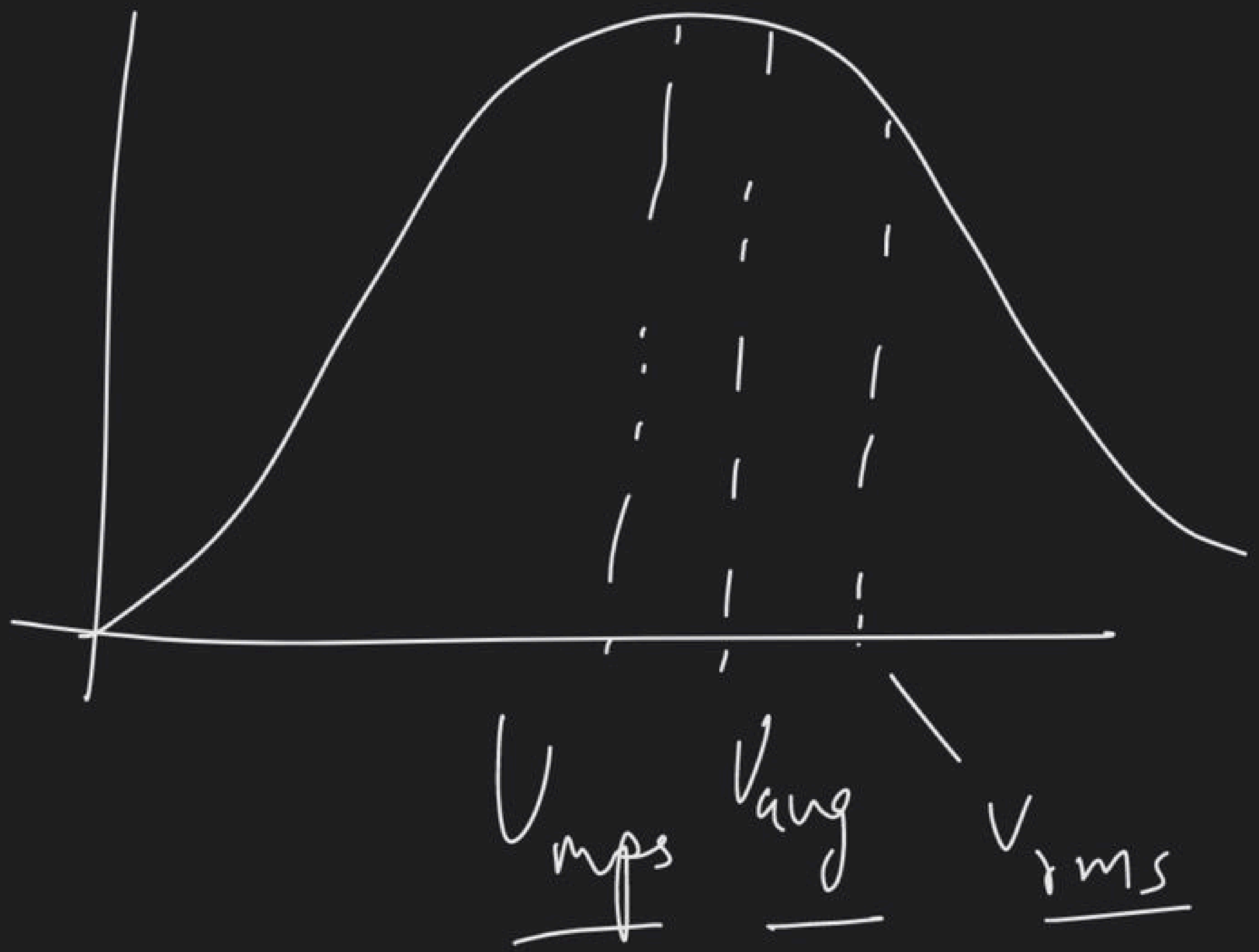
Problems and Sheet Discussion

Course on States of Matter for Class XI

akhilesh • Lesson 15 • Aug 4, 2021

5

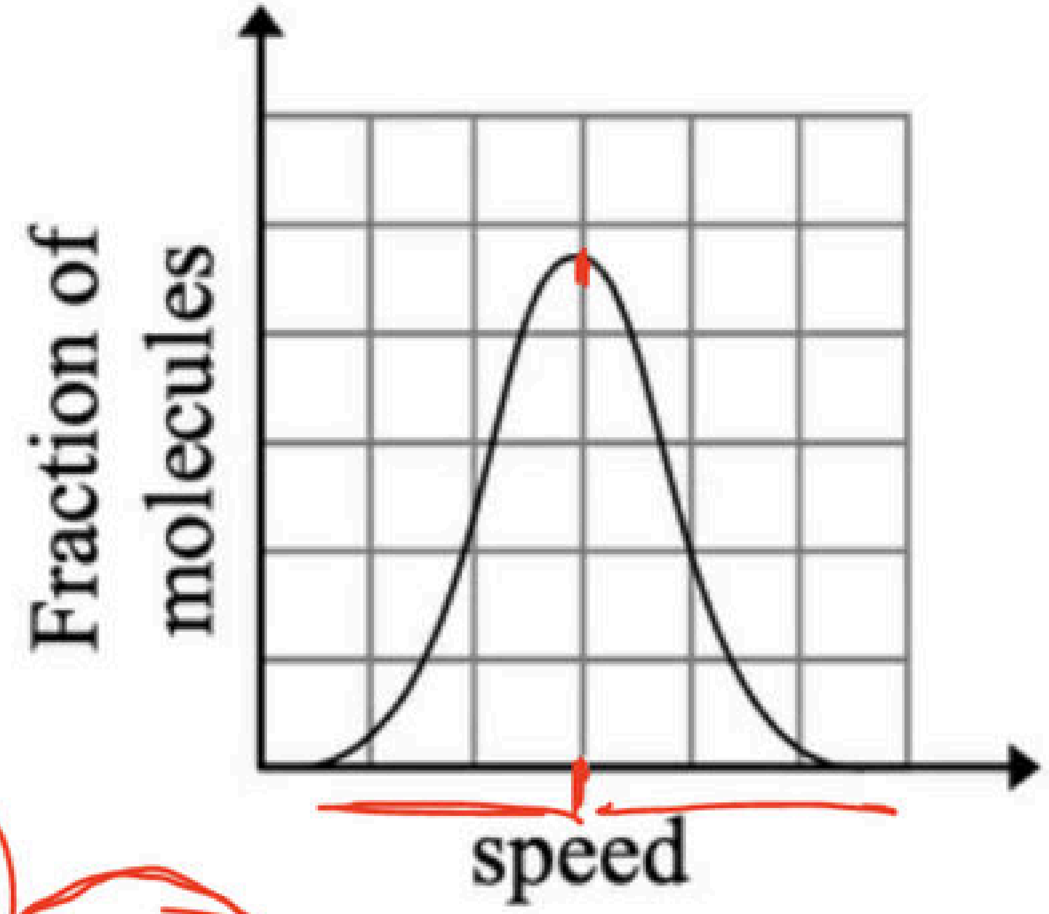
12 $V_{mps} : V_{avg} : V_{rms} = \sqrt{2} : \sqrt{\frac{8}{\pi}} : \sqrt{3}$



2020

1. If the distribution of molecular speeds of a gas is as per the figure shown below, then the ratio of the most probable, the average, and the root mean square speeds, respectively, is

