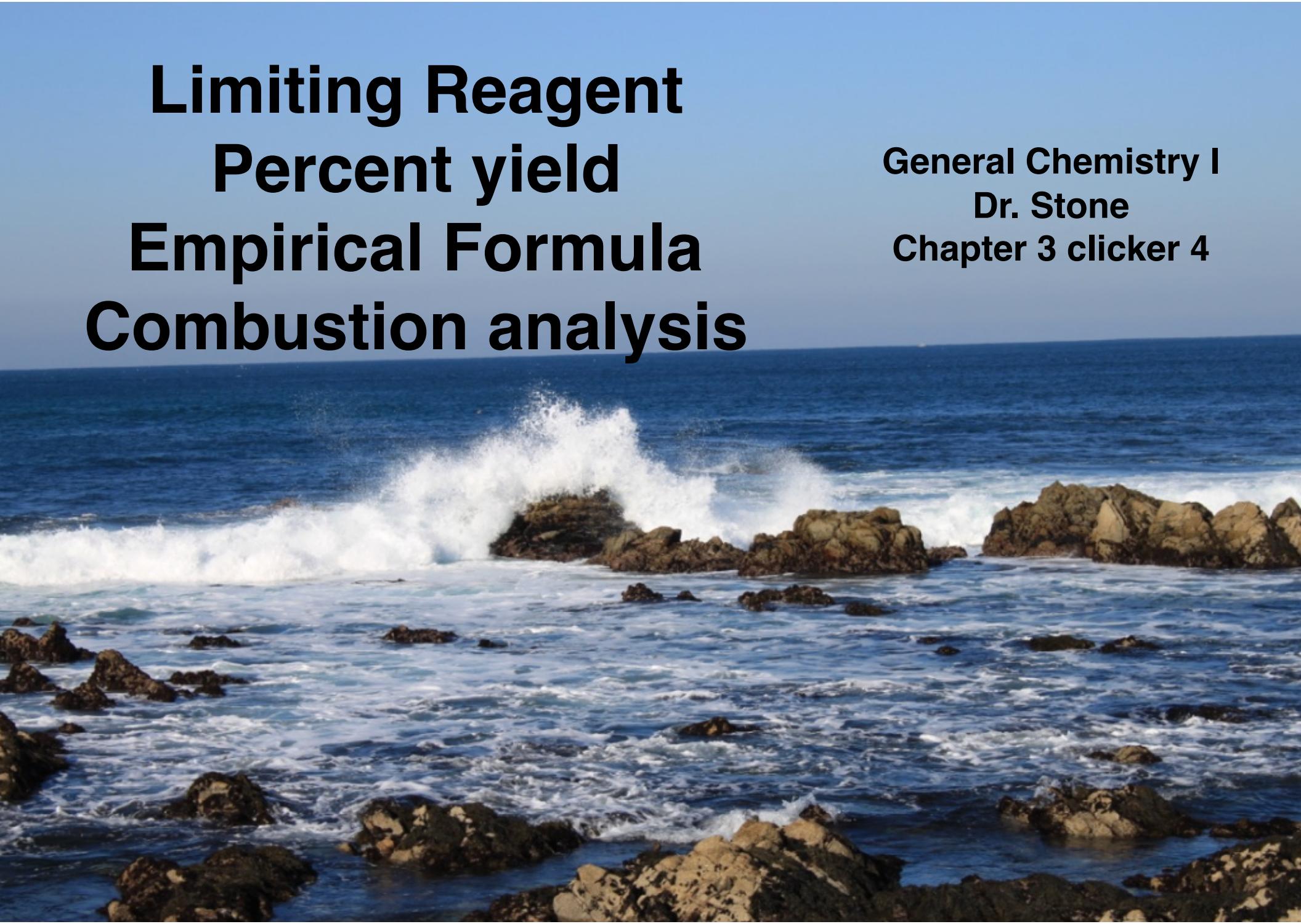
Limiting Reagent
Percent yield
Empirical Formula
Combustion analysis



General Chemistry I
Dr. Stone
Chapter 3 clicker 4

What is Leftover?

If you have 20 slices of bread and 8 slices of cheese and using the following recipe:

2 slices bread + 1 slice of cheese —> 1 sandwich

How many sandwiches can you make?

