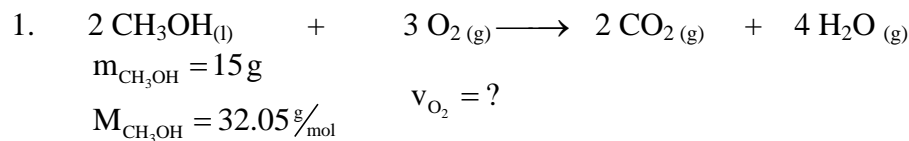


Chemistry 20 – Lesson 33

Gas Volume Stoichiometry

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A. calculate moles

$$n_{\text{CH}_3\text{OH}} = \frac{15 \text{ g}}{32.05 \text{ g/mol}}$$

$$n_{\text{CH}_3\text{OH}} = 0.47 \text{ mol}$$

B. mole ratio

$$\frac{n_{\text{O}_2}}{3} = \frac{n_{\text{CH}_3\text{OH}}}{2}$$

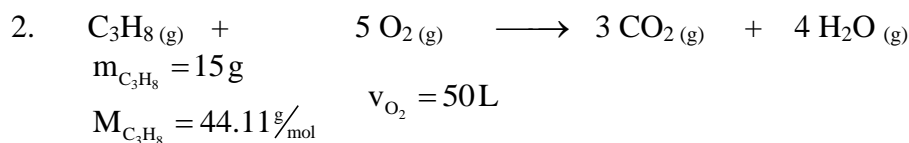
$$\frac{n_{\text{O}_2}}{3} = \frac{0.47 \text{ mol}}{2}$$

$$n_{\text{O}_2} = 0.70 \text{ mol}$$

C. calculate volume

$$v_{\text{O}_2} = 0.70 \text{ mol}(24.8 \text{ L/mol})$$

$v_{\text{O}_2} = 17 \text{ L}$



/6

A. calculate moles

$$n_{\text{O}_2} = \frac{50 \text{ L}}{24.8 \text{ L/mol}}$$

$$n_{\text{O}_2} = 2.0 \text{ mol}$$

B. mole ratio

$$\frac{n_{\text{C}_3\text{H}_8}}{1} = \frac{n_{\text{O}_2}}{5}$$

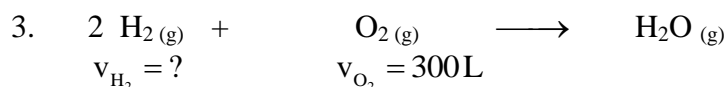
$$\frac{n_{\text{C}_3\text{H}_8}}{1} = \frac{2.0 \text{ mol}}{5}$$

$$n_{\text{C}_3\text{H}_8} = 0.40 \text{ mol}$$

C. calculate mass

$$m_{\text{C}_3\text{H}_8} = 0.40 \text{ mol}(44.11 \text{ g/mol})$$

$m_{\text{C}_3\text{H}_8} = 18 \text{ g}$



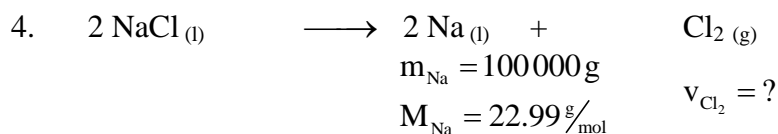
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A. mole/gas volume ratio

$$\frac{v_{\text{H}_2}}{2} = \frac{v_{\text{O}_2}}{1}$$

$$\frac{v_{\text{H}_2}}{2} = \frac{300 \text{ L}}{1}$$

$v_{\text{H}_2} = 600 \text{ L}$



/6

A. calculate moles

$$n_{\text{Na}} = \frac{100\,000 \text{ g}}{22.99 \text{ g/mol}}$$

$$n_{\text{Na}} = 4349.7 \text{ mol}$$

B. mole ratio

$$\frac{n_{\text{Cl}_2}}{1} = \frac{n_{\text{Na}}}{2}$$

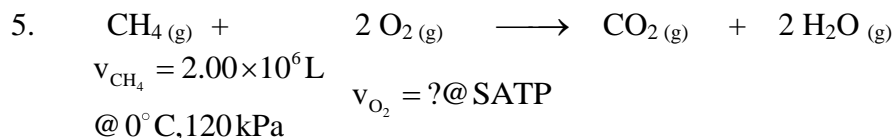
$$\frac{n_{\text{Cl}_2}}{1} = \frac{4349.7 \text{ mol}}{2}$$

