

~~36.4~~ = 78  
 36.4R 28.4 free

1. In an experiment similar to Experiment 11, a student reacted 0.085 grams of magnesium in a eudiometer filled with water and HCl. The water temperature was 26.0°C. The barometer in the lab read 29.20 inches of mercury and 56.2 milliliters of gas were collected.

(a) Based on the student's data, what is the value of the ideal gas constant, R?

(At 26.0°C, the vapor pressure for water is 25.2 mm Hg.)

(b) What is the percent error for the student's experiment?

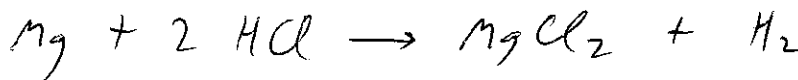
(The true value of R is  $0.08206 \frac{\text{liters} \cdot \text{atm}}{\text{K} \cdot \text{mol}}$ .)

total Eq. = 5

28

(a)

23



$$R = \frac{PV}{nT}$$

$$P_{\text{H}_2} = P_{\text{TOT}} - P_{\text{H}_2\text{O}} \quad (1)$$

$$P_{\text{TOT}} = 29.20 \text{ in} \left( \frac{2.54 \text{ cm}}{1 \text{ in}} \right) \left( \frac{1 \text{ m}}{100 \text{ cm}} \right) \left( \frac{1000 \text{ mm}}{1 \text{ m}} \right) = 741.7 \text{ mm Hg}$$

$$P_{\text{H}_2} = 741.7 - 25.2 = 716.5 \text{ mm Hg} \times \left( \frac{1 \text{ atm}}{760 \text{ mm}} \right) = 0.9428 \text{ atm}$$

$$T = 26.0^\circ\text{C} + 273.15 = \cancel{325.2 \text{ K}} 299.2 \text{ K} \quad (1)$$

$$V = 56.2 \text{ mL} \left( \frac{1 \text{ L}}{1000 \text{ mL}} \right) = 0.0562 \text{ L} \quad (1)$$

$$n = 0.085 \text{ g Mg} \left( \frac{1 \text{ mol Mg}}{24.31 \text{ g}} \right) \left( \frac{1 \text{ mol H}_2}{1 \text{ mol Mg}} \right) = 0.003497 \text{ mol H}_2$$

$$R = \frac{PV}{nT} = \frac{(0.9428 \text{ atm})(0.0562 \text{ L})}{(0.003497 \text{ mol})(299.2 \text{ K})} = \frac{0.0506 \text{ L} \cdot \text{atm}}{0.0466 \text{ K} \cdot \text{mol}}$$

$$\% \text{ error} = \left( \frac{\text{true} - \text{obs}}{\text{true}} \right) \times 100 = \left( \frac{0.08206 - 0.0466}{0.08206} \right) \times 100 = \frac{43.2\%}{38.37\%}$$

$$\begin{array}{r} 0.08206 \\ - 0.0466 \\ \hline 0.0337 \end{array}$$

2. What is the molarity of a solution made by dissolving 9.50 grams of chromium (III) nitrate in with water so that the total volume is 250.00 mL?

$$M(\text{NO}_3)_3 = 52.00 + (14.01 \times 3) + (16.00 \times 9) = 238.03 \text{ g/mol}$$

$$M = \frac{\text{mol}}{\text{L}} = \frac{(9.50 \text{ g}) \left( \frac{1 \text{ mol}}{238.03 \text{ g}} \right)}{(250.00 \text{ mL}) \left( \frac{1 \text{ L}}{1000 \text{ mL}} \right)} = 0.160 \text{ M}$$

