DISCUSSION OF THE MAXWELL DISTRIBUTION LAW

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$$dn_c = 4\pi n a^3 e^{-bc^2} c^2 \, dc \quad \text{---} (1)$$

$$\Rightarrow \frac{dn_c}{n} = y\,dx$$

$$\Rightarrow bc^2 = x^2$$

$$\Rightarrow b\, 2c\, dc = 2x\, dx$$

$$\Rightarrow dc = \frac{x\,dx}{bc}$$

$$\Rightarrow \frac{dn_c}{n} = \frac{4\pi b^{3/2}}{(\pi)^{3/2}} \frac{e^{-x^2} c^2 x\,dx}{bc}$$

$$= 4\pi^{-1/2} b^{1/2} c\, e^{-x^2} x\, dx$$

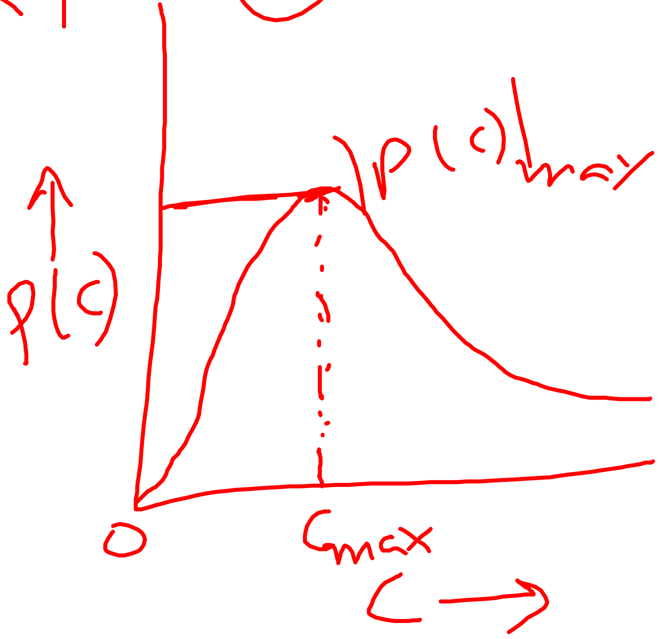
$$\frac{dn_c}{n} = \underbrace{4\pi^{-1/2} x^2 e^{-x^2}}_{y} dx$$

$$\frac{dn_c}{n}$$

0 to ∞

c & $c+dc$

$$P(c) = 4\pi \left(\frac{m}{2\pi KT}\right)^{3/2} c^2 e^{-mc^2/2kT} \quad \text{— (2)}$$



(1) $P(c) = 0$ when $c = 0$

(2) At low values of c, $\frac{mc^2}{2kT} < 1$

$$\Rightarrow e^{-\frac{mc^2}{2kT}} \simeq 1$$

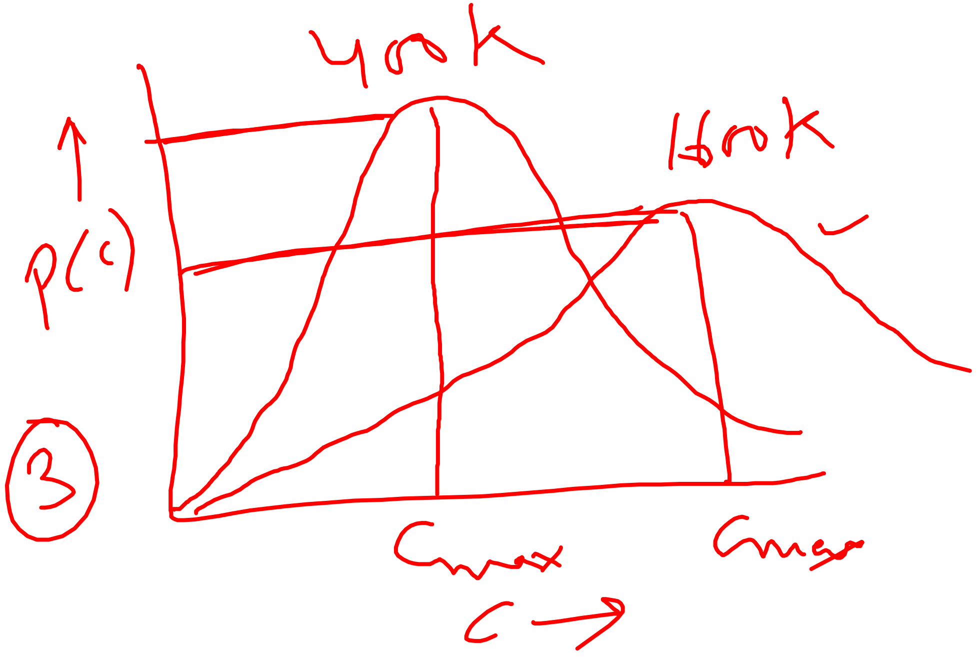
Most prob speed Cmax or Cpeak

$$\frac{d}{dc} P(c) = 0$$

$$4\left(\frac{m}{2\pi kT}\right)^{3/2} \frac{d}{dc}\left[c^2 e^{-\frac{mc^2}{2kT}}\right] = 0$$