$V_{mps} = V_{avg}$

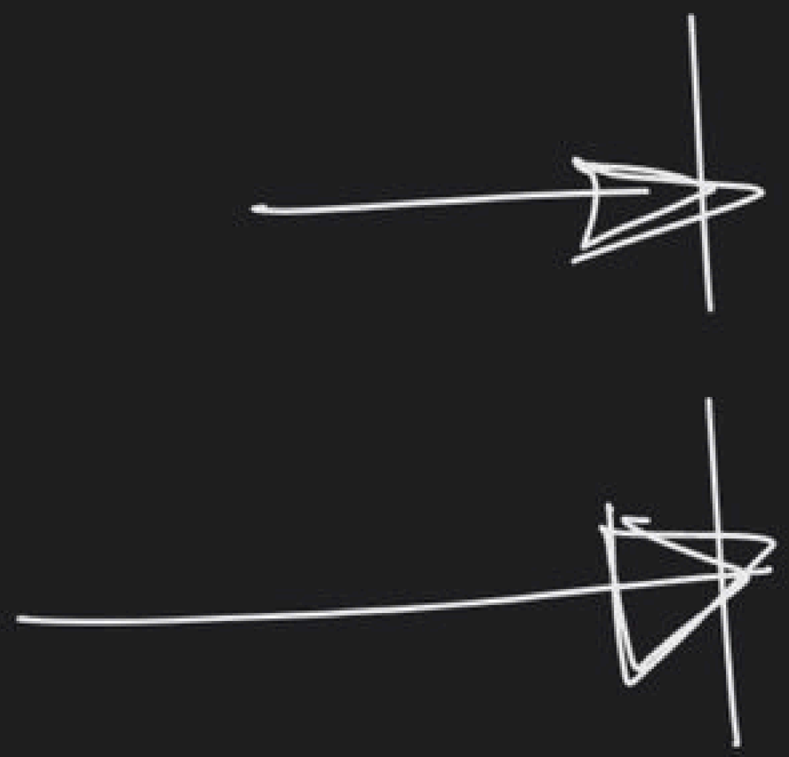


$U_{rms} = \sqrt{\frac{3RT}{M}}$

(A) 1 : 1 : 1 (B) 1 : 1 : 1.224 (C) 1 : 1.128 : 1.224 (D) 1 : 1.128 : 1

$$\frac{1/38}{1/57} = \frac{0.8}{1.6}\sqrt{\frac{M}{28}}$$

7) $P \propto T$. $(V = \text{Const})$ True



$u \propto \sqrt{T}$

$2mv \propto \sqrt{T}$

0.1 mol He

0.32 atm

T = 273

1 mol

(0.68 atm)

