Answer on the question #66904, Chemistry / Physical Chemistry

Question:

A mixture of 2.0 x 10^-3 kg of H2 and 2.0 x 10^-3 kg of He exerts a pressure of 1.5 x 10^5 Pa. What are the partial pressures of H2 and He?

Solution:

The number of the moles of hydrogen and helium gases are:

$$n_{H_2} = \frac{m}{M} = \frac{2.0 \cdot 10^{-3}(kg)}{2 \cdot 10^{-3}(kg\ mol^{-1})} = 1\ mol$$
$$n_{He} = \frac{2.0 \cdot 10^{-3}(kg)}{4 \cdot 10^{-3}(kg\ mol^{-1})} = 0.5\ mol$$

According to the ideal gas law, the pressure and the quantity of gas are related as:

$$pV = nRT.$$

Then, the pressure of the mixture of hydrogen and helium gases is:

$$pV = (n_{H_2} + n_{He})RT,$$

where overall pressure p is the sum of partial pressures $p_{H_2} + p_{He}$.

The ideal gas law can be equally written for hydrogen and helium gases:

$$p_{H_2}V = n_{H_2}RT$$

$$p_{He}V = n_{He}RT.$$

Thus, the partial pressure of hydrogen is:

$$p_{H_2} = \frac{n_{H_2}RT}{V} = \frac{n_{H_2}p}{n} = \frac{n_{H_2}p}{n_{H_2} + n_{He}} = \frac{1(mol) \cdot 1.5 \cdot 10^5(Pa)}{1 + 0.5(mol)} = 1 \cdot 10^5(Pa).$$

The partial pressure of helium is the overall pressure minus partial pressure of hydrogen:

$$p_{He} = 1.5 \cdot 10^5(Pa) - 1 \cdot 10^5(Pa) = 0.5 \cdot 10^5(Pa)$$

Answer: Partial pressure of hydrogen and helium are $1 \cdot 10^5(Pa)$ and $0.5 \cdot 10^5(Pa)$, respectively.