High School Science Virtual Learning

Chemistry

Partial Pressure and Rate of Effusion Calculation Practice

May 15th, 2020

Chemistry

Lesson: May 15th 2020

Objective/Learning Target:

The learner will be able to relate the total pressure of a mixture of gases to the partial pressure of the component gases. Describe how the molar mass of a gas affects the rates of diffusion and effusion.

Bell Ringer

1. What is diffusion?

2. What is effusion?

Bell Ringer Answers:

1. The tendency of molecules to move from a region of higher concentration to areas of lower concentration.

2. The process of gas escaping through a tiny hole.

Today our focus is on practicing using Dalton's Law of Partial Pressures and Graham's Law of Effusion

Dalton's Law: $P_{total} = P_1 + P_2 + P_3 + \ldots$

Graham's Law: $$\frac{Rate_A}{Rate_B} = \sqrt{\frac{molar\ mass_B}{molar\ mass_A}}$$

If you need refreshers on how to use these equations, what the following videos:

-Organic Chem Tutor Dalton's Law of Partial Pressure Problems & Examples

-Organic Chem Tutor Graham's Law of Effusion Practice Problems and Examples

1. Air contains oxygen, nitrogen, carbon dioxide, and trace amounts of other gases. What is the partial pressure of oxygen (P_{O2}) at 101.30 kPa of total pressure if the partial pressures of nitrogen, carbon dioxide, and other gases are 79.10 kPa, 0.040 kPa, and 0.94 kPa respectively?

2. What is the rate of effusion if nitrogen has a molar mass of 28.0 g and helium has a molar mass of 4.0 g?

3. Determine the total pressure of a gas mixture that contains oxygen, nitrogen, and helium. The partial pressures are P_{O2} = 20.0 kPa, P_{N2} = 46.7 kPa, and P_{He} = 26.7 kPa.

4. A gas mixture containing oxygen, nitrogen, and carbon dioxide has a total pressure of 32.9 kPa. If P_{O2} = 6.6 kPa and P_{N2} = 23.0 kPa, what is P_{CO2}

5. Which gas effuses faster: hydrogen or chlorine? How much faster?

Answers

1. $P_{total} = P_1 + P_2 + P_3 \ldots$

   $P_{total} = P_{O2} + P_{N2} + P_{CO2} + P_{other}$

   $101.30\ kPa = P_{O2} + 79.10\ kPa + 0.040\ kPa + 0.94\ kPa$

   $-80.08\ kPa \qquad\qquad -80.08\ kPa$

   $21.22\ kPa = P_{O2}$

2. $$\frac{Rate_A}{Rate_B} = \sqrt{\frac{molar\ mass_B}{molar\ mass_A}}$$

$$\frac{Rate_{He}}{Rate_{N_2}} = \sqrt{\frac{molar\ mass_{N_2}}{molar\ mass_{He}}} = \sqrt{\frac{28.0\ g}{4.0\ g}} = \sqrt{7.0} = 2.7$$

Answers

3. $P_{total} = P_1 + P_2 + P_3 \ldots$

$P_{total} = P_{O2} + P_{N2} + P_{He}$

$P_{total} = 20.0\ kPa + 46.7\ kPa + 26.7\ kPa$

$P_{total} = 93.4\ kPa$

4. $P_{total} = P_1 + P_2 + P_3 \ldots$

$P_{total} = P_{O2} + P_{N2} + P_{CO2}$

$32.9\ kPa = 6.6\ kPa + 23.0\ kPa + P_{CO2}$

$-29.6\ kPa \qquad -29.6\ kPa$

$3.3\ kPa = P_{CO2}$

Answers

5. Hydrogen Gas; 5.9307 times faster

$$\frac{Rate_A}{Rate_B} = \sqrt{\frac{molar\ mass_B}{molar\ mass_A}}$$

$$\frac{Rate_{H_2}}{Rate_{Cl_2}} = \sqrt{\frac{molar\ mass_{Cl_2}}{molar\ mass_{H_2}}} = \sqrt{\frac{70.906\ g}{2.0159\ g}} = \sqrt{35.1734} = 5.9307$$

You Try:

This simulation from PhET will allow you to explore diffusion (Requires FlashPlayer)

This site will provide you practice questions about partial pressures and the answers can be found on the right side of the page

This site will provide you practice questions with Graham's Law and will check your answers as you go.