1 atm

0.68

$KE = \frac{3}{2}RT$

$\underline{19}$

$\frac{5}{9} \times 4$

$\underline{18}$

$\frac{P}{T} \qquad \frac{P}{T}$

$20/9$

$25/9$

$n_A = \frac{5 \times 1}{4\cancel{00}}$

$n_B = \frac{1 \times 3}{3\cancel{00}}$

$\boxed{\frac{5}{4} = \frac{V_A}{V_B}}$

$\mathcal{E}_{AV}$

$$\begin{array}{cccc} \downarrow & \downarrow & \downarrow & \downarrow \\ 5 & 6 & 6 & 7 \end{array}$$

$$U_{mps} = \underline{U_{avg}} = \frac{5+6+6+7}{4}$$

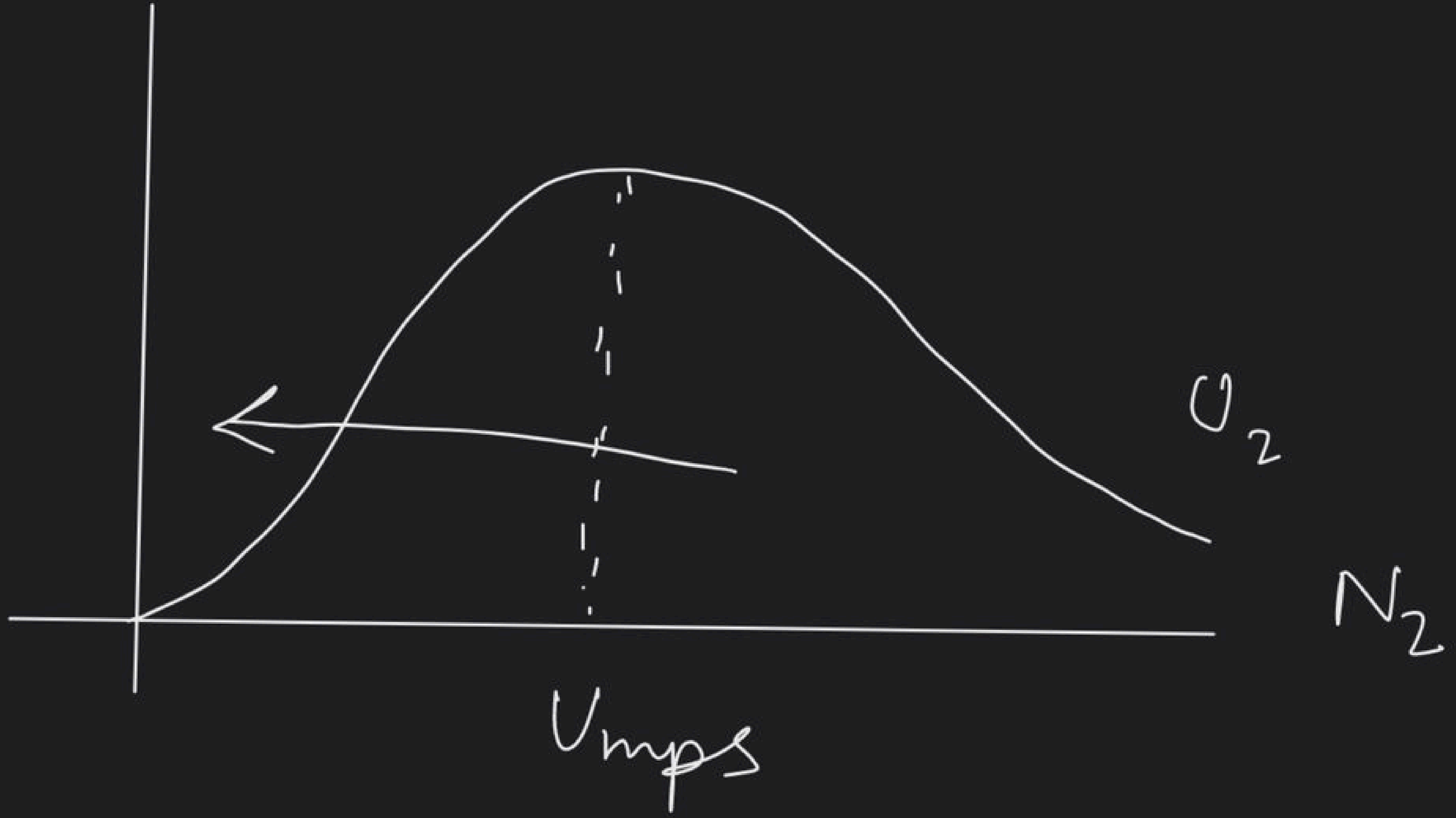
$$= 6$$

$$\underline{U_{rms}} = \sqrt{\frac{146}{4}} = \underline{6}$$

① Area = fraction of molecules

② Total area = 1

③ $V_{mps} = \sqrt{\frac{2RT}{M}}$



$$U_{mps} = \sqrt{\frac{2RT}{M}}$$

$$du = 1$$

Q. find fraction of particle moving betn U_{mps} to $U_{mps} + 1$

u to $u + du$

$$\frac{dN}{N} = 4\pi\left(\frac{M}{2\pi RT}\right)^{3/2} u^2 e^{-\frac{Mu^2}{2RT}} du$$