$$n_{\text{Cl}_2} = 2174.86 \text{ mol}$$

C. calculate volume

$$v_{\text{Cl}_2} = 2174.86 \text{ mol}(24.8 \text{ L/mol})$$

$$v_{\text{Cl}_2} = 53.9 \text{ kL}$$



/6

A. calculate moles

$$n_{\text{CH}_4} = \frac{pv}{RT}$$

$$n_{\text{CH}_4} = \frac{120 \text{ kPa} \times 2.00 \times 10^6 \text{ L}}{8.31 \frac{\text{kPa} \cdot \text{L}}{\text{mol} \cdot \text{K}} \times 273 \text{ K}}$$

$$n_{\text{CH}_4} = 1.06 \times 10^5 \text{ mol}$$

B. mole ratio

$$\frac{n_{\text{O}_2}}{2} = \frac{n_{\text{CH}_4}}{1}$$

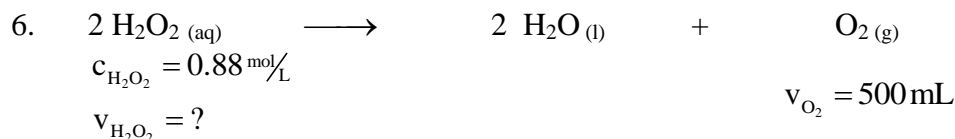
$$\frac{n_{\text{O}_2}}{2} = \frac{1.06 \times 10^5 \text{ mol}}{1}$$

$$n_{\text{O}_2} = 2.12 \times 10^5 \text{ mol}$$

C. calculate volume

$$v_{\text{O}_2} = 2.12 \times 10^5 \text{ mol} \times 24.8 \text{ L/mol}$$

$$v_{\text{O}_2} = 5.25 \times 10^6 \text{ L or } 5.25 \text{ ML}$$



/6

A. calculate moles

$$n_{\text{O}_2} = \frac{0.500 \text{ L}}{24.8 \text{ L/mol}}$$

$$n_{\text{O}_2} = 0.02016 \text{ mol}$$

B. mole ratio

$$\frac{n_{\text{H}_2\text{O}_2}}{2} = \frac{n_{\text{O}_2}}{1}$$

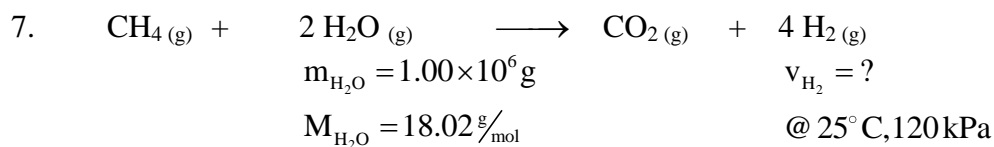
$$\frac{n_{\text{H}_2\text{O}_2}}{2} = \frac{0.02016 \text{ mol}}{1}$$

$$n_{\text{H}_2\text{O}_2} = 0.04032 \text{ mol}$$

C. calculate volume

$$v_{\text{H}_2\text{O}_2} = \frac{0.04032 \text{ mol}}{0.88 \text{ mol/L}}$$

$$v_{\text{H}_2\text{O}_2} = 46 \text{ mL}$$



/6

A. calculate moles

$$n_{\text{H}_2\text{O}} = \frac{1000000 \text{ g}}{18.02 \frac{\text{g}}{\text{mol}}}$$

