO_4} \times \frac{418.7g\,Ag_3PO_4}{1\,mol\,Ag_3PO_4} = 510.0g$

**164. g $Ag_3PO_4$**

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

$200g\,AgNO_3 \times \frac{1\,mol\,AgNO_3}{169.9g\,AgNO_3} \times \frac{1\,mol\,Na_3PO_4}{3\,mol\,AgNO_3} \times \frac{164g\,Na_3PO_4}{1\,mol\,Na_3PO_4} = 64.4g$ used

$200.g - 64.4 = 135.6g\,Na_3PO_4$ in excess

**136 g $Na_3PO_4$**




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