$$= \frac{4\pi}{\pi^{3/2}}\left(\frac{M}{2RT}\right)^{3/2}\left(\frac{2RT}{M}\right) e^{-\frac{M}{2RT}\times\frac{2RT}{M}} \times 1$$

$$\frac{dN}{N} = \frac{4}{\sqrt{\pi}}\left(\frac{M}{2RT}\right)^{1/2} e^{-1}$$

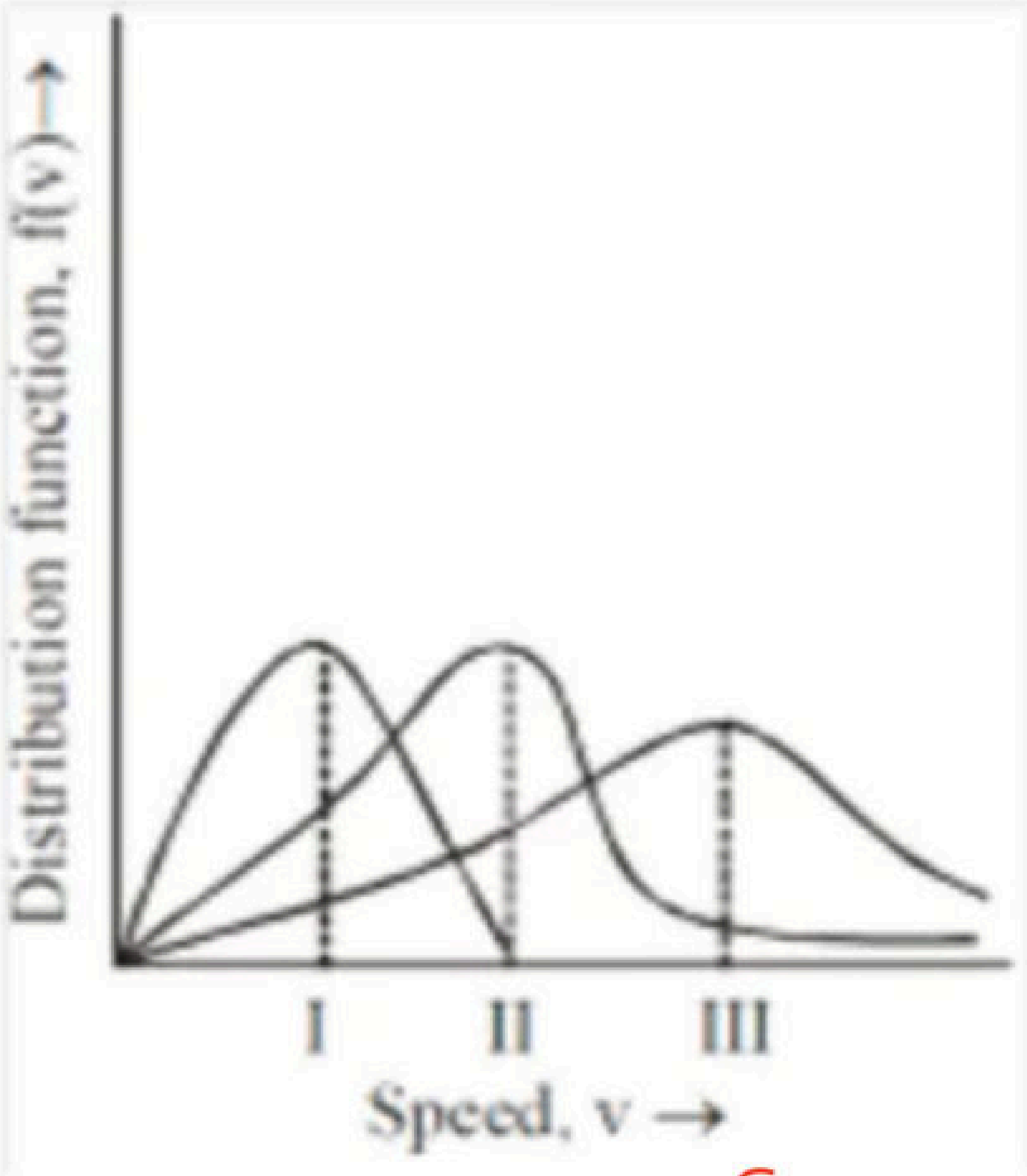
$$U_{mps} = \sqrt{\frac{2RT}{M}}$$

(4) As Temp ↑es fraction of particles moving with V_{mps} ↓es but V_{mps} ↑es

(5) As Mol. mass ↑es fraction of particle moving with V_{mps} ↑es but V_{mps} ↓es

22. Points I,II and III in the following plot respectively correspond to (V_{mp} :most probable velocity)

[JEE-Mains-2019 (Apr.)]



