

Assignment 1

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1 Question1:

1.1 2D case

1.1.1 Velocity Distribution

$$f(\vec{v}) = n \frac{m}{2\pi kT} e^{-\frac{m\vec{v} \cdot \vec{v}}{2kT}} \quad (1)$$

1.1.2 Speed Distribution

$$f(v) = n \frac{m}{2\pi kT} v e^{-\frac{mv^2}{2kT}} \quad (2)$$

1.1.3 Energy Distribution

$$f(\epsilon) = \frac{n}{2\pi kT} e^{-\frac{\epsilon}{kT}} \quad (3)$$

Mean velocity:

$$V_{mean} = \sqrt{\frac{kT}{8\pi m}} \quad (4)$$

Rms velocity:

$$V_{rms} = \frac{kT}{\pi m} \quad (5)$$

1.2 1D case

1.2.1 Speed Distribution:

$$f(v) = n \sqrt{\frac{m}{2\pi kT}} e^{-\frac{mv^2}{2kT}} \quad (6)$$

1.2.2 Energy Distribution

$$f(\epsilon) = n \frac{1}{2\sqrt{\pi kT}} \frac{1}{\sqrt{\epsilon}} e^{-\frac{\epsilon}{kT}} \quad (7)$$

Mean velocity:

$$V_{mean} = \sqrt{\frac{2kT}{\pi m}} \quad (8)$$

RMS velocity:

$$V_{rms} = \frac{kT}{4m} \quad (9)$$

2 Question 2:

(Refer code)