What is the limiting reagent?

What is leftover? How much is left over?

What is Leftover?

If you have 20 slices of bread and 8 slices of cheese and using the following recipe:

2 slices bread + 1 slice of cheese —> 1 sandwich

How many sandwiches can you make?

Convert bread to sandwiches: 20 slices x 1 sandwich/2 slices = 10 sandwiches

Convert cheese to sandwiches: 8 cheese slices x 1 sandwich/slice = 8 sandwiches

What is the limiting reagent?: Cheese

What is leftover? How much is left over?

8 sandwiches x 2 slices bread/sandwhich = 16 slices of bread

Have: 20 slices - 16 = 4 extra slices.

What is left over?

1. Use the limiting reagent process of converting each reactant into moles of product.

2. The smallest number of moles of product is from the limiting reagent.

3. Use the limiting reagent moles of product to covert into moles of the excess reagent needed then convert those moles to grams of the excess reagent. Those are the grams of excess reagent that are needed.

4. Subtract the needed grams of the excess reagent from the starting grams. The difference is the amount that is in excess, aka leftovers.

If 100 grams of nitrogen is reacted with 80 grams of hydrogen to produce ammonia, (NH_3), what reagent is present in excess amounts? How much excess?

1. Translate the names into symbols and balance the equation.

2. Convert grams of nitrogen to moles of ammonia

4. Convert grams of hydrogen to moles of ammonia

5. Which reactant makes the least amount of ammonia? That is the limiting reagent.

6. Use the smallest number of moles of ammonia and covert into moles of excess reagent, then into grams of excess reagent. These are the grams needed.

7. Subtract the needed grams from the starting grams to get the extra grams of the excess reagent.

If 100 grams of nitrogen is reacted with 80 grams of hydrogen to produce ammonia, (NH_3), what reagent is present in excess amounts? How much excess?

A. 21 grams of H_2

B. 21 grams of N_2

C. 59 grams of N_2

D. 59 grams of H_2

E. None of these

If 100 grams of nitrogen is reacted with 80 grams of hydrogen to produce ammonia, (NH_3), what reagent is present in excess amounts? How much excess?

1. Translate the names into symbols and balance the equation.

$$N_2 + 3H_2 \longrightarrow 2NH_3$$

2. Convert grams of nitrogen to moles of ammonia

$$100 \text{ grams } N_2 \times \frac{1 \text{ mole } N_2}{28 \text{ g}} \times \frac{2 \text{ moles } NH_3}{1 \text{ mole } N_2} = 7.14 \text{ moles } NH_3$$

4. Convert grams of hydrogen to moles of ammonia

$$80 \text{ grams } H_2 \times \frac{1 \text{ mole } H_2}{2 \text{ g}} \times \frac{2 \text{ moles } NH_3}{3 \text{ mole } H_2} = 27 \text{ moles } NH_3$$

5. Which reactant makes the least amount of ammonia? That is the limiting reagent.

N_2

6. Use the smallest number of moles of ammonia and covert into moles of excess reagent, then into grams of excess reagent. These are the grams needed.

$$7.14 \text{ moles } NH_3 \times \frac{3 \text{ mole } H_2}{2 \text{ moles } NH_3} \times \frac{2 \text{ g } H_2}{1 \text{ mole } H_2} = 21.4 \text{ g } H_2 \text{ needed}$$

7. Subtract the needed grams from the starting grams to get the extra grams of the excess reagent.

80-21.4 = 58.6 = 59 grams of excess hydrogen

Empirical Formula

The empirical formula is the lowest common multiple, whole number, mole ratio of atoms in a molecule or compound.

Methane (CH_4): 1 mole of C to 4 moles of H

Sodium oxide (Na_2O): 2 moles of sodium ions to 1 mole of oxide ions.

Magnesium chloride ($MgCl_2$): 1 mole of magnesium to 2 moles of chloride ions

Converting % to Empirical Formulas

Laughing gas has 63.65% nitrogen and 36.35% oxygen. What is the empirical formula for laughing gas?

1. Assume 100 gram sample, then each % is grams:

63.65g of N and 36.35g of O.

