GENERAL CHEMISTRY STANDARD 8.5

8.5: Use mole ratios and dimensional analysis to solve stoichiometry problems

DEFINITIONS

- **Stoichiometric Factor:** Mole ratios among specific compounds within a chemical formula
  - Stoichiometric factors are used in dimensional analysis to convert between two compounds

EXAMPLE

- Consider the following reaction:

$Na_2S_2O_3 + AgBr \rightarrow NaBr + Na_3(Ag(S_2O_3)_2)$

What is the mass of NaBr that will be produced form 42.7 g of AgBr?

First, balance the above equation:

$\mathbf{2}\ Na_2S_2O_3 + AgBr \rightarrow NaBr + Na_3Ag(S_2O_3)_2$

Next, use the **Yellow Brick Road** to make a plan, starting with mass of AgBr:

Mass AgBr → Moles AgBr → Moles NaBr → Mass AgBr

Now set up the problem using Dimensional Analysis:

$$\frac{42.7\text{ g AgBr}}{} \times \frac{1\text{ mol AgBr}}{187.8\text{ g AgBr}} \times \frac{1\text{ mol NaBr}}{1\text{ mol AgBr}} \times \frac{102.9\text{ g NaBr}}{1\text{ mol NaBr}} = 23.4\text{ g NaBr}$$

ANOTHER EXAMPLE

- Consider the following reaction:

$B_2H_6 + O_2 \rightarrow HBO_2 + H_2O$

What is the mass of O_2 that is needed to burn 36.1 g of B_2H_6?

First, balance the above equation:

$B_2H_6 + \mathbf{3}\ O_2 \rightarrow \mathbf{2}\ HBO_2 + H_2O$

Next, use the **Yellow Brick Road** to make a plan, starting with mass of B_2H_6:

Mass B_2H_6 → Moles B_2H_6 → Moles O_2 → Mass O_2

Now set up the problem using Dimensional Analysis:

$$\frac{36.1\text{ g } B_2H_6}{} \left| \frac{1\text{ mol } B_2H_6}{27.7\text{ g } B_2H_6} \right| \frac{3\text{ mol } O_2}{1\text{ mol } B_2H_6} \left| \frac{32.0\text{ g } O_2}{1\text{ mol } O_2} \right| = 125\text{ g } O_2$$

YET ANOTHER EXAMPLE

- Consider the following reaction:

$Cu + AgNO_3 \rightarrow Ag + Cu(NO_3)_2$

How many molecules of silver will be created by 35 g of $AgNO_3$?

First, balance the above equation:

$Cu + \mathbf{2}\ AgNO_3 \rightarrow \mathbf{2}\ Ag + Cu(NO_3)_2$

Next, use the **Yellow Brick Road** to make a plan, starting with mass of B_2H_6:

Mass $AgNO_3$ → Moles $AgNO_3$ → Moles Ag → Number of Atoms of Ag

Now set up the problem using Dimensional Analysis:

$$\frac{35\text{ g } AgNO_3}{} \times \frac{1\text{ mol } AgNO_3}{169.9\text{ g } AgNO_3} \times \frac{2\text{ mol Ag}}{2\text{ mol } AgNO_3} \times \frac{6.02 \times 10^{23}\text{ atoms Ag}}{1\text{ mol Ag}} = 1.2 \times 10^{23}\text{ atoms Ag}$$

TRY IT YOURSELF

- Consider the following reaction:

$KNO_3 \rightarrow KNO_2 + O_2$

What mass of KNO_2 will be created from 12.5 g of KNO_3?

TRY IT YOURSELF SOLUTION

- Consider the following reaction:

$KNO_3 \rightarrow KNO_2 + O_2$

What mass of KNO_2 will be created from 12.5 g of KNO_3?

First, balance the above equation:

$\mathbf{2}\ KNO_3 \rightarrow \mathbf{2}\ KNO_2 + O_2$

Next, use the **Yellow Brick Road** to make a plan, starting with mass of KNO_3:

Mass KNO_3 → Moles KNO_3 → Moles KNO_2 → Mass of KNO_2

Now set up the problem using Dimensional Analysis:

$$\frac{12.5\text{ g } KNO_3}{} \left| \frac{1\text{ mol } KNO_3}{101.1\text{ g } KNO_3} \right| \frac{2\text{ mol } KNO_2}{2\text{ mol } KNO_3} \left| \frac{85.1\text{ g } KNO_2}{1\text{ mol } KNO_2} \right. = 10.5\text{ g } KNO_2$$