3 Question 3:

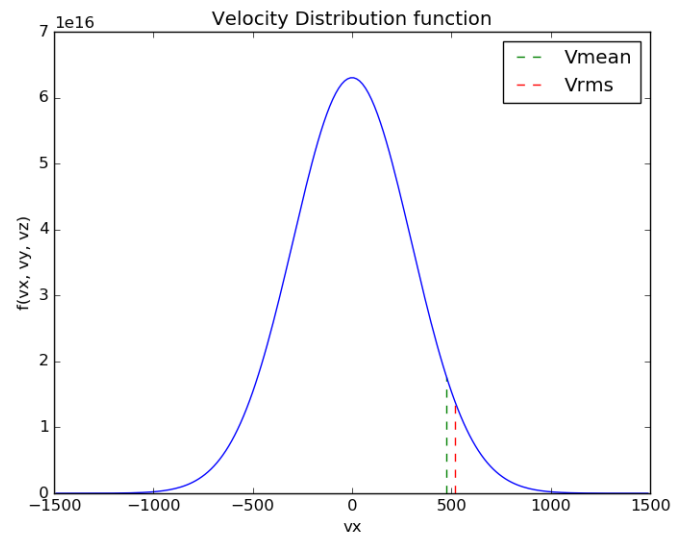


Figure 1: Velocity Distribution Function

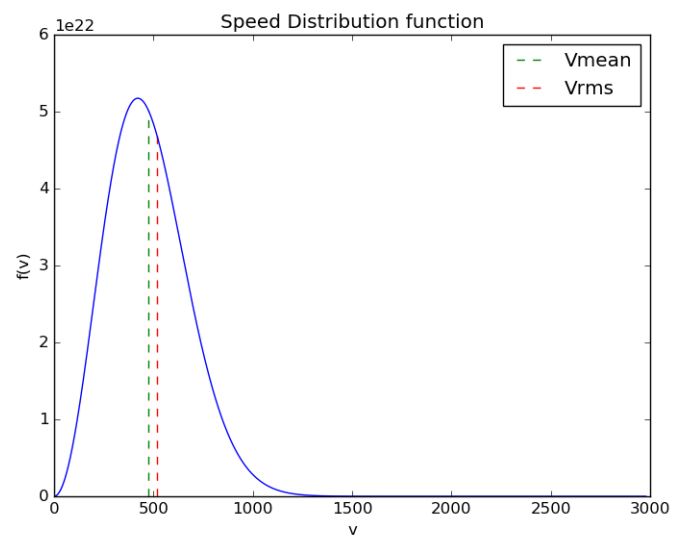


Figure 2: Speed Distribution Function

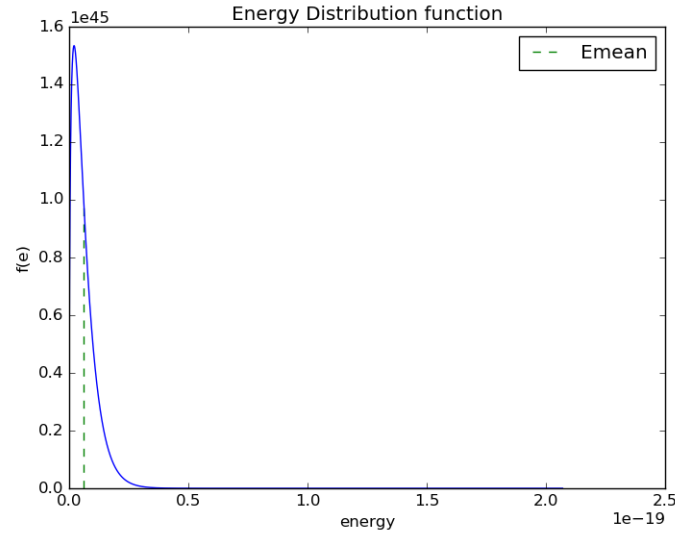


Figure 3: Energy Distribution Function

4 Question 4:

(Done in the above plots)

5 Question 5:

(Refer code) The values given below are for 20000 grids in velocity and energy

$$\text{Pressure} = 1.087 \times 10^5 Pa$$

$$\text{Energy} = 8.150 \times 10^4 J$$

$$V_{\text{mean}} = 475.321 m/s$$

$$\text{Entropy} = 1.36 \times 10^{27}$$

6 Question 6:

(Refer code) We see that the mean velocity and the pressure are almost independent of grid size. The error in Pressure and the Mean velocity was of the order of 10^{-9} and 10^{-11} respectively. So the pattern of the graph isn't of much relevance as the values of Boltzmann constant and the Avagadro number are taken only till 2 decimal places

