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Recap

$$f_y = -\frac{u\ell}{6}\frac{\partial b}{\partial y}, \quad f_y = -D\frac{\partial b}{\partial y}$$

$$\boxed{D = \frac{u\ell}{6}}$$

$u \equiv c$ molecular velocity

$\ell \equiv \lambda$ "smallest jump distance"
or in Gas Kinetic Theory, λ is referred to the "mean free path" between collisions

Gas Kinetic Theory

$$c = \left(\frac{8RT}{\pi M}\right)^{\frac{1}{2}} = \left(\frac{8k_B T}{\pi m}\right)^{\frac{1}{2}}$$

$$\lambda = \frac{RT}{\sqrt{2}\,\pi d^2 N_A P} = \frac{k_B T}{\sqrt{2}\,\pi d^2 P}$$

$k_B = 1.38 \times 10^{-23}$ J/K (Boltzmann constant)
$N_A = 6.02 \times 10^{-23}$ mol^{-1} (Avogadro Number)
$M = \left(\frac{1}{M_A} + \frac{1}{M_B}\right)^{-1}$ (convoluted molar mass) [kg/kmol]
$R = 8.314$ J/K·mol (ideal (universal) gas constant

→

more parameters in Gas Kinetic Theory:

$d = \frac{1}{2}(d_A + d_B)$ convoluted molecular diameter [m]

$m = \left(\frac{1}{M_A} + \frac{1}{M_B}\right)^{-1}$ convoluted molecular weight [kg].

As per Deen (p. 15), the gas kinetic theory yields for the transport coefficients:

$$\boxed{\begin{aligned} k &= \rho C_p \alpha = \frac{1}{3\pi^{3/2}} \frac{(m k_B T)^{\frac{1}{2}} C_p}{d^2} \\ D_{AB} &= \mathcal{D} = \frac{1}{3\pi^{3/2}} \frac{(k_B T)^{3/2}}{d^2\, m^{1/2}\, P} \\ \mu &= \rho \nu = \frac{1}{3\pi^{3/2}} \frac{(m k_B T)^{1/2}}{d^2} \end{aligned}}$$

with $\mathcal{D} = \nu = \alpha$

Note 1 Da(lton) = 1.661×10^{-27} kg