36

3. What is the mass percent of a solution prepared by dissolving 35.0 grams of sodium sulfate in 100.0 grams of water?

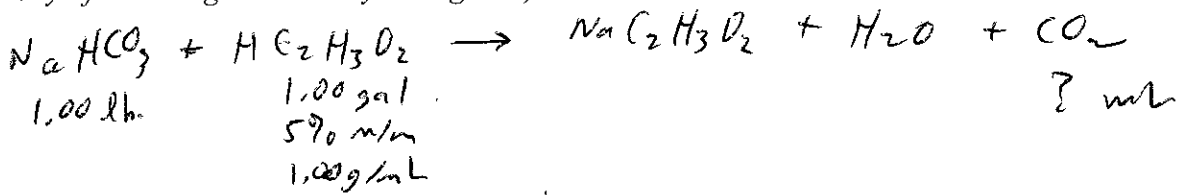
8

$$\text{Mass Percent} = \frac{35.0 \text{ g Na}_2\text{SO}_4}{(100.0 + 35.0) \text{ g solution}} \times 100 = 25.9\%$$

*(Handwritten notes: 1) solute / 2) solution, 1) Ans, 1) SF)*

4. Solid sodium bicarbonate and aqueous acetic acid react to form carbon dioxide and water. The other product of the reaction is sodium acetate, which remains dissolved as an aqueous solution. (As noted on page 121 of your lab manual, the carbonic acid that originally forms in this double-displacement reaction decomposes into water and carbon dioxide gas.) At 22°C and 749 torr, how many milliliters of CO<sub>2</sub> gas would form from the reaction of the contents of a 1.00-pound box of baking soda (pure sodium bicarbonate) with a 1.00-gallon container of distilled white vinegar (about 5.00 percent acetic acid, by mass)? (Assume that the density of the vinegar is exactly 1.00 g/mL.)

34



$$1.00 \text{ lb NaHCO}_3 \left( \frac{453.6 \text{ g}}{1 \text{ lb}} \right) \left( \frac{1 \text{ mol NaHCO}_3}{84.008 \text{ g}} \right) \left( \frac{1 \text{ mol CO}_2}{1 \text{ mol NaHCO}_3} \right) = 5.399 \text{ mol CO}_2$$

molar mass = 22.99  
 NaHCO<sub>3</sub> + 1.008  
 + 12.01  
 + 16.00 x 3  
 84.008 g/mol

~~NaC<sub>2</sub>H<sub>3</sub>O<sub>2</sub> = 22.99 x 2~~  
 1.008 x 2  
 16.00 x 2  
 81.004 g/mol

HC<sub>2</sub>H<sub>3</sub>O<sub>2</sub>  
 1.008 x 4  
 12.01 x 2  
 16.00 x 2  
 60.052 g/mol

$$1.00 \text{ gal HC}_2\text{H}_3\text{O}_2 \left( \frac{3.785 \text{ L}}{1 \text{ gal}} \right) \left( \frac{10^3 \text{ mL}}{1 \text{ L}} \right) \left( \frac{1 \text{ g}}{1 \text{ mL}} \right) \left( \frac{5.00 \text{ g HC}_2\text{H}_3\text{O}_2}{100 \text{ g solution}} \right) \left( \frac{1 \text{ mol HC}_2\text{H}_3\text{O}_2}{60.052 \text{ g}} \right) \left( \frac{1 \text{ mol CO}_2}{1 \text{ mol HC}_2\text{H}_3\text{O}_2} \right) = 3.151 \text{ mol CO}_2$$

$PV = nRT$   
 $T = 22^\circ\text{C} + 273.15 = 295 \text{ K}$   
 $P = 749 \text{ torr} \left( \frac{1 \text{ atm}}{760 \text{ torr}} \right) = 0.9855 \text{ atm}$

$$V = \frac{nRT}{P} = \frac{(3.151 \text{ mol}) (0.08206 \frac{\text{L atm}}{\text{K mol}}) (295 \text{ K})}{(0.9855 \text{ atm})} \left( \frac{1000 \text{ mL}}{1 \text{ L}} \right) = 7.74 \times 10^4 \text{ mL}$$

42