$U_{mps} = \sqrt{\frac{T}{M}}$

O_2 N_2 H_2

$\sqrt{\frac{400}{32}}$ $\sqrt{\frac{300}{28}}$ $\sqrt{\frac{300}{2}}$

(1) V_{mp} of O_2 (400 K) ; V_{mp} of N_2 (300 K); V_{mp} of H_2 (300 K)

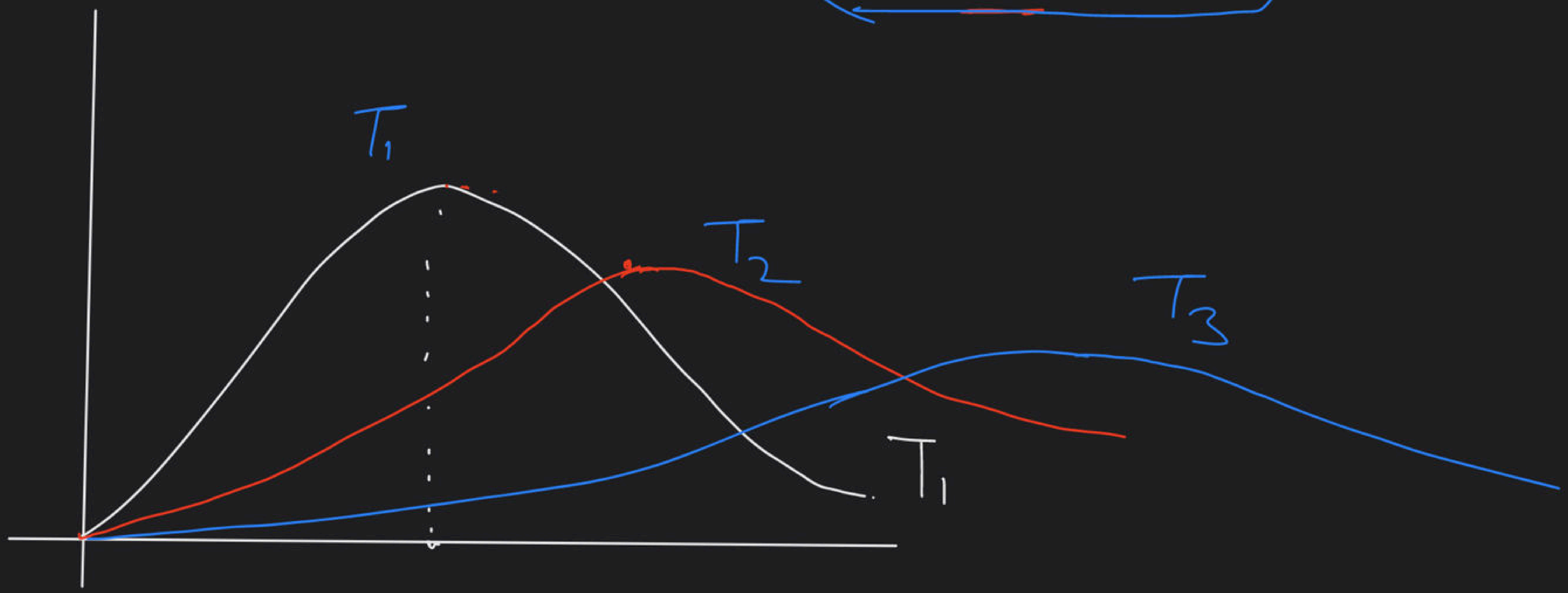
(2) V_{mp} of N_2 (300 K) ; V_{mp} of H_2 (300 K); V_{mp} of O_2 (400 K)

(3) V_{mp} of H_2 (300 K) ; V_{mp} of N_2 (400 K); V_{mp} of O_2 (300 K)

