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Advantages

- To be used for...
- To be used for...
- To be used for...
- To be used for...

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Handwritten Section Header

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Ans. (ii)

Maxwell's distribution of molecular velocities :-

—The velocities of the gaseous molecules are different. In other words, we can say that all the molecules do not possess the same velocities.

The first part of the paper is devoted to a general discussion of the problem. It is shown that the problem is equivalent to the problem of finding the minimum of a certain function. This is done by using the method of Lagrange multipliers.

The second part of the paper is devoted to the solution of the problem. It is shown that the minimum is attained at a certain point. This is done by using the method of Lagrange multipliers.



Let x and y be the coordinates of the point. The function to be minimized is $f(x, y) = x^2 + y^2$. The constraint is $g(x, y) = x + y = 1$. The Lagrangian function is $L(x, y, \lambda) = x^2 + y^2 + \lambda(x + y - 1)$. The necessary conditions for a minimum are $\frac{\partial L}{\partial x} = 2x + \lambda = 0$, $\frac{\partial L}{\partial y} = 2y + \lambda = 0$, and $\frac{\partial L}{\partial \lambda} = x + y - 1 = 0$. Solving these equations, we find $x = \frac{1}{2}$ and $y = \frac{1}{2}$. This point is the minimum of the function.

The minimum value of the function is $f(\frac{1}{2}, \frac{1}{2}) = \frac{1}{2}$.

The problem is solved. The minimum value of the function is $\frac{1}{2}$. This is attained at the point $(\frac{1}{2}, \frac{1}{2})$.



The minimum value of the function is $\frac{1}{2}$.

In this regard, a question is arisen that how many molecules are there which have the same magnitudes of their velocities. Of course, on that time, it was difficult to research upon this point but Maxwell had done this work successfully which was based on the rules of the probabilities known as Maxwell's distribution of molecular velocities.

—On the basis of the probability considerations, according to Maxwell and Boltzmann, the actual distribution of the molecular velocities depend upon their temperature and molecular weights respectively, which can be shown as—

$$\frac{dn_c}{n^1} = 4\pi \left(\frac{M}{2\pi RT} \right)^{3/2} e^{-\frac{MC^2}{2RT}} C^2 d_c$$

Where $\left\{ \begin{array}{l} n^1 = \text{Total number of the molecules} \\ dn_c = \text{The number of the molecules having their velocities} \\ \quad \text{in between } C \text{ \& } C + dc \\ M = \text{molecular weight} \\ T = \text{Temperature} \end{array} \right.$

Actually $\frac{dn_c}{n^1}$ is such type of the fraction of the total molecules whose velocities lie in between C & $C + dc$.

The above equation can also be known as Maxwell-Boltzmann distribution law of molecular velocities.

—After dividing by ' d_c ' on both sides of the above equation, we have

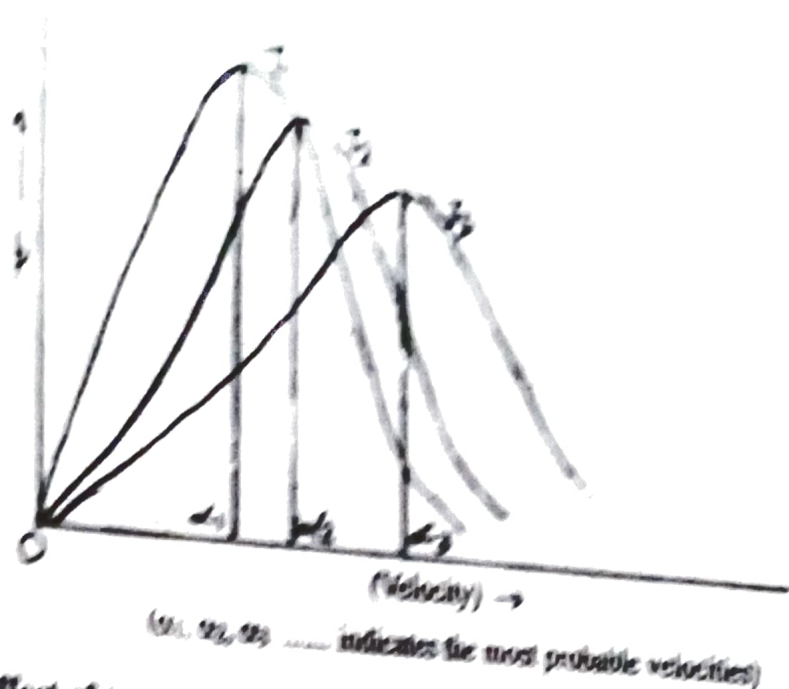
$$\frac{1}{n^1} \frac{dn_c}{d_c} = \frac{4\pi \left(\frac{M}{2\pi RT} \right)^{3/2} e^{-\frac{MC^2}{2RT}} C^2 d_c}{d_c}$$

$$\text{or, } p = \frac{1}{n^1} \frac{dn_c}{d_c} = 4\pi \left(\frac{M}{2\pi RT} \right)^{3/2} e^{-\frac{MC^2}{2RT}} C^2$$

where, p = probability of finding of such type of molecules having their velocities = C

