# GAS STOICHIOMETRY

In dealing with the stoichiometry of reactions involving gases, it is useful to define the volume occupied by 1 mole of a gas at 0°C and 101.3 kPa, (Standard Temperature and Pressure STP) as Molar Volume, which equals 22.4 Liters. The following equations may be useful in finding the answers below:

$PV = nRT$ number of moles = Volume in litres/Volume at STP.

1. A sample of $N_2$ (g) has a volume of 1.75 L at STP. How many moles of $N_2$ are present?
($7.81 \times 10^{-2}$ mol)

2. $NH_3$ is commonly used as a fertilizer to provide a source of $N_2$ for plants. A sample of $NH_3$ occupies 5.0 L at 25°C and 15.0 atm. What volume will this sample occupy at STP?
(68.8 L)

3. Quicklime, CaO, is produced by heating $CaCO_{3\,(s)}$. Calculate the volume of $CO_{2\,(g)}$ produced at STP from the decomposition of 152g of $CaCO_{3\,(s)}$ according to the following equation...
( 34.1 L)

$$CaCO_{3\,(s)} \longrightarrow CaO_{(s)} + CO_{2\,(g)}$$

4. Consider the above reaction... What volume of $CO_{2\,(g)}$ is produced at 25°C and a pressure of 1.02 atm when 10.0 g of $CaCO_{3\,(s)}$ is decomposed?
( 2.4 L )

5. Calculate the volume of $O_{2\,(g)}$ produced at 25°C and 630 mm Hg when 50 g of $KClO_3$ is heated according to the following equation...
(18.1 L)

$$2\ KClO_{3(s)} \longrightarrow 2KCl_{(s)} + 3\ O_{3(s)}$$

6. Consider the following equation...

$$2\ NO_{2(g)} \longrightarrow N_2O_{4(g)}$$

If 25.0 mL of $NO_{2(g)}$ is completely converted to $N_2O_{4(g)}$ under the same conditions of temperature and pressure, what volume of $N_2O_{4(g)}$ will be obtained?
(12.5 mL)

7. A 2.64 g sample of $X_2CO_3$ reacts with $HCl_{(aq)}$ according to the following equation:

$$X_2\,CO_{3\,(s)} + 2\ HCl_{\,(aq)} \longrightarrow 2\ XCl_{\,(aq)} + H_2O_{\,(l)} + CO_{2\,(g)}$$

The $CO_{2\,(g)}$ which is collected at 27°C occupies 600 mL at 101.3 kPa, therefore, calculate the molar mass of X. (24 g/mol)
Clue: Determine the no. moles $X_2\,CO_3$ = no. moles of $CO_2$ in 2.64 g from PV = n Rt
Find the molar mass of $X_2\,CO_3$ = mass/ moles. Hence molar mass of X from total molar mass.

8. Standard marijuana cigarettes produce more carcinogenic chemicals than standard tobacco cigarettes. Many of these compounds are related to pyrene, an aromatic hydrocarbon. At 350°C and 80 kPa, 1.17 g of pyrene has a volume of 375 mL. Calculate the molar mass of pyrene, check your answer against the molecular formula of $C_6 H_{10.}$
(201.0 g/mol.)

9. Trichloroethylene, formerly used for coffee decaffination, in high doses causes liver cancer. It has a mass of 2.75 g in a volume of 1.80 L at 38.8 kPa and at 127°C. Find its molar mass.
(130.88 g/mol.)

10. Peroxyacetyl nitrate (PAN) produced in photo-chemical smog has a density of 1.85 g/L at 50.66 kPa and 125°C. Find its molar mass.
(129.78 g/mol.)

11. Nitroglycerine $C_3 N_4 H_5 O_9$ is used both as a heart drug to relieve severe heart pains and as a powerful explosive. The equation for the explosion of nitroglycerine is:

$$4\ C_3 N_3 H_5 O_9 \longrightarrow 6\ N_{2(g)} + 12\ CO_{2(g)} + 10\ H_2O_{(g)} + O_{2(g)}$$

All of the products are gases. In an explosion, these gases are produced at high temperature in a very short time. The rapid expansion of these high pressure and high temperature gases constitute the explosion. Calculate the total volume of gases at 250°C and 300 kPa when 1.00 kg of liquid Nitroglycerine explodes.
(462.14 L)