CONCEPT: MEAN FREE PATH

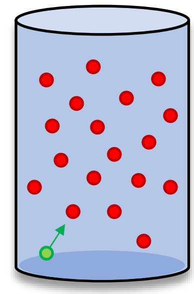
● **Mean Free Path:** Average (mean) distance gas particles travel before __________ with another particle.

- Analogy: If you walked through a crowded room, the average distance you walk before bumping into someone.

λ = _____ = ____________

- t_{avg} = average time between collisions

- r = radius of particles. If not given, assume $r = 0.5\times10^{-10}$ (monoatomic), $r = 1\times10^{-10}$ m (diatomic)



EXAMPLE: Calculate **a)** the mean free path of oxygen molecules in the air at STP; **b)** the average time between molecule collisions. The radius of oxygen molecules is approximately 1.5×10^{-10} m, and they move with an average speed 450 m/s.

THERMO EQs & CONSTANTS
$PV = nRT$ OR $PV = Nk_BT$
$k_B = 1.38\times10^{-23}\ \frac{J}{K}$
$R = 8.314\ \frac{J}{mol\cdot K}$

PROBLEM: Laboratory environments can achieve pressures of 3.5×10^{-13} atm and temperatures of 300K. Calculate the mean free path (in km) of air molecules, which you can assume are diatomic.

A) 1.04×10^{-32} km
B) 6.65 km
C) 660 km
D) 8.22×10^{-10} km

IDEAL GAS EQs & Constants
$PV = nRT = Nk_BT$
$\lambda = v_{avg}t_{avg} = \frac{V}{\sqrt{2}\cdot 4\pi r^2 N}$
$r_{monoatomic} = 0.5\times10^{-10}$ m
$r_{diatomic} = 1.0\times10^{-10}$ m
$R = 8.314 \frac{J}{mol\ K}$
$k_B = 1.38\times10^{-23} \frac{J}{K}$
$N_A = 6.02\times10^{23}$

CONVERSIONS
1L = 0.001 m^3
1 atm = 1.01×10^5 Pa

PROBLEM: The mean free path of nitrogen particles at STP is 8×10^{-8} m. What is the radius of the nitrogen particles?

IDEAL GAS EQs & Constants
$PV = nRT = Nk_BT$
$\lambda = v_{avg}t_{avg} = \frac{V}{\sqrt{2}\cdot 4\pi r^2 N}$
$R = 8.314 \frac{J}{mol\ K}$
$k_B = 1.38\times10^{-23} \frac{J}{K}$
$N_A = 6.02\times10^{23}$
STP: T = 273K, P = 1.01×10^5 Pa