JQ.2.7.soln

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(2.7) The mole fraction of argon in a gas mixture with air is 0.1. The mixture is at a pressure of 1000 Pa and 25^oC. What is the partial pressure of the argon?

There are two gas models that allow us to better understand how to answer this question. Amagat's law and Dalton's law lead to two idfferent interpretations of the mole fraction. Consider a binary (two gas) mixture with gas A and gas B. In Amagat's law, a mixtue of gases is assumed to each fill seperate piston cylinder systems of different volumes but with equal pressure. By the ideal gas equation of state:

$$P_T V_A = n_A \bar{R} T$$

and

$$P_T V_B = n_B \bar{R} T$$

and

$$P_T (V_A + V_B) = (n_A + n_B) \bar{R} T$$

Since the total pressure is the same,

$$\frac{n_A}{V_A} = \frac{(n_A + n_B)}{V_A + V_B}$$

which suggests that

$$X_A = \frac{n_A}{n_A + n_B} = \frac{V_A}{V_A + V_B}$$

Using Dalton's law, the model is that each gas fills a volume of the same size, but with different pressures (also called partial pressures).

$$P_A V_T = n_A \bar{R} T$$

and

$$P_B V_T = n_B \bar{R} T$$

and

$$(P_A + P_B) V_T = (n_A + n_B) \bar{R} T$$

$$X_A = \frac{n_A}{n_A + n_B} = \frac{P_A}{P_A + P_B}$$

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In [1]: X_A=0.1; P_T=1000.; P_A=X_A*P_T; P_A
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Out[1]: 100.0
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The partial pressure of argon is 100. Pa