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| Chemistry 20 | Unit 2 |
| Lesson 9 - Law of Combined Volumes | 84 mins |

Density

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| - The measure of how tightly packed particles are<br><br>If the same number of moles $SF_6$ and $H_2$ gases were in identical containers, Which would have a higher density?<br><br>$PV = nRT$<br>$n = \frac{m}{M}$ $\quad PV \div V = \frac{mRT}{M} \div V$<br>$P = \frac{m}{V} \times \frac{RT}{M}$ $\quad d = \frac{m}{V}$<br><br>$P = \frac{dRT}{M}$ | $d = \frac{m}{V}$<br>$d = density\ (g/L)$<br>$m = mass\ (g)$<br>$V = volume\ (L)$<br><br>$SF_6$ - Higher molar mass<br><br>Ex. What is the density of $N_{2(g)}$ at a pressure of 1520.00 mmHg, temperature of 400.0 K?<br><br>$P = \frac{dRT}{M}$<br><br>$d = \frac{MP}{RT}$<br><br>$P = 1520.00\ mmHg \times \frac{101.325\ kPa}{760.00\ mmHg} = 202.650\ kPa$<br>$T = 400.0\ K$<br>$M = (14.01 g/mol) \times 2 = 28.02\ g/mol$<br><br>$d = \frac{(28.02 g/mol)(202.650\ kPa)}{(8.314\ \frac{L \cdot kPa}{K \cdot mol})(400.0\ K)}$<br><br>$d = 1.707\ g/L$ |

Law of Combining Volumes (pg. 164)

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| When measured at the same temperature and pressure, volumes of gaseous reactants and products are always in simple ratios of whole numbers<br><br>1.00 mol of $O_2$ will occupy the same volume as 1.00 mol of $N_2$<br><br>All gases under the same temperature and pressure (acting like ideal gases) will occupy the same volume if they have the same amount of moles. (Avogadro's Theory) | $2H_2 + O_2 \rightarrow 2H_2O$<br><br>2 : 1 : 2<br>2 mol : 1 mol : 2 mol<br><br>Ideal gas law states that type of gas doesn't matter just moles… therefore<br><br>2L : 1L : 2L<br>Or<br>4L : 2L : 4L |

Examples

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| $S_8 + (8)O_2 \rightarrow (8)So_2$<br>1 : 8 : 8<br>If you produced 4 L of $SO_2$ how much $S_8$ was used?<br>(Unit conversions…. Sig figs only from original)<br><br>4L of $SO_2$ x $\frac{1\ S_8\ (what\ you\ want)}{8\ SO_2\ (what\ you\ have)}$ = 0.5L | 4.0 L of $O_2$ was used in the combustion of methanol.<br>How much $CO_2$ was produced?<br><br>$(2)CH_3OH + (3)O_2 \rightarrow (2)CO_2 + (4)H_2O$<br><br>2 : 3 : 2 : 4<br><br>4L of $O_2$ x $\frac{2\ CO_2\ (what\ you\ want)}{3\ O_2\ (what\ you\ have)}$ = 5.3 L |

Increasing Solubility for Solids and Gases in Liquids (Ch. 4)

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| <u>Solids</u><br>- Increase T (more motion) (collisions)<br>- $P_{ext}$ Ineffective | <u>Gases</u><br>- Decrease T (Calms gas down) (lease collisions)<br>- Increase $P_{ext}$ (closer together) |

Pg. 181 (1-21)

# Chemistry 20 - Unit 2 - Law of Combined Gases

Name: ________________________________

1. Butane, $C_4H_{10(g)}$, is highly valued as a readily available hydrocarbon that can be used in a variety of applications, including household lighters.
    a. Write a balanced chemical equation, complete with state subscripts, detailing the complete combustion of butane.
    b. If 3.0 L of butane are consumed in this reaction, what volume of carbon dioxide is produced?
2. Gaseous hydrogen chloride, $HCl_{(g)}$, is often used to prepare hydrochloric acid for use in laboratory and industrial settings.
    a. Write a balanced chemical equation, complete with state subscripts, detailing the formation of hydrogen chloride from its elements.
    b. If 1.5 mol of hydrogen are consumed in this reaction, how many mol of hydrogen chloride are produced?

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3. The Fritz-Haber process was discovered in the early 20th century and revolutionized agriculture by allowing the mass production of ammonia, $NH_{3(g)}$, to take place.
    a. Write a balanced chemical equation, complete with state subscripts, detailing the formation of ammonia from its elements.
    b. If 4.0 mL of nitrogen are consumed in this reaction, what volume of ammonia is produced in litres?

4. Gas barbeques burn propane, $C_3H_{8(g)}$, using oxygen from the air.
    a. Write a balanced chemical equation, complete with state subscripts, detailing the complete combustion of propane.
    b. If 5.00 L of propane are burned, what volume of carbon dioxide is produced in millilitres?

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