Ans. 1. The densities of N_2, O_2, and air at STP are

$$\rho_{N_2} = \frac{p}{RT} = \frac{1.013 \cdot 10^5 \text{N/m}^2}{\left(\frac{8317}{28.00}\right) \text{J/(kg K)} \cdot 300 \text{ K}} = 1.137 \text{ kg/m}^3$$

$$\rho_{O_2} = 1.299 \text{ kg/m}^3, \quad \rho_m = 1.176 \text{ kg/m}^3$$

From Table IIIE-2, $\sigma^+_{N_2} = 44.2(\mathring{A})^2$ and $\sigma^+_{O_2} = 42.6(\mathring{A})^2$.

$$D_{N_2,N_2} = \frac{2}{3\rho_{N_2}\sigma^+_{N_2}} \left(\frac{M_{N_2} kT}{\pi N_A}\right)^{\frac{1}{2}}$$

$$= \frac{2}{3 \cdot 1.137 \text{ kg/m}^3 \cdot 44.2 \cdot 10^{-20} \text{m}^2} \left[28.00 \text{ kg/(kg mol)} \cdot \frac{1.380 \cdot 10^{-23} \text{J/(part K)} \cdot 300 \text{ K} \cdot 1 \text{ kg m}^2}{\pi \cdot 6.023 \cdot 10^{26} \text{part/(kg mol)}} (\text{J s}^2)\right]^{\frac{1}{2}} = 1.04 \cdot 10^{-5} \text{m}^2/\text{s}$$

Similarly, $D_{O_2,O_2} = 1.01 \cdot 10^{-5} \text{m}^2/\text{s}$. Then

$$D_{N_2,O_2} = \frac{2\left(1 + \frac{y_{O_2}}{y_{N_2}}\right)}{3\rho\left[\sigma^+_{N_2} + \frac{y_{O_2} M_{N_2}}{y_{N_2} M_{O_2}}\left(\frac{\sigma_{N_2} + \sigma_{O_2}}{2}\right)\right]} \left(\frac{M_{N_2} kT}{\pi N_A}\right)^{\frac{1}{2}} = 1.04 \cdot 10^{-5} \text{m}^2/\text{s}$$

and $$D_{O_2,N_2} = 0.988 \cdot 10^{-5} \text{m}^2/\text{s}$$