

14.29 This problem asks that we compute the diffusion flux at 350 K for water in polystyrene. It is first necessary to compute the value of the permeability coefficient at 350 K. The temperature dependence of P_M is given in the problem statement, as follows:

$$P_M = P_{M_0} \exp\left(-\frac{Q_p}{RT}\right)$$

And, incorporating values provided for the constants P_{M_0} and Q_p , we get

$$\begin{aligned} P_M &= \left[9.0 \times 10^{-5} \frac{(\text{cm}^3 \text{ STP})(\text{cm})}{\text{cm}^2 \cdot \text{s} \cdot \text{Pa}} \right] \exp\left[-\frac{42,300 \text{ J/mol}}{(8.314 \text{ J/mol} \cdot \text{K})(350 \text{ K})}\right] \\ &= 4.4 \times 10^{-11} \frac{(\text{cm}^3 \text{ STP})(\text{cm})}{\text{cm}^2 \cdot \text{s} \cdot \text{Pa}} \end{aligned}$$

And, using Equation 14.9, the diffusion flux is equal to

$$\begin{aligned} J &= P_M \frac{\Delta P}{\Delta x} = P_M \frac{P_2 - P_1}{\Delta x} \\ &= 4.4 \times 10^{-11} \frac{(\text{cm}^3 \text{ STP})(\text{cm})}{\text{cm}^2 \cdot \text{s} \cdot \text{Pa}} \left(\frac{20,000 \text{ Pa} - 1,000 \text{ Pa}}{3.0 \text{ cm}} \right) \\ &= 2.8 \times 10^{-7} \frac{(\text{cm}^3 \text{ STP})}{\text{cm}^2 \cdot \text{s}} \end{aligned}$$