

Problem 1.34

[Difficulty: 1]

1.34 The mean free path λ of a molecule of gas is the average distance it travels before collision with another molecule. It is given by

$$\lambda = C \frac{m}{\rho d^2}$$

where m and d are the molecule's mass and diameter, respectively, and ρ is the gas density. What are the dimensions of constant C for a dimensionally consistent equation?

Given: Equation for mean free path of a molecule.

Find: Dimensions of C for a dimensionally consistent equation.

Solution: Use the mean free path equation. Then "solve" for C and use dimensions.

The mean free path equation is

$$\lambda = C \cdot \frac{m}{\rho \cdot d^2}$$

"Solving" for C , and using dimensions

$$C = \frac{\lambda \cdot \rho \cdot d^2}{m}$$

$$C = \frac{L \times \frac{M}{L^3} \times L^2}{M} = 0$$

The constant C is dimensionless.