Stoichiometry

For those of you who have been introduced to mole to mole stoichiometry, what follows is a review of what you will have already learned. Those who have no experience with stoichiometry whatever will need to learn the basics of stoichiometry for the first time using the material below.

What is Stoichiometry?

The term **stoichiometry** comes for the Greek word *stoicheion* meaning "component" and *metron* meaning "measure." When put together, the resulting word stoichiometry refers to the measurement and relationships of quantities involved in chemical reactions. That is the stuffy definition.

For practical purposes, stoichiometry is about using a balanced equation to predict how much of one substance will react or be produced in a chemical reaction, given the amount of one other substance in the chemical reaction. The "given quantity of matter" can be in units of:

1. moles
2. grams, if the substance is in the solid state
3. solution, concentration and volume if the substance is in solution, or
4. pressure, temperature and volume if the substance is in the gas phase.

Mole-to-mole Stoichiometry

The simplest of all stoichiometry problems, this type of question involves using the mole ratio of a balanced equation to predict the number of moles of one substance, given the number of moles of another substance.

The steps required to solve such a problem are:

1. Write a balanced equation for the reaction
2. Use dimensional analysis and the mole ratio of the balanced equation to answer the question

Here is the "pattern" that can be used to solve the following example

Moles of "given" (A) ----------*predict*---------> moles of "required" (B)

Example 1:

How many moles of hydrogen gas (substance "B" or required) are needed to completely react with 6.20 mol of oxygen gas (substance "A" or given) to produce water vapor?

The balanced equation: **$2H_{2(g)}$ + $O_{2(g)}$ --------> $2H_2O_{(g)}$**

Given: 6.20 mol of $O_{2(g)}$ (A)
Find: _?_ moles of $H_{2(g)}$ (B)

x mol of $H_{2(g)}$ = 6.20 ~~mol of $O_{2(g)}$~~ x $\frac{\text{2 mol } H_{2(g)}}{\text{1 } \cancel{\text{mol } O_{2(g)}}}$ ⇐=== **(from balanced eq'n)** / ⇐=== **(same!!)**

= 12.4 mol $H_{2(g)}$

Note that the ratio $\frac{\text{2 mol } H_{2(g)}}{\text{1 mol } O_{2(g)}}$ is referred to as the "mole ratio".

Example 2:

How many moles of hydrogen gas are needed to make 2.73 moles of ammonia gas when reacted with sufficient nitrogen gas?

The balanced equation:

$3H_{2(g)}$ + $N_{2(g)}$ -------> $2NH_{3(g)}$

Given: 2.73 mol $NH_{3(g)}$ (A)
Find: _?_ mol $H_{2(g)}$ (B)

x mol of $H_{2(g)}$ = 2.73 ~~mol $NH_{3(g)}$~~ x $\frac{\text{3 mol } H_{2(g)}}{\text{2 } \cancel{\text{mol } NH_{3(g)}}}$

= 4.10 mol $H_{2(g)}$

Example 3

How many moles of sodium metal are needed to make 5.25 mole of sodium nitride?

The balanced equation:

$6Na_{(s)}$ + $N_{2(g)}$ -------> $2Na_3N_{(s)}$

Given: 5.25 mol $Na_3N_{(s)}$ (A)
Find: _?_ mol $Na_{(s)}$ (B)

x mol of $Na_{(s)}$ = 5.25 ~~mol $Na_3N_{(s)}$~~ x $\frac{\text{6 mol } Na_{(s)}}{\text{2 } \cancel{\text{mol } Na_3N_{(s)}}}$

= 15.8 mol $Na_{(s)}$