

Bio390

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Problem: Gas Laws

You accept a position in a laboratory that is located on ground level on the planet Mars. Ambient pressure at ground level on Mars is approximately one-tenth that of the average barometric pressure at sea level on Earth. Inside the ground-level plastic chamber the pressure is maintained at a level 20 mm Hg higher than the ambient pressure outside, and the temperature inside the chamber is exactly 16°C. An automatic humidifier holds the **water vapor tension within the chamber at 10 mm Hg**. The artificial chamber atmosphere has the following composition, all on a dry gas basis: (a) oxygen = 70%; (b) carbon dioxide = 3%; and (c) the remaining gases, nitrogen and argon, are maintained at a two to one ratio.

Calculate the percent concentration on a dry gas basis and the partial pressure of each gas in the chamber atmosphere.

<u>Gas</u>	<u>% Composition</u>	<u>Partial Pressure</u>
Oxygen	70	
CO ₂	3	
Nitrogen	18	
Argon	9	

$$N_2 + Ar = \text{Total} - O_2 - CO_2 = 100 - 70 - 3 (\%) = 27 (\%)$$

$$N_2 = 2 * Ar \text{ (given above)}$$

$$2Ar + Ar = 27 \text{ thus:}$$

$$\mathbf{Ar = 9 (\%) \text{ and } N_2 = 18 (\%)}$$

For all Partial pressures, simply multiply the fraction for each gas (%/100) times the total pressure without water

$$\mathbf{\text{Total pressure} = 0.1 (760 \text{ torr}) + 20 \text{ torr} = 76 + 20 = \mathbf{96 \text{ torr}}}$$

Water pressure is given as 10 mm Hg, total dry gas pressure = 86 torr

$$\text{Thus: } \mathbf{P_{O_2} = 70/100 * 86 = \mathbf{60.2 \text{ torr}}}$$

$$P_{\text{CO}_2} = 3/100 * 86 = \mathbf{2.6 \text{ torr}}$$

$$P_{\text{N}_2} = 18/100 * 86 = \mathbf{15.5 \text{ torr}}$$

$$P_{\text{Ar}} = 9/100 * 86 = \mathbf{7.7 \text{ torr}}$$

These had better all add to 96 torr (including the water vapor):

$$P_t = P_{\text{O}_2} + P_{\text{N}_2} + P_{\text{Ar}} + P_{\text{CO}_2} + P_{\text{H}_2\text{O}} = 60.2 + 15.5 + 7.7 + 2.8 + 10 = 96 \text{ torr}$$

it checks