Name _____ Date _____ Class _____

Chapter 19

CONCEPT REVIEW

Molar Volume

EXAMPLE: Calculate the volume in cubic decimeters of 156 grams of chlorine gas, Cl_2, collected at STP.
Solving process:
The molar volume of a gas is the volume of 1 mole of the gas at STP, or 22.4 dm^3.

$$V = \frac{156\,g}{71.0\,g} \left| \frac{1\ \text{mol}}{1\ \text{mol}} \right| \frac{22.4\ dm^3}{} = 49.2\ dm^3$$

1. Calculate the volume in cubic decimeters of oxygen gas collected at STP if the sample has a mass of 2.67 grams.

$$2.67\,g\ O_2 \left| \frac{1\ \text{mol}\ O_2}{32.00\,g} \right| \frac{22.4\,L}{1\ \text{mol}} = 1.87\,L$$

2. Calculate the volume in cubic decimeters of 101 grams of neon gas collected at STP.

$$101\,g\ Ne \left| \frac{1\ \text{mol}\ Ne}{20.18\,g} \right| \frac{22.4\,L}{1\ \text{mol}} = 112\,L$$

3. A volume of sulfur dioxide gas, SO_2, is collected at STP. What is the mass of 75.6 dm^3?

$$75.6\,L\ SO_2 \left| \frac{1\ \text{mol}\ SO_2}{22.4\,L} \right| \frac{64.07}{1\ \text{mol}} = 2.16 \times 10^2\,g$$

Ideal Gas Equation

EXAMPLE: What pressure in kPa will be exerted by 1.32 mol of gas contained in an 18.0-dm^3 vessel at 27.0°C?
Solving process:
The equation $PV = nRT$ is called the ideal gas equation. The value for the constant R = 8.31 $dm^3 \cdot kPa/mol \cdot K$. This value for R is constant and can always be used if the units for n, P, V, and T are not changed.

$$P = \frac{nRT}{V} = \frac{1.32\ \text{mol}}{18.0\ dm^3} \left| \frac{8.31\ dm^3 \cdot kPa}{\text{mol} \cdot K} \right| 300\,K = 183\ kPa$$

4. How many moles of gas will occupy a 562-cm^3 flask at −15.0°C and 88.7 kPa pressure?

$$\frac{PV}{RT} = n = \frac{.877\,(.562)}{.0821\,(258)} = 2.33 \times 10^{-2}\ \text{mol}$$

.877 over 1.05

5. What volume will be occupied by 0.766 mol of gas at 106 kPa and 15.5°C?

$$V = \frac{nRT}{P} = \frac{.766\,(.0821)\,(289)}{1.05} = 17.3\,L$$

.973

6. A 759-cm^3 vessel contains 0.0945 mol of a gas at 98.6 kPa. What is the Kelvin temperature of the gas?

$$\frac{PV}{nR} = T = \frac{.973\,(.759)}{(.0945)\,(.0821)} = 95.2\,K$$

Name _____ Date _____ Class _____

Gas Stoichiometry

EXAMPLE: What volume of oxygen gas, O_2, at STP can be produced when 17.5 grams of potassium chlorate is decomposed by heating?

Solving process:

In Section 9.2, we learned a method of solving mass-mass problems called stoichiometry. It is usually difficult to measure the mass of a gas. An easier method is to measure the volume under existing conditions and convert the volume to standard conditions. We have learned that 1 mole of any gas at STP occupies 22.4 dm^3, the molar volume. We shall use this knowledge to determine the volume of gas in a reaction by using the balanced equation for the reaction.

a. Write a balanced equation. $2KClO_3 \rightarrow 2KCl + 3O_2$

b. Express the mass (17.5 g) of potassium chlorate, $KClO_3$, in moles.

$$\frac{17.5 \text{ g } KClO_3 \mid 1 \text{ mol } KClO_3}{\mid 123 \text{ g } KClO_3} \cdots$$

c. Determine the mole ratio from the balanced chemical equation. Note that 2 moles of $KClO_3$ yield 3 moles of O_2.

$$\frac{17.5 \text{ g } KClO_3 \mid 1 \text{ mol } KClO_3 \mid 3 \text{ mol } O_2}{\mid 123 \text{ g } KClO_3 \mid 2 \text{ mol } KClO_3} \cdots$$

d. Express the volume of oxygen gas, O_2, in terms of dm^3 by using the relationship that one mole of any gas has a volume of 22.4 dm^3 at STP.

$$\frac{17.5 \text{ g } KClO_3 \mid 1 \text{ mol } KClO_3 \mid 3 \text{ mol } O_2 \mid 22.4 \text{ dm}^3}{\mid 123 \text{ g } KClO_3 \mid 2 \text{ mol } KClO_3 \mid 1 \text{ mol}} = 4.78 \text{ dm}^3 \text{ O}_2$$

7. How many dm^3 of hydrogen gas at STP will be produced from 16.7 g of magnesium reacting with an excess amount of hydrochloric acid, HCl?

$Mg + 2HCl \rightarrow MgCl_2 + H_2$

16.7 g

$$\frac{16.7 \text{ g Mg} \mid 1 \text{ mol Mg} \mid 1 \text{ mol } H_2 \mid 22.4 \text{ L}}{\mid 24.31 \text{ g Mg} \mid 1 \text{ mol Mg} \mid 1 \text{ mol } H_2} = \boxed{15.4 \text{ L}}$$

P = 1.00
V
n
R = .0821
T = 273

8. How many dm^3 of carbon dioxide gas will be produced when 75.0 g of calcium carbonate, $CaCO_3$, are decomposed into calcium oxide, CaO?

$CaCO_3 \rightarrow CaO + CO_2$

75.0 g ?L

Assume STP

$$\frac{75.0 \text{ g } CaCO_3 \mid 1 \text{ mol } CaCO_3 \mid 1 \text{ mol } CO_2 \mid 22.4 \text{ L}}{\mid 100.09 \text{ g} \mid 1 \text{ mol } CaCO_3 \mid 1 \text{ mol } CO_2} = \boxed{16.8 \text{ L}}$$

9. Chlorine gas will react with 3.45 dm^3 of hydrogen gas to yield what mass of hydrogen chloride gas, HCl, at STP?

$Cl_2 + H_2 \rightarrow 2HCl(g)$

3.45 L ?g

$$\frac{3.45 \text{ L} \mid 1 \text{ mol } H_2 \mid 2 \text{ mol HCl} \mid 36.469 \text{ g}}{\mid 22.4 \text{ L } H_2 \mid 1 \text{ mol } H_2 \mid 1 \text{ mol HCl}} = \boxed{11.2 \text{ g HCl}}$$