$$n_{\text{H}_2\text{O}} = 55493.9 \text{ mol}$$

B. mole ratio

$$\frac{n_{\text{H}_2}}{4} = \frac{n_{\text{H}_2\text{O}}}{2}$$

$$\frac{n_{\text{H}_2}}{4} = \frac{55493.9 \text{ mol}}{2}$$

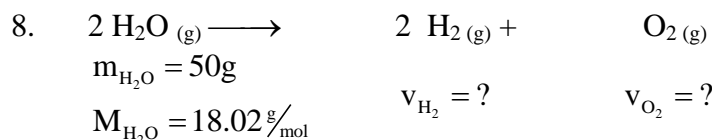
$$n_{\text{H}_2} = 110987.8 \text{ mol}$$

C. calculate volume

$$v_{\text{H}_2} = \frac{nRT}{p}$$

$$v_{\text{H}_2} = \frac{110987.8 \text{ mol} \times 8.31 \frac{\text{kPa} \cdot \text{L}}{\text{mol} \cdot \text{K}} \times 298 \text{ K}}{120 \text{ kPa}}$$

$v_{\text{H}_2} = 2.3 \times 10^6 \text{ L or } 2.3 \text{ ML}$



/9

A. calculate moles

$$n_{\text{H}_2\text{O}} = \frac{50 \text{ g}}{18.02 \frac{\text{g}}{\text{mol}}}$$

$$n_{\text{H}_2\text{O}} = 2.77 \text{ mol}$$

B. mole ratios

$$\frac{n_{\text{H}_2}}{2} = \frac{n_{\text{H}_2\text{O}}}{2}$$

$$\frac{n_{\text{H}_2}}{2} = \frac{2.77 \text{ mol}}{2}$$

$$n_{\text{H}_2} = 2.77 \text{ mol}$$

$$\frac{n_{\text{O}_2}}{1} = \frac{n_{\text{H}_2\text{O}}}{2}$$

$$\frac{n_{\text{O}_2}}{1} = \frac{2.77 \text{ mol}}{2}$$

$$n_{\text{O}_2} = 1.39 \text{ mol}$$

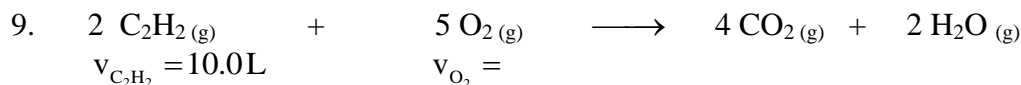
C. calculate volumes

$$v_{\text{H}_2} = 2.77 \text{ mol} \times 22.4 \frac{\text{L}}{\text{mol}}$$

$v_{\text{H}_2} = 62.1 \text{ L}$

$$v_{\text{O}_2} = 1.39 \text{ mol} \times 22.4 \frac{\text{L}}{\text{mol}}$$

$v_{\text{O}_2} = 31.1 \text{ L}$



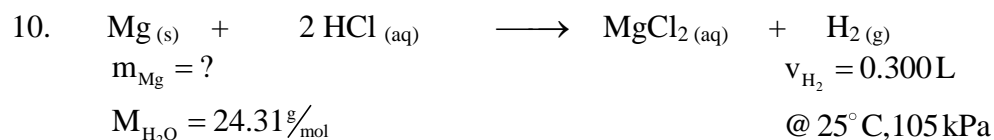
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A. mole/gas volume ratio

$$\frac{v_{\text{O}_2}}{5} = \frac{v_{\text{C}_2\text{H}_2}}{2}$$

$$\frac{v_{\text{O}_2}}{5} = \frac{10.0 \text{ L}}{2}$$

$v_{\text{O}_2} = 25.0 \text{ L}$



/6

A. calculate moles

$$n_{\text{H}_2} = \frac{pv}{RT}$$

$$n_{\text{H}_2} = \frac{105 \text{ kPa} \times 0.300 \text{ L}}{8.31 \frac{\text{kPa} \cdot \text{L}}{\text{mol} \cdot \text{K}} \times 298 \text{ K}}$$

