PROBLEM SET – 1-2
KINETIC THEORY OF GASES

1. What is the ratio of the probability that a gas molecules have two times the mean speed to the probability that they have the mean speed?

2. For CH_4(g) at 300 K and 1 bar, calculate the probability that a molecule picked at random has its speed in the range 400.000 to 400.001 m/s. This interval is small enough to be considered infinitesimal.

3. For CO_2 at 500 K and for N_2 at 300 K calculate
(a) $\langle \upsilon^2 \rangle^{1/2}$ (b) $\langle \upsilon \rangle$ (c) υ_{mp}

4. Find the molecular weight of hydrocarbon gas that effuses 0.872 times as fast as O_2 through a small hole the temperatures and pressures being equal.

5. Use $F(\upsilon)d\upsilon$ function for υ to find $\langle \upsilon^3 \rangle$ for ideal gas molecule. Does $\langle \upsilon^3 \rangle$ equal to $\langle \upsilon^2 \rangle \langle \upsilon \rangle$.

6. Calculate the total molecular translational kinetic energy at 25 °C and 1 atm for 2 moles of N_2.

7. The average translational kinetic energy for a molecule (ϵ) is given by

$$\epsilon = \frac{1}{2} m \langle v^2 \rangle$$

where m is the mass of the molecule and $\langle v^2 \rangle$ is the average of the square of the velocity. Given $\langle v^2 \rangle = \frac{3kT}{m}$, where k is Boltzmann's constant, calculate the ratio of the kinetic energies at 200 ^{0}C and 100 ^{0}C.

8. For 1.00 mol of O_2 at 300 K and 1.00 atm, calculate (a) the number of molecules whose speed lies in the range 500.00 to 500.001 m/s (b) the number of molecules with υ_z in the range 150.00 to 150.002 m/s

9. For molecular oxygen at 25 °C, a) Define collision frequency, b) Define collision density.
c) calculate the collision frequency Z_1 and the collision density Z_{11} at a pressure of 1 bar. (d_{O_2} = 3.61x10^{-10} m)

10. What are the mean free paths in meters for O_2 at (a) 1 bar pressure and (b) 0.1 Pa pressure?

11. For an equimolar mixture of H_2 and I_2 at 500 K and 1 atm, calculate the number of collisions per second per cm^3 between H_2-H_2 and H_2-I_2 molecules. (d_{H_2} = 2.18x10^{-8} cm) (d_{I_2} = 3.76x10^{-8} cm)

12. Find $\bar{\upsilon}$ for (a) H_2 at 0 °C and 1 atm, (b) N_2 at 25 °C and 1 atm.

13. For a gas with collision diameter of 3x10^{-8} cm, calculate the mean free path at 0 °C and 1 atm.

14. Calculate the thermal conductivity of Argon at 300 K and 15 Mbar. Gas is confined in a cubic vessel of side 15 cm, one wall being 305 K and one opposite at 295 K. What is the rate of flow of energy as heat from one wall to the other?

15. For 1.00 mol of O_2 at 300 K and 1.00 atm, calculate (a) the number of molecules whose speed lies in the range 500.00 to 500.001 m/s (b) the number of molecules with v_z in the range 150.00 to 150.002 m/s (c) the number of molecules that simultaneously have v_z in the range 150.00 to 150.001 m/s and have v_x in the range 150.00 to 150.001 m/s.