Holt Modern Chemistry Review
CHAPTER 9: STOICHIOMETRY

The following pages contain the bulk (but not all) of the information for the chapter 9 test. Focus on this content, but make sure to review class notes, activities, handouts, questions, etc. If you study this document and NOTHING else, you should at least be able to PASS the test. ** Test items will be recall, examples, and/or application of this content. ********

OUTCOMES

- Collaborate with peer(s) to understand chemistry content (C C)
- Communicate chemistry content to teacher and peer(s) (E C)
- 9.1: Determine number of moles from balanced chemical equations. (T & R)
- 9.2: Perform stoichiometry calculations such as: mole to mole, mole to gram, gram to mole, and gram to gram. (F & PK)
- 9.3: Calculate stoichiometry problems and determine the limiting reactant, excess reactant, and amount of product produced. (F & PK)

9.1: INTRODUCTION TO STOICHIOMETRY

- ***Vocabulary***
  - **composition stoichiometry** -- calculations involving the mass relationships of elements in compounds
  - **reaction stoichiometry** -- calculations involving the mass relationships between reactants and products in a chemical reaction
  - **mole ratio** -- a conversion factor that relates the amounts in moles of any two substances involved in a chemical reaction
- ***Chapter Highlights***
  - Reaction stoichiometry involves the mass relationships between reactants and products in a chemical reaction.
  - Stoichiometry is based on the law of conservation of mass.
  - Relating one substance to another requires expressing the amount of each substance in moles.
  - A mole ratio is the conversion factor that relates the amount in moles of any two substances in a chemical reaction. The mole ratio is derived from the balanced equation.
    - Example: $2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$ What is the ratio of iron to carbon dioxide? 4:3 or 4/3
  - Amount of a substance is expressed in moles, and mass of a substance is expressed by using mass units such as grams, kilograms, or milligrams.
  - Mass and amount of substance are quantities, whereas moles and grams are units.
  - A balanced chemical equation is necessary to solve any stoichiometric problem.

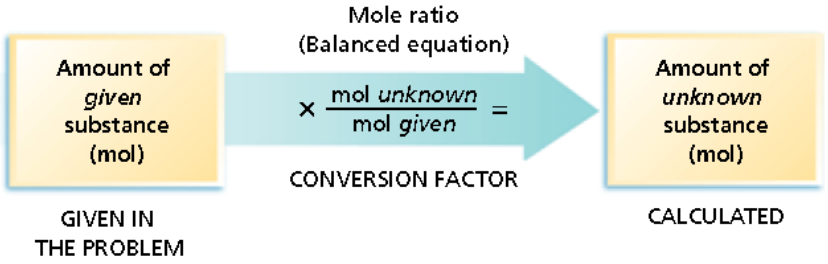
9.2: IDEAL STOICHIOMETRIC CALCULATIONS

- ***Chapter Highlights***
  - In an ideal stoichiometric calculation, the mass or the amount of any reactant or product can be calculated if the balanced chemical equation and the mass or amount of any other reactant or product is known.

9.3: LIMITING REACTANTS AND PERCENTAGE YIELD

- ***Vocabulary***
  - **limiting reactant** -- the substance that controls the quantity of product that can form in a chemical reaction
  - **excess reactant** -- the substance that is not used up completely in a reaction
  - **theoretical yield** -- the maximum amount of product that can be produced from a given amount of reactant
  - **actual yield** -- the measured amount of a product of a reaction
  - **percentage yield** -- the ratio of the actual yield to the theoretical yield, multiplied by 100
- ***Chapter Highlights***
  - In actual reactions, the reactants may be present in proportions that differ from the stoichiometric proportions required for a complete reaction in which all of each reactant is converted to product.
  - The limiting reactant controls the maximum possible amount of product formed.
    - Limiting reactant runs out FIRST.
    - Excess reactant has some LEFT OVER.
  - For many reactions, the quantity of a product is less than the theoretical maximum for that product. Percentage yield shows the relationship between the theoretical yield and actual yield for the product of a reaction.

******* FOR ALL TYPES, START WITH A BALANCED CHEMICAL EQUATION. *******

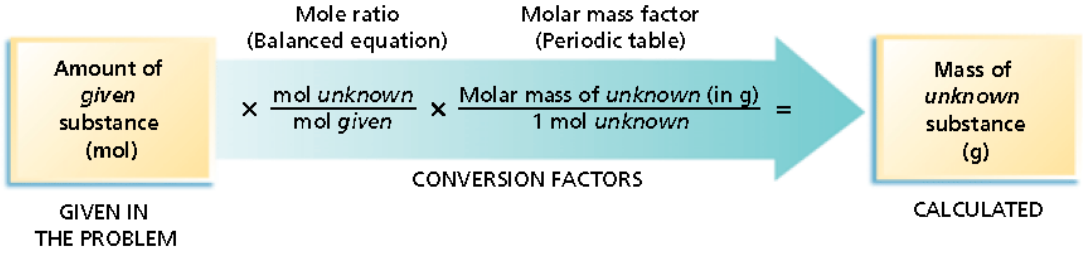


In the first type, both given and unknown quantities are expressed in moles.
There is one conversion factor used to solve it.