$$n_{\text{H}_2} = 0.0127 \text{ mol}$$

B. mole ratio

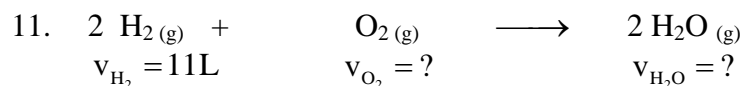
$$\frac{n_{\text{Mg}}}{1} = \frac{n_{\text{H}_2}}{1}$$

$$n_{\text{Mg}} = 0.0127 \text{ mol}$$

C. calculate mass

$$m_{\text{Mg}} = 0.0127 \text{ mol} (24.31 \text{ g/mol})$$

$$m_{\text{Mg}} = 0.31 \text{ g}$$



/6

assume that the gases are all under the same conditions

$$\frac{v_{\text{O}_2}}{1} = \frac{v_{\text{H}_2}}{2}$$

$$\frac{v_{\text{O}_2}}{1} = \frac{11 \text{ L}}{2}$$

$$v_{\text{O}_2} = 5.5 \text{ L}$$

$$\frac{v_{\text{H}_2\text{O}}}{2} = \frac{v_{\text{H}_2}}{2}$$

$$\frac{v_{\text{H}_2\text{O}}}{2} = \frac{11 \text{ L}}{2}$$

$$v_{\text{H}_2\text{O}} = 11 \text{ L}$$



/6

A. calculate moles

$$n_{\text{CH}_4} = \frac{14 \text{ g}}{16.04 \text{ g/mol}}$$

$$n_{\text{CH}_4} = 0.873 \text{ mol}$$

B. mole ratio

$$\frac{n_{\text{CO}_2}}{1} = \frac{n_{\text{CH}_4}}{1}$$

$$n_{\text{CO}_2} = 0.873 \text{ mol}$$

C. calculate volume & %error

$$v_{\text{CO}_2} = \frac{nRT}{p}$$

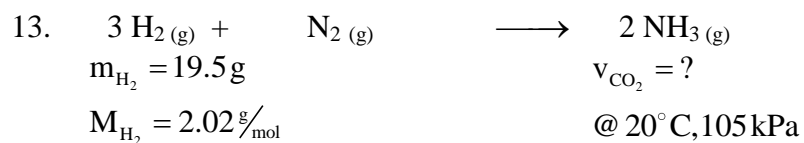
$$v_{\text{CO}_2} = \frac{0.873 \text{ mol} \times 8.31 \frac{\text{kPa} \cdot \text{L}}{\text{mol} \cdot \text{K}} \times 293 \text{ K}}{105 \text{ kPa}}$$

$$v_{\text{CO}_2} = 20.2 \text{ L}$$

$$\% \text{error} = \frac{\text{exp. yield} - \text{theo. yield}}{\text{theo. yield}} \times 100$$

$$\% \text{error} = \frac{19.6 - 20.2}{20.2} \times 100$$

$$\% \text{error} = -3.2\%$$



/6

A. calculate moles

$$n_{\text{H}_2} = \frac{19.5 \text{ g}}{2.02 \text{ g/mol}}$$

$$n_{\text{H}_2} = 9.65 \text{ mol}$$

B. mole ratio

$$\frac{n_{\text{NH}_3}}{2} = \frac{n_{\text{H}_2}}{3}$$

$$\frac{n_{\text{NH}_3}}{2} = \frac{9.65 \text{ mol}}{3}$$

$$n_{\text{NH}_3} = 6.44 \text{ mol}$$

C. calculate volume & %error

$$v_{\text{NH}_3} = 6.44 \text{ mol} \times 22.4 \text{ L/mol}$$

$$v_{\text{NH}_3} = 144 \text{ L}$$

$$\% \text{error} = \frac{\text{exp. yield} - \text{theo. yield}}{\text{theo. yield}} \times 100$$

$$\% \text{error} = \frac{140 - 144}{144} \times 100$$

$$\% \text{error} = -2.9\%$$