or $$2c e^{-mc^2/2kT} + c^2 e^{-mc^2/2kT}\left(-\frac{2cm}{2kT}\right) = 0$$

$$\Rightarrow \boxed{C_{max} \text{ or } C_{peak} = \sqrt{\frac{2kT}{m}}} \quad \text{— (3)}$$



$$|P(c)|_{max} = 4\pi\left(\frac{m}{2\pi kT}\right)^{3/2} C_{max}^2 \, e^{\frac{mC_{mx}^2}{2kT}}$$

$$\boxed{|P(c)|_{max} = 4\sqrt{\frac{m}{2\pi kT}}\, e^{-1}} \quad \text{— (4)}$$

400K

1600K

MEAN OR AVERAGE SPEED

$$C_{mean} \text{ or } C_{av} = \int_0^\infty c\, P(c)\, dc$$

$$= \int_0^\infty c\, 4\pi \left(\frac{m}{2\pi kT}\right)^{3/2} c^2 e^{-\frac{mc^2}{2kT}} dc$$

$$= 4\pi \left(\frac{m}{2\pi kT}\right)^{3/2} \int_0^\infty c^3 e^{-mc^2/2kT} dc$$

$$\Downarrow \quad \frac{1}{2\left(\frac{m}{2kT}\right)^2}$$

$$\boxed{C_{mean} = \sqrt{\frac{8kT}{m\pi}}} \quad \text{— (5)}$$

MEAN SQUARE SPEED

$$(C_{mean})^2 \text{ or } \bar{C}^2 = \int_0^\infty c^2 \, P(c) \, dc$$

$$\int_0^\infty c^4 e^{-\frac{mc^2}{2KT}} \, dc = \frac{3}{8}\sqrt{\frac{\pi}{(m/2KT)^5}}$$