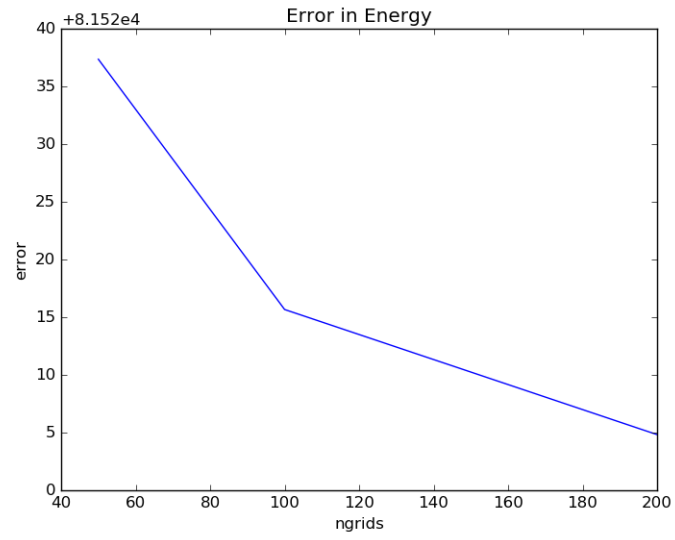


Figure 4: Error in energy calculation

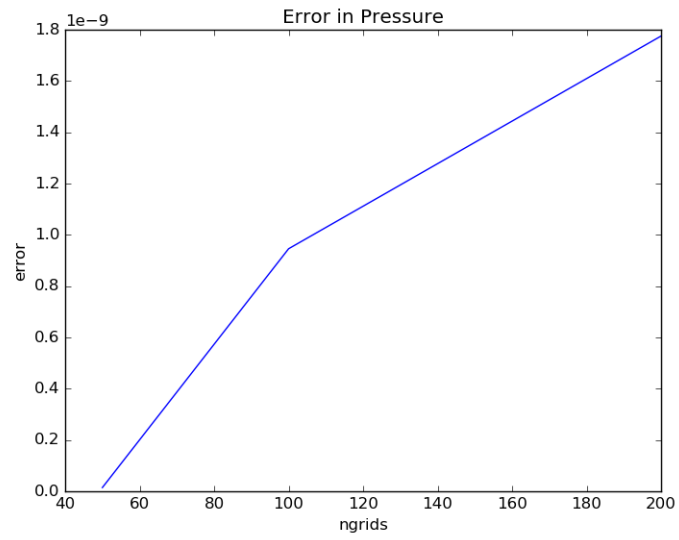


Figure 5: Error in pressure calculation

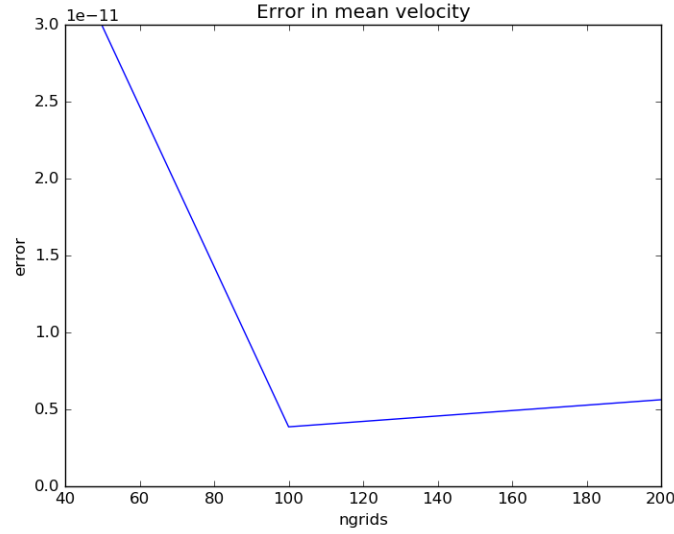


Figure 6: Error in mean velocity

7 Question 7:

Following functions were chosen

- Exponential fuction
Entropy = -4.57×10^{30}

$$p(x) = e^{-x} \quad (10)$$

- Exponential Logarithmic function: $p = 0.5$; $\beta = 2$
Entropy = -1.33×10^{31}

$$p(x, p, \beta) = \frac{-1}{\ln(p)} \frac{\beta(1-p)e^{-\beta x}}{1 - (1-p)e^{-\beta x}} \quad (11)$$

- Levy Distribution: $\mu = 0$, $c = 2$
Entropy = 4.52×10^{27}

$$p(x; \mu, c) = \sqrt{\frac{c}{2 * np.pi}} \frac{e^{\frac{c}{x-\mu}}}{(x-\mu)^{3/2}} \quad (12)$$

(Results are weird, not able to justify/find the bug)

8 Question 8:

V has been plotted in logarithmic scale

Plasma_velocity.png

Figure 7: Velocity PDF of electrons and ions

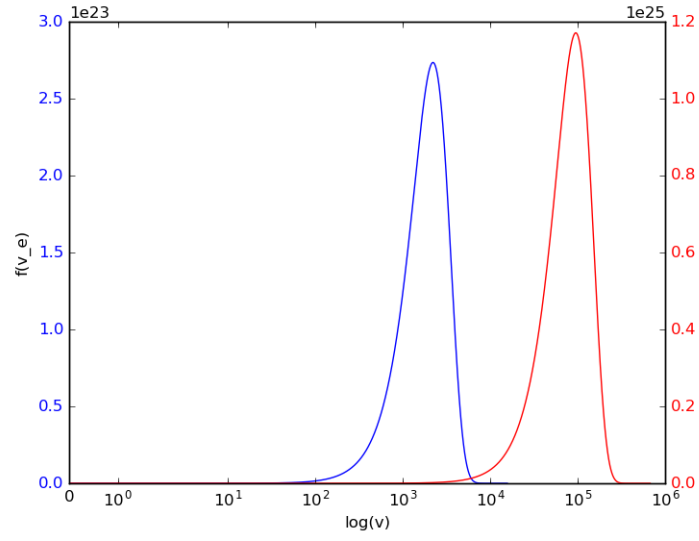


Figure 8: Speed pdf of electrons and ions

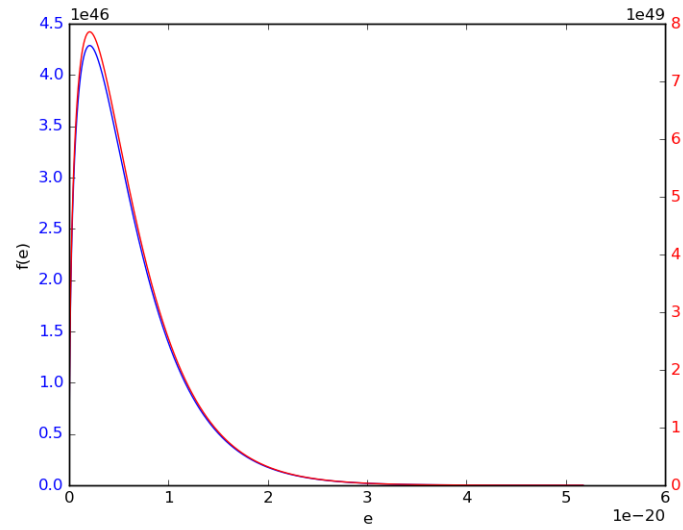


Figure 9: Energy PDF of electrons and ions