Answer on Question #58141 - Chemistry - Other

Task:

How many grams of ethane gas (C_2H_6) are in a 12.7 liter sample at 1.6 atmospheres and 24°C? Show all work used to solve this problem.

Solution:

The ideal gas law is the equation of state of a hypothetical ideal gas. It is a good approximation to the behavior of many gases under many conditions. The ideal gas law is written as:

$$pV = nRT$$

where:

p is the pressure of the gas;

V is the volume of the gas;

n is the amount of substance of gas ;

R is the ideal, or universal, gas constant, equal to the product of the Boltzmann and the Avogadro constant. The gas constant value is $R = k_b * N_a = 8.3144598(48)$ J mol^{-1} K^{-1}.

T is the temperature of the gas.

The chemical amount (n) (in moles) is equal to the mass (m) (in grams) divided by the molar mass (M) (in grams per mole):

$$n = \frac{m}{M}$$

By replacing n with m / M we get:

$$pV = \frac{m}{M}RT$$

We perform algebraic transformation so that on one side of the sign = was an unknown quantity, and on the other - all known.

$$m = \frac{pVM}{RT}$$

Calculate the molar mass (M) of ethane gas (C_2H_6):

$M(C_2H_6) = 12*2+1*6 = 30$ (grams/mole) = $30 \cdot 10^{-3}$ (kg/mole);

Convert some magnitude:

T= t° +273.15 = 24+273.15 = 297.15 K;

Since 1 liter = 10^{-3} m^3 , the 12,7 liter = $12.7*10^{-3}$ m^3;

Since 1 atm = 101 325 Pa, the 1.6 atm = 162120 Pa.

The result is:

M = $30*10^{-3}$ kg/mole;

p = 162120 Pa;

T= 297.15 K;

V= $12.7*10^{-3}$ m^3;

R= 8.314 J mol^{-1} K^{-1}.

Then,

$$m = \frac{pVM}{RT} = \frac{162120 \times 12.7 \cdot 10^{-3} \times 30 \cdot 10^{-3}}{8.314 \times 297.15} = 0.025(kg) = 25(g).$$

Answer:

$m(C_2H_6) = 25g.$