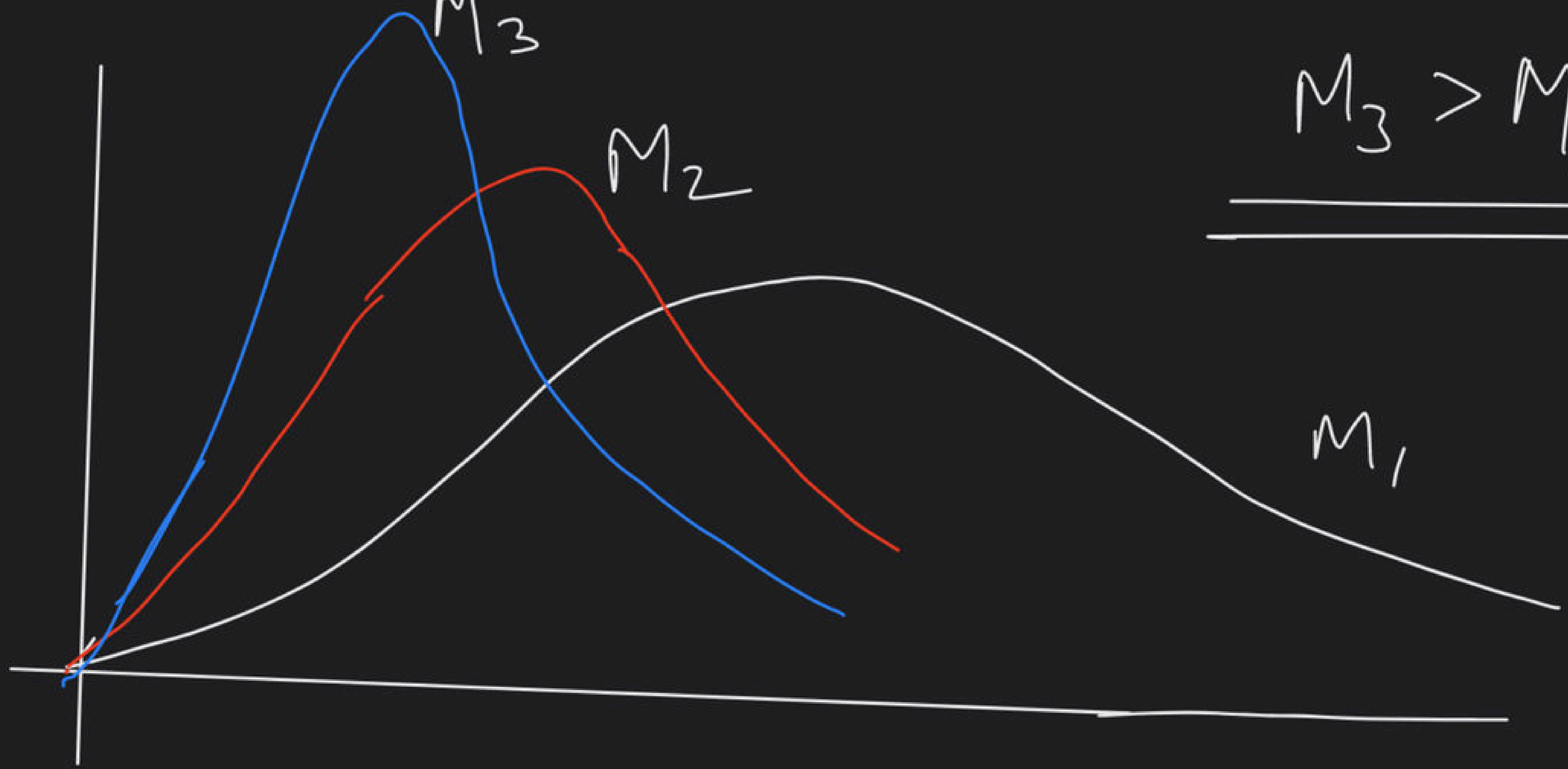
(4) V_{mp} of N_2 (300 K) ; V_{mp} of O_2 (400 K); V_{mp} of H_2 (300 K)

⑤ Effect of Temp:

$T_3' > T_2 > T_1$



⑥ Effect of Mol. mass



$$M_3 > M_2 > M_1$$

7 Maxwell eqn in terms of KE

$$\frac{R}{N_A} = k$$

$$\frac{M}{R} = \frac{m}{k}$$

$$E = KE = \frac{1}{2} m u^2$$

$$dE = \frac{1}{2} m (2u\, du) = m u\, du$$

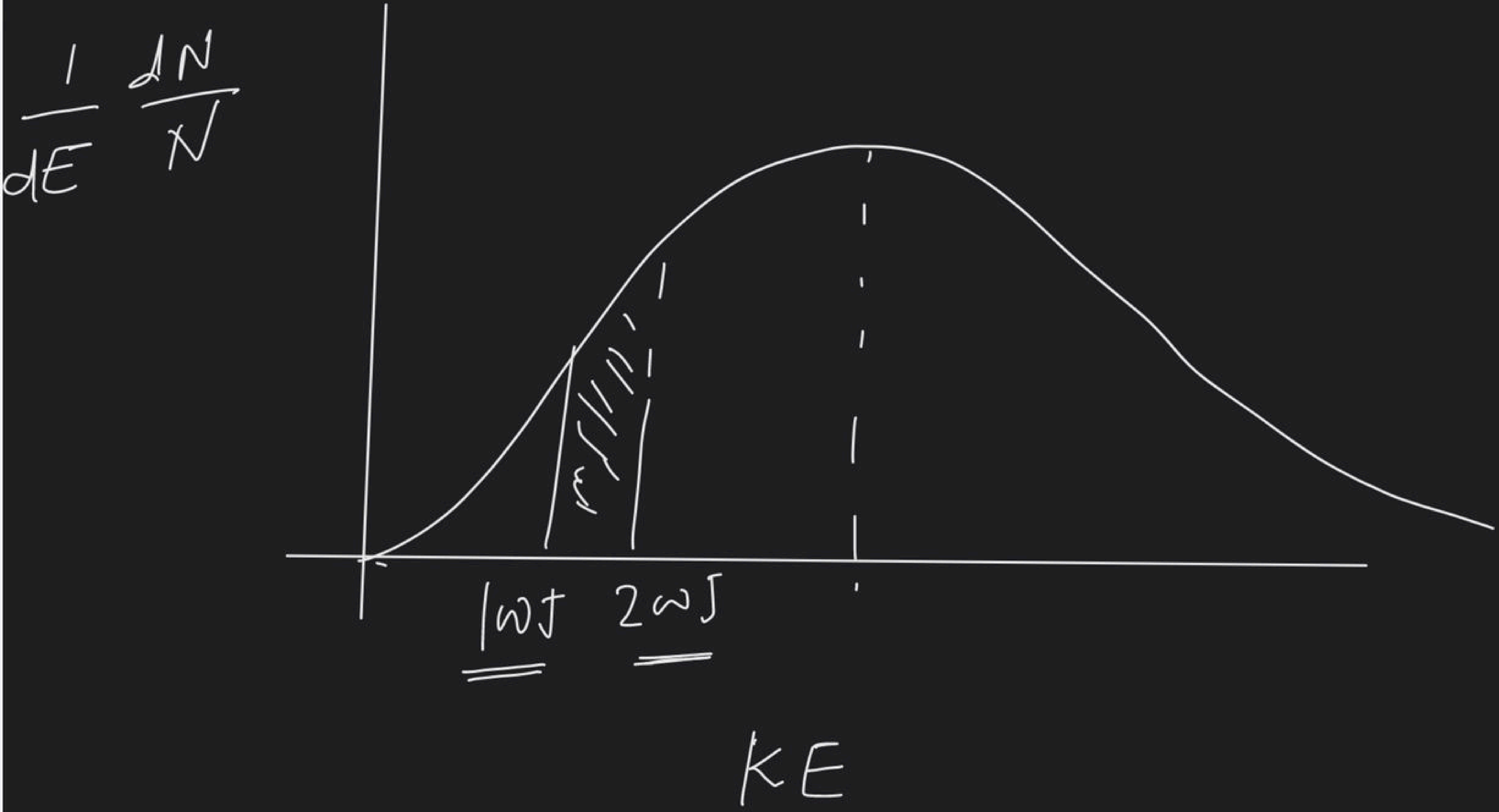
$$dN = 4\pi N \left(\frac{M/N_A}{2\pi R/N_A\, T} \right)^{3/2} u^2 e^{-Mu^2/2RT} du$$

$$= \frac{4\pi N}{\pi^{3/2}} \left(\frac{m}{2kT} \right)^{3/2} u^2 e^{\frac{-mu^2}{2kT}} du$$

$$dN = \frac{4}{\sqrt{\pi}} N \left(\frac{m}{2kT}\right)^{3/2} u^{\cancel{2}} \cdot e^{-E/kT} \cdot \frac{dE}{m\cancel{u}}$$

$$= \frac{4}{\sqrt{\pi}} N \left(\frac{\cancel{m}}{2kT}\right)^{3/2} \left(\frac{2E}{\cancel{m}}\right)^{1/2} e^{-E/kT} \frac{dE}{\cancel{m}}$$

$$dN = \frac{2}{\sqrt{\pi}} N \left(\frac{1}{kT}\right)^{3/2} \cdot \underline{\underline{\sqrt{E} \cdot e^{-E/kT}}} \cdot dE$$


$\frac{1}{N}\frac{dN}{dE}$
1ωJ
2ωJ
KE

$$\frac{d}{dx}\left(\sqrt{x}\right) \Rightarrow \frac{1}{2\sqrt{x}}$$

$$y = \frac{1}{dE}\frac{dN}{N} = C\sqrt{E}\, e^{-E/kT}$$

$$\frac{dy}{dE} = C\left[\frac{1}{2\sqrt{E}} e^{-E/kT} + \sqrt{E}\, e^{-E/kT}\left(-\frac{1}{kT}\right)\right] = 0$$

$$= C\, e^{-E/kT}\left[\frac{1}{2\sqrt{E}} - \sqrt{E}/kT\right] = 0$$

$$\boxed{E_{mpKE} = \frac{1}{2}kT}$$

Q U_{mps} to $U_{mps}+1$

find $\dfrac{\dfrac{dN}{N} \text{ from } U_{mps} \text{ to } U_{mps}+1 \text{ for } O_2 \text{ at } 300K}{\text{'' '' '' for } O_2 \text{ at } 600K}$

