

Molar Volume of a Gas – Notes and Practice

***** One mole of any gas occupies 22.4 liters at STP. *****

MOLE MAP:

KEY

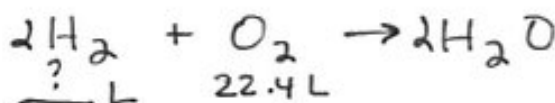
Example 1: What is the volume of 5.0 moles of carbon dioxide at STP?

$$\frac{5 \text{ mol CO}_2}{1} \left| \frac{22.4 \text{ L CO}_2}{1 \text{ mol CO}_2} \right. = \boxed{112 \text{ L CO}_2}$$

Example 2: Calculate the number of moles of ammonia gas, NH₃, in 2.3 liters measured at STP.

$$\frac{2.3 \text{ L NH}_3}{1} \left| \frac{1 \text{ mol NH}_3}{22.4 \text{ L NH}_3} \right. = \boxed{.10 \text{ mol NH}_3}$$

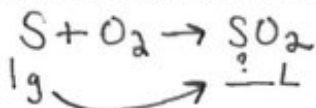
Example 3: What volume of hydrogen will react with 22.4 liters of oxygen to form water? (All volumes are measured at STP.)



mole ratio = volume ratio *

$$\frac{22.4 \text{ L O}_2}{1} \left| \frac{1 \text{ mol O}_2}{22.4 \text{ L O}_2} \right| \frac{2 \text{ mol H}_2}{1 \text{ mol O}_2} \left| \frac{22.4 \text{ L H}_2}{1 \text{ mol H}_2} \right. = \boxed{44.8 \text{ L H}_2}$$

Example 4: When sulfur burns in air it forms sulfur dioxide. What volume of sulfur dioxide (at STP) is produced when 1 gram of sulfur burns?



$$\frac{1 \text{ g S}}{1} \left| \frac{1 \text{ mol S}}{32.07 \text{ g S}} \right| \frac{1 \text{ mol SO}_2}{1 \text{ mol S}} \left| \frac{22.4 \text{ L SO}_2}{1 \text{ mol SO}_2} \right| = \boxed{.7 \text{ L SO}_2}$$

Example 5: What is the density of Br₂ at STP?

$$D = \frac{M}{V} = \frac{\text{molar mass}}{\text{molar volume}} = \frac{159.80 \text{ g}}{22.4 \text{ L}} = \boxed{7.13 \text{ g/L}}$$

$$\text{Br}_2 = \frac{159.80 \text{ g}}{1 \text{ mole}} \rightarrow M$$

$$T = 273 \text{ K}$$

$$P = 1 \text{ atm}$$

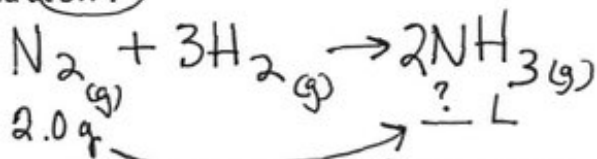
$$PV = nRT$$

$$V = \frac{nRT}{P}$$

$$V = 22.4 \text{ L}$$

$$D = \frac{159.80 \text{ g}}{22.4 \text{ L}} = \boxed{7.13 \text{ g/L}}$$

Example 6: Nitrogen reacts with hydrogen to produce ammonia (NH₃). If 2.0 grams of nitrogen reacts with an excess of hydrogen, how many liters of ammonia will be produced at STP?



$$\frac{2.0 \text{ g N}_2}{1} \left| \frac{1 \text{ mol N}_2}{28.02 \text{ g N}_2} \right| \frac{2 \text{ mol NH}_3}{1 \text{ mol N}_2} \left| \frac{22.4 \text{ L NH}_3}{1 \text{ mol NH}_3} \right| = \boxed{3.2 \text{ L NH}_3}$$

Practice Problems

1. Calculate the number of moles contained in 6.500 L of sulfur dioxide at STP?

$$V = 6.500 \text{ L}$$

$$T = 0^\circ\text{C} = 273 \text{ K}$$

$$P = 1 \text{ atm}$$

$$n = ?$$

$$PV = nRT$$

$$n = \frac{PV}{RT}$$

$$n = \frac{(1)(6.500)}{(0.0821)(273)} = .290 \text{ mol SO}_2$$

$$\frac{6.500 \text{ L SO}_2}{1} \left| \frac{1 \text{ mole SO}_2}{22.4 \text{ L SO}_2} \right| = \boxed{.290 \text{ mol SO}_2}$$

2. What volume would a 200.0 g sample of hydrogen sulfide gas occupy at STP?

$$\frac{200.0 \text{ g H}_2\text{S}}{1} \left| \frac{1 \text{ mol H}_2\text{S}}{34.09 \text{ g H}_2\text{S}} \right| \frac{22.4 \text{ L H}_2\text{S}}{1 \text{ mol H}_2\text{S}} = \boxed{131.4 \text{ L H}_2\text{S}}$$

3. If a balloon filled with carbon dioxide gas occupies a volume of 31 L at (STP), what is the mass of the gas?

$$\frac{31 \text{ L CO}_2}{1} \times \frac{1 \text{ mol CO}_2}{22.4 \text{ L CO}_2} \times \frac{44.01 \text{ g CO}_2}{1 \text{ mol CO}_2} = 60.9 \text{ g CO}_2$$

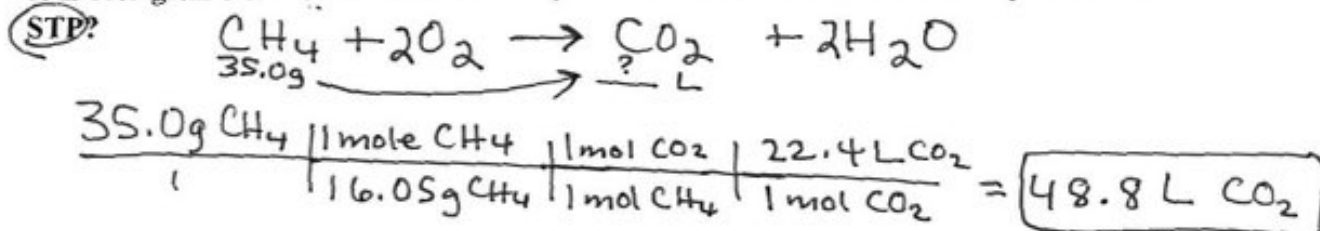
4. A sample of ammonia (NH₃) contains 0.500 mol. What volume at (STP) would the gas occupy?

$$\frac{0.500 \text{ mol NH}_3}{1} \times \frac{22.4 \text{ L NH}_3}{1 \text{ mol NH}_3} = 11.2 \text{ L NH}_3$$

5. What is the density of helium at (STP)?

$$D = \frac{M}{V} = \frac{\text{molar mass}}{\text{molar volume}} = \frac{4.00 \text{ g}}{22.4 \text{ L}} = 0.179 \text{ g/L}$$

6. If 35.0 grams of methane (CH₄) burns in air, what volume of carbon dioxide is produced at (STP)?



7. When 2.0 Liters of hydrogen reacts with excess oxygen, what mass of water vapor is produced? Assume all gases are at (STP)?

