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| UNIT 6  Stoichiometry |

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| **KEY IDEAS** | |
| Vocabulary | What does it mean? |
| stoichiometry |  |
| excess reagent |  |
| limiting reagent |  |
| percent yield |  |

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| **6.0 – Mole Bridge** |

**Stoichiometry:** the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ between \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

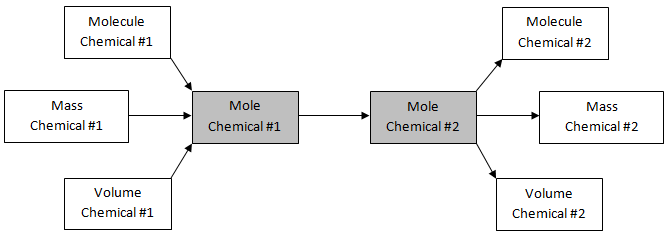
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| **Example**: What are the stoichiometric ratios of the reaction H3PO4 + 2KOH → K2HPO4 + 2H2O?  If we react 1 mole of H3PO4 with 2 moles of KOH, we will produce \_\_\_\_\_\_ mol of K2HPO4 and \_\_\_\_\_\_ mol H2O  If we want to produce 10 mol K2HPO4, \_\_\_\_\_\_ mol of H3PO4 is needed, along with \_\_\_\_\_\_ mol of KOH |

It is possible to calculate how much product is produced knowing how much reactants we start with, or vice versa (the other way around).

* stoichiometry is always done with \_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_\_\_\_ for gases
* mole ratio/molecule ratio/volume ratio, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* the conversion factor is equal to the mole ratio between two species

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| **Practice**: Consider the reaction N2 + 3H2 → 2NH3 for the following questions.   1. How many moles of NH3 are produced when 18 mol of H2 are reacted? 2. How many molecules are N2 are required to react with 15 molecules of H2? 3. How many moles of NH3 is produced when 5.11 g of N2 has reacted? 4. How many grams of NH3 is produced when 7.22 g of N2 has reacted? 5. How many molecules of N2 have reacted when 2.00 g of NH3 is produced? |
| **Practice**: Consider the reaction C3H8(g) + 5O2(g) → 3CO2(g) + 4H2O(l)   1. What volume of O2 at STP has reacted if 10.0 L of CO2 at STP was produced? 2. What mass of H2O is produced if the reaction also produced 50.0 L of CO2 at STP? |

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| QUESTION | ANSWER |



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| **6.1 – Limiting Reagents** |

Suppose you want to make a bicycle. You need one frame, one bell, one handlebar, and two tires.

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How many bicycles can you make from the following?

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| Bell | Frame | Handlebar | Tire | Bicycles | Limited By | Excess |
| 1 | 1 | 1 | 2 |  | - | - |
| 10 | 2 | 5 | 20 |  |  |  |
| 55 | 22 | 20 | 10 |  |  |  |

In chemical reactions, there is often one or more excess reactants because

* one of the reactants is really expensive so you want to make sure ALL of it is used up
* you only have a limited amount of one reactant

**excess:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**limiting reagent:** the reactant that is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ used up in a reaction

How do you find which reactant is the limiting reagent?

* method 1
  + main method
  + calculate the amount of product produced using each reactant given
  + the reactant that produces the least number of product is the limiting reagent
* method 2
  + calculate the number of moles of each reactant
  + compare the mole ratio you have to the mole ratio in the reaction
* method 3
  + good if you just want to find which reactant is the limiting reagent
  + choose 1 reactant and calculate how much of the 2nd reactant is needed
  + compare this number with how much of the 2nd reactant you actually have

When trying to predict how much product you will get from a reaction, you must perform calculations using the limiting reagent

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| **Example**: 20.0 g of H2(g) reacts with 100.0 g of O2(g) according to the reaction 2H2(g) + O2(g) → 2H2O(l).   1. What is the limiting reagent? 2. How much H2O is made? 3. How much excess of the excess reagent will be left over? | | |
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| **6.2 – Percent Yield** |

So far, all the calculations we did represent the perfect world, that all the reactants will be used up and turn into products. Is this ever true?

* all the reactants are \_\_\_\_\_\_\_\_\_\_\_ (no contaminants)
* all the reactants will \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* no errors in the experiment
* no reactants or products lost during the experiment (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_)

In the real word, the above conditions are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

This has 2 implications:

1. you will always get \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ than you expect
2. you will need to use \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ than theoretically \_\_\_\_\_\_\_\_\_\_\_\_ to make what you want

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| **Example**: When 15.0 g of CH4 is reacted with an excess of Cl2 according to the reaction CH4 + Cl2 → CH3Cl + HCl, a total of 29.7 g of CH3Cl is formed. What is the percent yield of the reaction?  **Example**: What mass of K2CO3 is produced when 1.50 g of KO2 is reacted with an excess of CO2 according to the reaction 4KO2(s) + 2CO2(g) → 2K2CO3(s) + 3O2(g) if the reaction has a 76.0% yield?  **Example**: What mass of CuO is required to make 10.0 g of Cu according to a 58.0% yield reaction  2NH3 + 3CuO → N2 + 3Cu + 3H2O? |

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| **6.3 – Percent Purity** |

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| **Example**: If 100.0 g of FeO produces 12.9 g of pure Fe according to the reaction 2FeO + 2C + O2 → 2Fe + 2CO2 what is the percentage purity of the FeO used?  **Example**: What mass of pure Na2CO3 can be formed by heating and decomposing 5.00 kg of 79.4% pure trona, Na3CO3 HCO3 · 2H2O, according to the reaction 2Na3CO3 HCO3 · 2H2O → 3Na2CO3 + CO2 + 5H2O?  **Example**: What mass of impure zinc metal having a purity of 89.5% is required to produce 975 mL of hydrogen gas at STP according to the reaction Zn(s) + 2HCl(aq) → ZnCl2(aq) + H2(g)? |