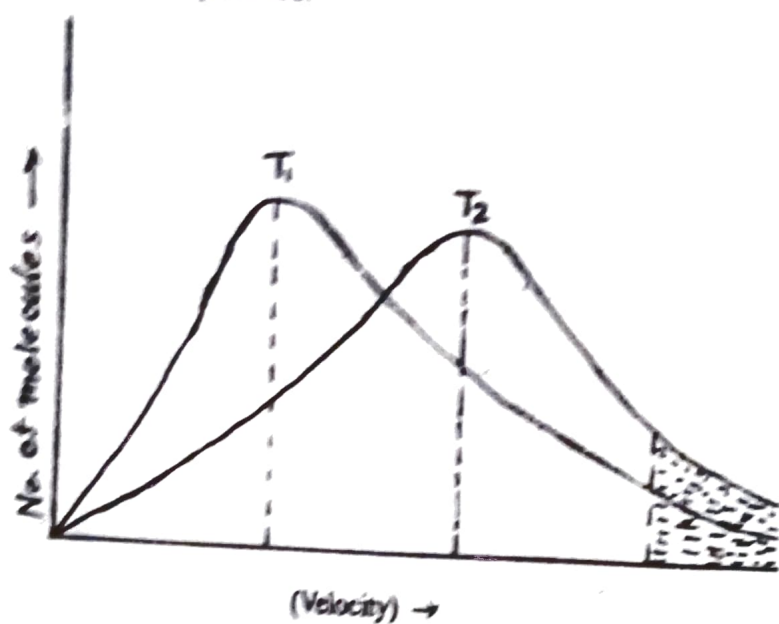
—By plotting the graph p Vs. c at the several temperatures, say

$$T_1, T_2, T_3 \dots\dots$$



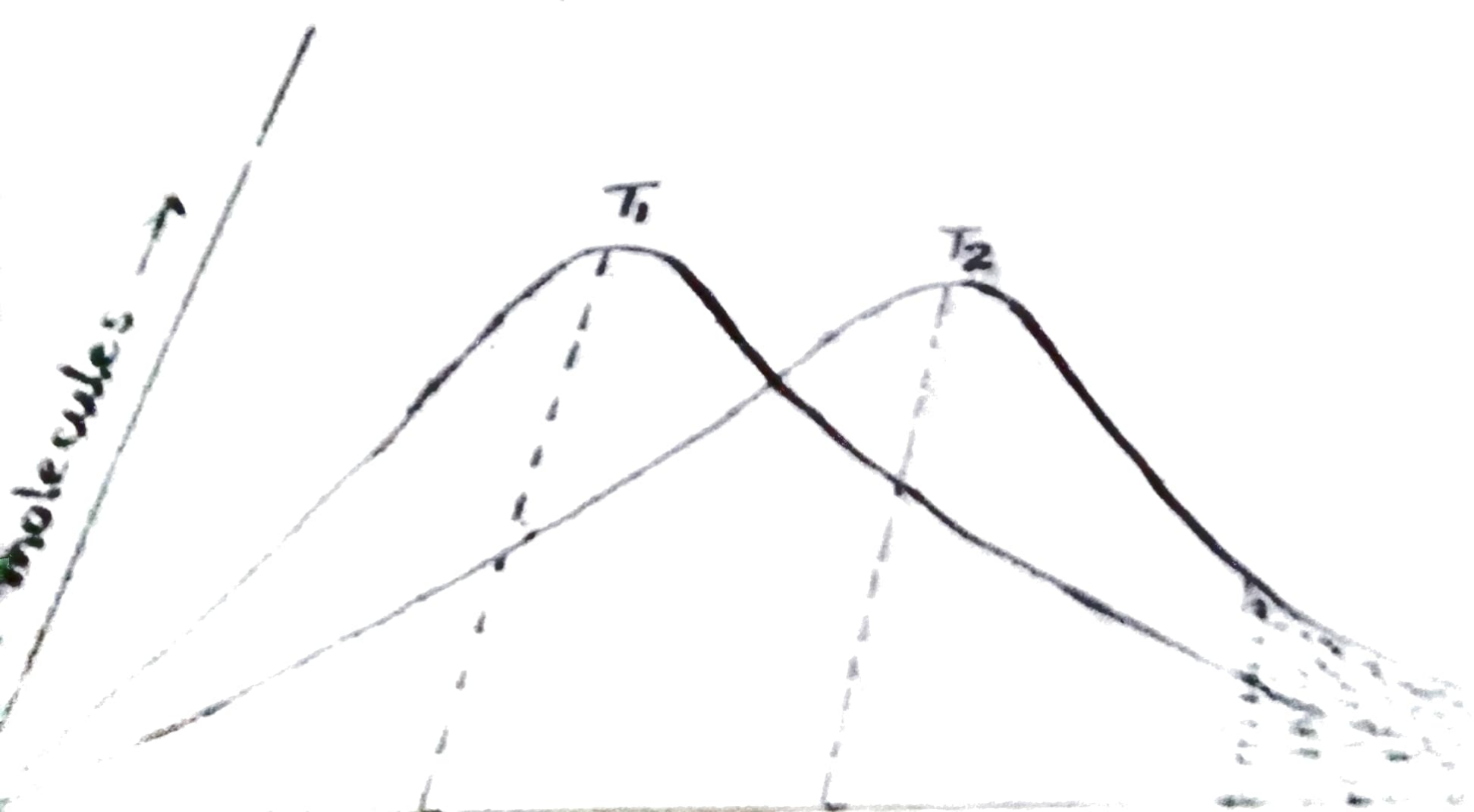
Effect of temperature on velocity distribution :