(A) $1/2$

(B) 2

(C) $1/\sqrt{2}$

(D) $\sqrt{2}$

$$\frac{1/\sqrt{300}}{1/\sqrt{600}} = \sqrt{\frac{600}{300}} = \sqrt{2}$$

Q. $\frac{\Delta N}{N}$ from v_{mps} to $v_{mps} + f\,v_{mps}$ of O_2 at 300K

" " " " at 600K

A) $2\sqrt{2}$

B) $\frac{1}{2\sqrt{2}}$

C) $2/1$

D) $1/1$

E) $1/2$

$$\underline{du = f \times v_{mps}}$$

$$f << 1$$

$$\frac{dN}{N} = \frac{4\pi}{\pi^{3/2}} \cancel{\left(\frac{M}{2RT}\right)^{3/2}} \cancel{\left(\frac{2RT}{M}\right)} e^{-1} \times f \cancel{\left(\frac{2RT}{M}\right)^{1/2}}$$

$$= \frac{4}{\sqrt{\pi}} \frac{1}{e} \times f = 10^{-3}$$

Q. $\dfrac{dN}{N}$ from U_{rms} to $U_{rms} + \frac{1}{100} U_{rms}$ for O_2 at 300K

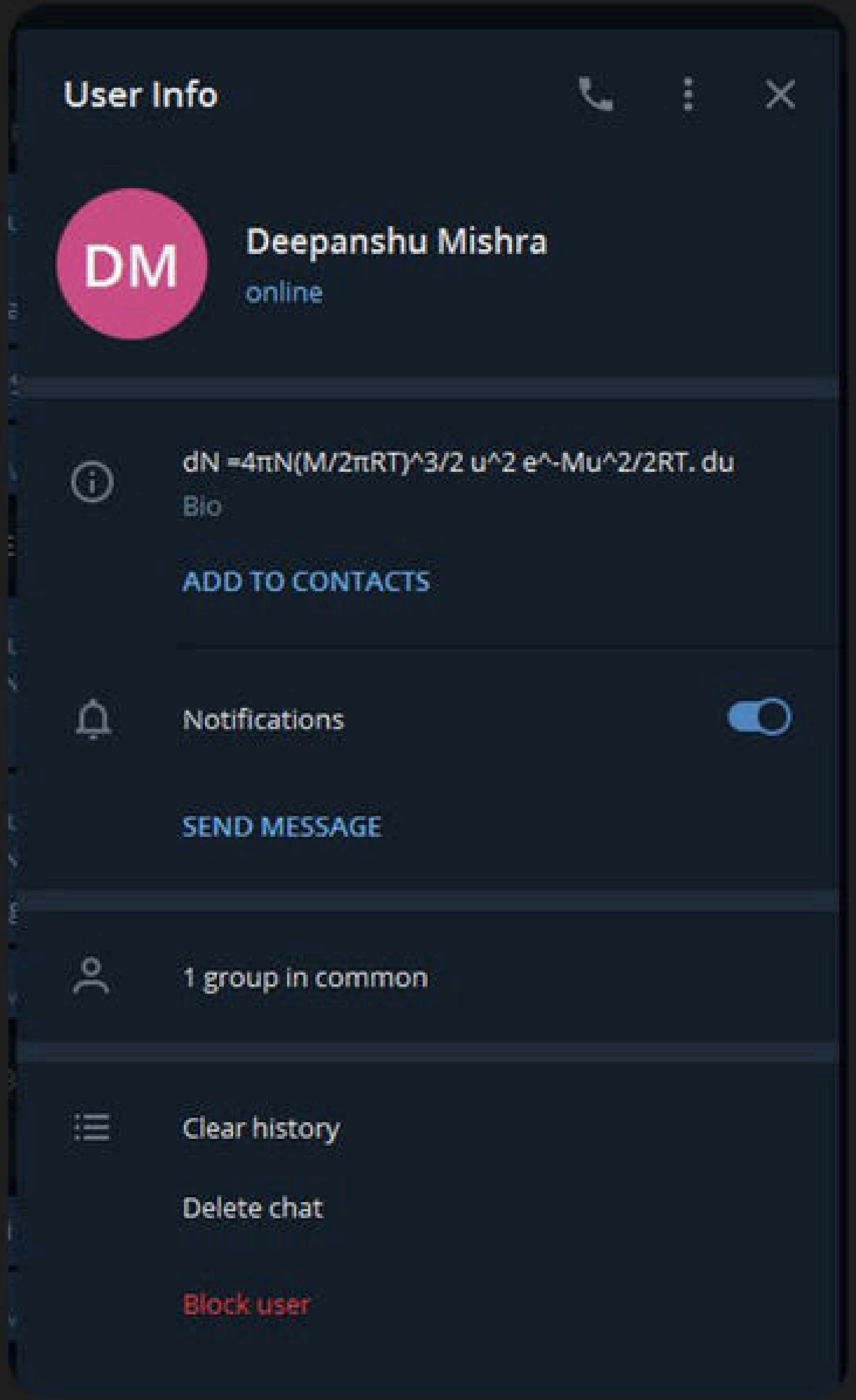
" " " SO_2 at 300K

0 - 1

0 - 2

Question
from Ankur

sir yeh dekho deepanshu ka bio



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