1 STEP: mole - mole

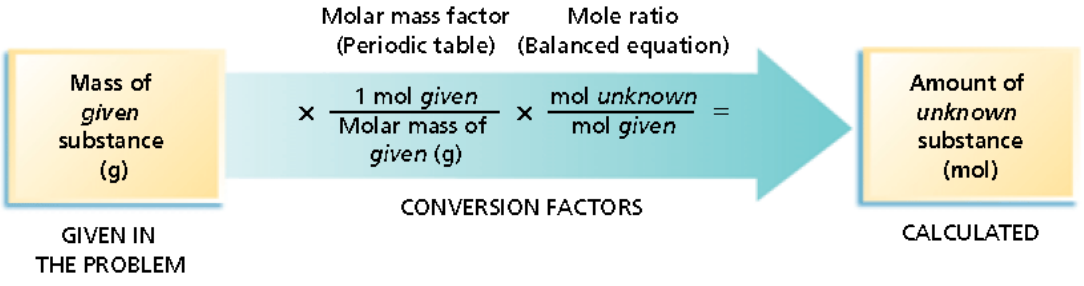
In the second type, the given quantity is expressed in moles and the unknown is in grams.
Two conversion factors are needed.

2 STEPS: mole - mass



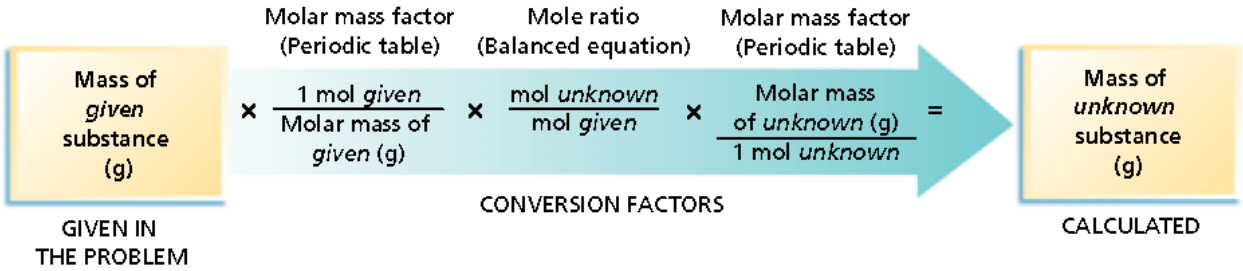
The third type has a given quantity in grams and an unknown amount in moles.
This type of problem also requires two conversion factors.

2 STEPS: mass - mole



The last type has both the given and the unknown as masses. Three conversion factors are needed.

3 STEPS: mass - mass



3 STEP MASS – MASS and LIMITING/EXCESS EXAMPLE PROBLEM:

What mass of iron will be produced from 25.00 g of iron(III) oxide and 25.00 g of carbon monoxide? Also determine the limiting reactant and the excess reactant.

(The solution is similar to a mass-mass problem, except there are two problems being solved at the same time.)

$$Fe_2O_3(s) + 3\ CO(g) \longrightarrow 2\ Fe(s) + 3\ CO_2(g)$$

$$25.00\ g\ Fe_2O_3 \times \frac{1\ mol\ Fe_2O_3}{159.70\ g} \times \frac{2\ Fe}{1\ Fe_2O_3} \times \frac{55.85\ g\ Fe}{1\ mol\ Fe} = 17.49\ g\ Fe$$

$$25.00\ g\ CO \times \frac{1\ mol\ CO}{28.01\ g} \times \frac{2\ Fe}{3\ CO} \times \frac{55.85\ g\ Fe}{1\ mol\ Fe} = 33.23 g\ Fe$$

LIMITING REACTANT: Fe_2O_3 (because it produced the smaller mass of Fe)
EXCESS REACTANT: CO (because it produced the larger mass of Fe)
AMOUNT OF PRODUCT PRODUCED: 17.49 g Fe (the amount produced by the limiting reactant before the reaction stopped)

STOICHIOMETRY MOLE ISLAND DIAGRAM

(When in doubt… convert to moles!)