2. Convert grams to moles:

$$63.65 \text{ grams N} \times \frac{1 \text{ mole N}}{14.028 \text{ g}} = 4.54 \text{ moles N}$$

$$36.35 \text{ grams O} \times \frac{1 \text{ mole O}}{15.9994 \text{ g}} = 2.27 \text{ moles O}$$

3. Divide all terms by the smallest number of moles

O moles: 2.27/2.7= 1 N moles: 4.54/2.7 = 2

N_2O

Converting % to Empirical Formulas

Propane has 81.8% carbon and 18.2% hydrogen. What is the empirical formula for propane?

1. Assume 100 gram sample, then each % is grams.

2. Convert grams to moles:

3. Divide all terms by the smallest number of moles and multiply both terms by the same factor to get whole numbers.

A. $C_{6.8}H_{18.1}$ B. C_7H_{18} C. CH_3 D. C_3H_8 E. none of these

Converting % to Empirical Formulas

Propane has **81.8**% carbon and **18.2**% hydrogen. What is the empirical formula for propane?

1. Assume 100 gram sample, then each % is grams.

2. Convert grams to moles:

81.8 grams C $\times \frac{1 \text{ mole C}}{12.011 \text{ g}} =$ 6.8104moles C

18.2 grams H $\times \frac{1 \text{ mole H}}{1.0078 \text{ g}} =$ 18.05 moles H

3. Divide all terms by the smallest number of moles and multiply both terms by the same factor to get whole numbers.

6.81/6.81. = 1 mole C x 3 = 3

18.05/6.81 = 2.65 moles H x 3 = 7.95 = 8

A. $C_{6.8}H_{18.1}$ B. C_7H_{18} C. CH_3 D. C_3H_8 E. none of these

Empirical vs Molecular Formulas

Empirical is the least common multiple of the mole ratio of atoms in a compound or molecule.

Molecular formula is the actual formula, it is a multiple of the empirical formula. CH_2O is the empirical formula for glucose, $C_6H_{12}O_6$ is the molecular formula for glucose. The molecular formula is a whole number multiple of the empirical formula. ($CH_2O \times 2 = C_6H_{12}O_6$)

The empirical formula can be the same as the molecular formula. C_3H_8 is both the empirical and the molecular formula for propane.

What is the molecular formula for lycopene? The molar mass is 536.88. Lycopene has 89.49% carbon and 10.51% hydrogen.

1. Assume 100 gram sample, then each % is grams.
2. Convert grams to moles.
3. Divide all terms by the smallest number of moles and multiply both terms by the same factor to get whole numbers.
4. Determine the molar mass of the empirical formula. Divide the molar mass of the molecular formula by the molar mass of the empirical formula.
5. Multiply the coefficients (mole ratio) of the empirical formula by the the value obtained when you divided the molecular molar mass by the empirical molar mass.

A. C_5H_7 B. $C_{7.45}H_{10.42}$ C. $CH_{1.40}$ D. $C_{40}H_{57}$ E. None of these

What is the molecular formula for lycopene? The molar mass is 536.88. Lycopene has 89.49% carbon and 10.51% hydrogen.

1. Assume 100 gram sample, then each % is grams.
2. Convert grams to moles.

$$89.49 \text{ grams C} \times \frac{1 \text{ mole C}}{12.011 \text{ g}} = 7.45 \text{ moles C}$$

$$10.51 \text{ grams H} \times \frac{1 \text{ mole H}}{1.0078 \text{ g}} = 10.42 \text{ moles H}$$

3. Divide all terms by the smallest number of moles and multiply both terms by the same factor to get whole numbers.

moles H/moles C = 10.42/7.45 = 1.40
moles C/ moles C = 7.45/7.45 = 1

Need whole number ratios, so multiply both C and H by 5= C_5H_7

4. Determine the molar mass of the empirical formula. Divide the molar mass of the molecular formula by the molar mass of the empirical formula.

Molar mass of C_5H_7 is 67 ==> 536.88/67 = 8

5. Multiply the coefficients (mole ratio) of the empirical formula by the the value obtained when you divided the molecular molar mass by the empirical molar mass.

A. C_5H_7 B. $C_{7.45}H_{10.42}$ C. $CH_{1.40}$ **D. $C_{40}H_{57}$** E. None of these