1. For the equation:

$$f(v_x) = Ae^{-\gamma v_j^2}$$

determine whether γ must be strictly positive, strictly negative, or either by considering limits.

2. Without looking at the slides for the result, evaluate $\langle v_x + \rangle$ and $\langle v_x \rangle$. $\langle v_x + \rangle$ denotes the average of positive values of v_x. Potentially useful integrals:

$$f(v_x) = \left(\frac{M}{2\pi RT}\right)^{1/2} e^{-Mv_x^2/2RT}$$

$$\int_{-\infty}^{\infty} e^{-ax^2}\,dx = \sqrt{\frac{\pi}{a}} \qquad \int_{-\infty}^{\infty} x^2 e^{-ax^2}\,dx = \frac{1}{2a}\sqrt{\frac{\pi}{a}} \qquad \int_{0}^{\infty} x e^{-ax^2}\,dx = \frac{1}{2a} \quad \text{for } a > 0$$

3. For the speed distribution, show that $\langle u \rangle = \sqrt{\frac{8RT}{\pi M}}$. Potentially useful integral:

$$\int_{0}^{\infty} x^3 e^{-ax^2}\,dx = \frac{1}{2a^2}$$

4. (a) Derive an expression for u_{probable}.

(b) Rank the characteristic speeds u_{rms}, u_{probable} and $\langle u \rangle$ in ascending order.

(c) Compute u_{rms}, u_{probable} and $\langle u \rangle$ numerically for N_2 at 298 K and rank them in ascending order. Does this match our expectations?

Homework Problem 31

1. Compute $\langle v_x^2 \rangle$ to verify the result from lecture, $\langle v_x^2 \rangle = \frac{RT}{M}$.

$$\int_{-\infty}^{\infty} x^2 e^{-ax^2}\, dx = \frac{1}{2a}\sqrt{\frac{\pi}{a}}$$