Answer on Question #55490 – Chemistry – Other

Question:

Part 1: An old supply of nitrogen gas held in a 0.250 m3 tank inside a hospital storage room exerts a pressure of 1.11 atm at 303 K. Calculate the density of the nitrogen gas in units of (g/L).

Part 2: Refer to Part 1. For waste disposal, the gas is moved to a 22.0 L container, and cooled to a temperature at which the gas pressure is 8.60 x 103 mm Hg. Calculate the final temperature of the gas in absolute Kelvin.

Part 1:

Solution:

V1 = 0.250 m^3 = 250 L;

P1 = 1.11 atm = 112470.75 Pa = 112.47075 kPa;

T1 = 303 K;

M(N2) = 28 g×mol^{-1};

D - ?

According to the ideal gas law:

PV = nRT;

P – the pressure (Pa or atm or mm Hg);

V – the volume (L or m^3);

N – the amount of substance (mol);

R – the universal gas constant (8.314 J×K^{-1}×mol^{-1} or 8.314 L×kPa×K^{-1}×mol^{-1});

T – the temperature (K);

$$\mathrm{n} = \frac{\mathrm{m}}{\mathrm{M}}; \mathrm{PV} = \frac{\mathrm{m}}{\mathrm{M}}\mathrm{RT}; \mathrm{D} = \frac{\mathrm{m}}{\mathrm{V}};$$

M – the molar mass (g×mol^{-1});

$$m = \frac{PVM}{RT}; D = \frac{m}{V} = \frac{PVM}{RTV} = \frac{PM}{RT};$$

P = 112.47075 kPa;

T = 303 K;

M(N2) = 28 g×mol^{-1};

R = or 8.314 L×kPa×K^{-1}×mol^{-1};

$$\mathrm{D} = \frac{112.47075 \times 28}{8.314 \times 303};$$

D = 1.25 g/L;

Answer: 1.25 g/L;

Part 2

Solution:

V1 = 250 L;

V2 = 22.0 L;

P1 = 112.47075 kPa;

P2 = 8.6×10^3 mm Hg = 1146.573 kPa;

T1 = 303 K;

T2 - ?

According to the Boule's law:

$$\frac{\mathrm{P1V1}}{\mathrm{T1}} = \frac{\mathrm{P2V2}}{\mathrm{T2}}; \mathrm{T2} = \frac{\mathrm{P2V2T1}}{\mathrm{P1V1}};$$

$$\mathrm{T2} = \frac{1146.573 \times 22 \times 303}{112.47075 \times 250} = 271.82\ \mathrm{K};$$

T2 = 271.82 K;

Answer: 271.82 K