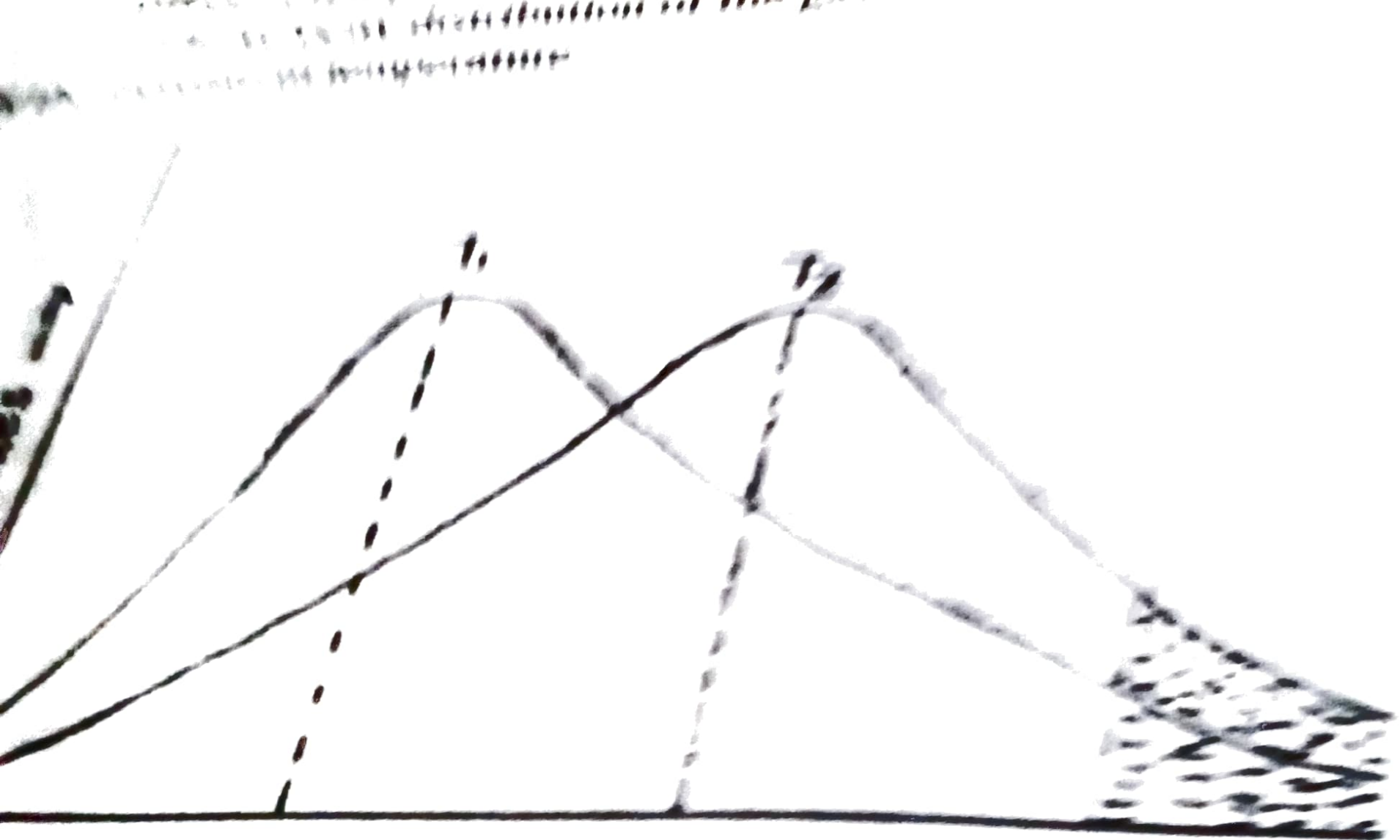
—The velocity distribution of the gaseous molecules is influenced by the increase in temperature.



—Let us suppose that T_1 and T_2 are the two different temperatures, then at the higher temperature, the most probable velocity will be high but the molecules which have already got the most probable velocities then in that cases, their number will be decreased. Due to the reason that in such cases they were widely distributed.

—Since the energy of the molecules is a function of velocity. Therefore, the distribution of the energy among the molecules follows the same pattern which is followed by the distribution of the velocities and





(Velocity) →

... that T_1 and T_2 ...