$$\boxed{\bar{C}^2 = \frac{3KT}{m}} \quad \text{—} \quad (6)$$

ROOT MEAN SQUARE SPEED

$$\overline{c}^2 = \frac{3kT}{m}$$

$$C_{rms} = \sqrt{\overline{c}^2} = \sqrt{\frac{3kT}{m}}$$

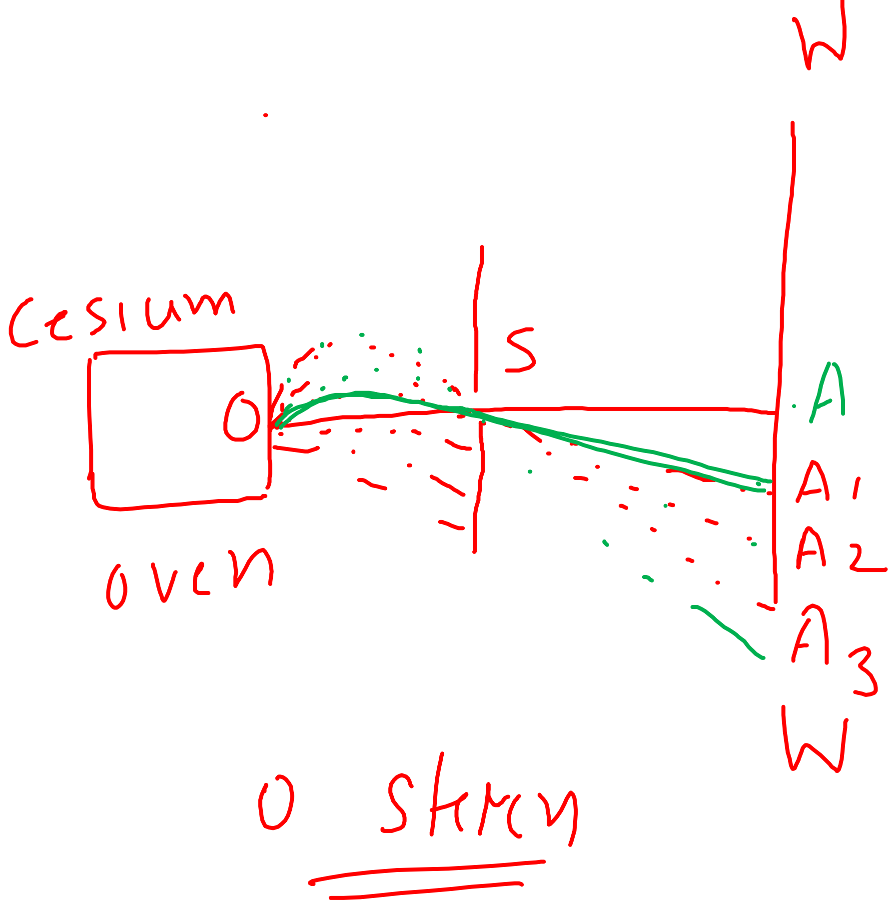
C_{rms}

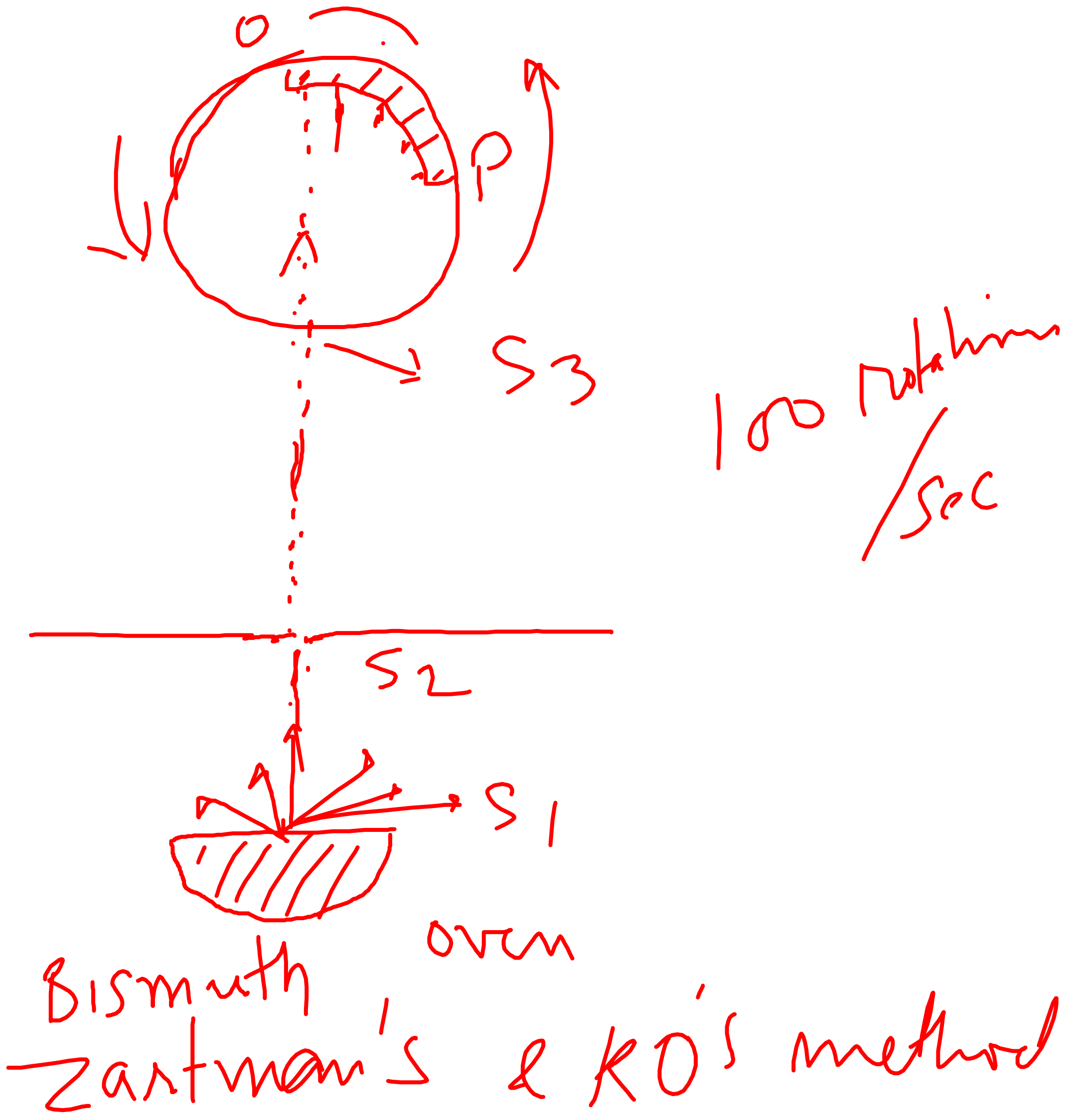
C_{mean}

C_{mp}

$$C_{rms} > C_{mean} > C_{mp}$$

EXPERIMENTAL VERIFICATION OF MAXWELL DISTRIBUTION LAW





LAW OF EQUIPARTITION OF ENERGY

$$\frac{3}{2}KT$$

av KE per mol per deg of freedom

$$\frac{1}{3} \times \frac{3}{2}KT = \frac{1}{2}KT$$

Degrees of freedom

① 1

② 2

③ 3

$$3N - K$$

N → No of particles of the system

K → no of independent relations b/w them

Monoatomic gas

$3N - K$

$3 \times 1 - 0 = 3$

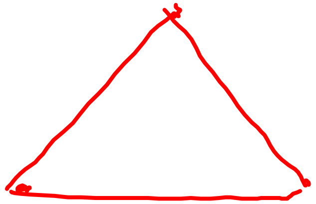
Diatomic

$3N - K$

$3 \times 2 - 1 = 5$

Triatomic

$3N - K = 3 \times 3 - 2 = 7$



$3N - K$

$\Rightarrow 3 \times 3 - 3 = 6$

THANK YOU