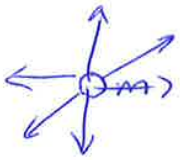
EuPhO 2017
Theory Solution Sheet

Problem Number: 2

Student Code: RUS 4

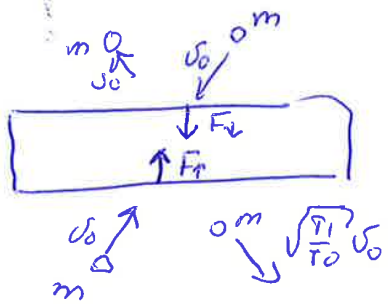


lets think m can have 6 type of speed: $(-v,0,0)$, $(v,0,0)$, $(0,-v,0)$, $(0,v,0)$, $(0,0,-v)$, $(0,0,v)$.

$$\frac{3}{2}k_B T_0 = \frac{m v_0^2}{2} \Rightarrow v_0 = \sqrt{\frac{3k_B T_0}{m}}$$

$$\Delta t F_\downarrow = \frac{S \cdot v_0 \Delta t \rho}{m \cdot 6} \cdot 2mv_0$$

$$\Delta t F_\uparrow = \frac{S v_0 \Delta t \rho}{6m} \cdot m(v_0 + \sqrt{1000} v_0)$$



$$a_0 \cdot M = F_\uparrow - F_\downarrow = \frac{S v_0^2 \rho m}{6m} (\sqrt{1000} - 1).$$

$$a_0 = \frac{S \rho k_B T_0}{2Mm} \cdot \left(\sqrt{T_1/T_0} - 1\right).$$

answer: $a_0 = \frac{S \rho k_B T_0}{2Mm} \left(\sqrt{T_1/T_0} - 1\right)$

when $v_{Disk} = v_{max}$ $F_\downarrow = F_\uparrow$

so $\frac{(v + v_{max}) \rho S \Delta t}{6m} \cdot (2v + 2v_{max}) m = \frac{(v - v_{max}) \rho S \Delta t}{6m} \cdot \left(v - 2v_{max}\sqrt{\frac{T}{T_0}} v\right) m$

with T - temperature when $V_{Disk} = V_{max}$.

$$2(v + v_{max}) = (v - v_{max}) \cdot \left(v\left(1 + \sqrt{\frac{T}{T_0}}\right) + 2v_{max}\right).$$

also $\frac{(v - v_{Disk}) \rho S \Delta t}{6m} \cdot \frac{3k_B(T - T_0)}{2} N k_B \Delta T$.

$$\frac{dT}{dt} = (T - T_0) \cdot \frac{1 \cdot (v - v_{Disk}) \rho S}{4 m N}$$

~~we can find v_{max}: $v_{max} =$~~

we can see when $V_{Disk} = v_{max}$

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at first time $T = e^{-\frac{\upsilon \rho S}{4mN}t} \cdot (T_1 - T_0) + T_0$, when $v_{disk} \ll \upsilon$.

and while T change $\frac{T}{T-\Delta T} = e \quad t = \frac{4mN}{\upsilon \rho S}$.

$$\upsilon_{disk} \approx a_0 \Delta t = \frac{S \rho k_B T_0}{2mm} \cdot \left(\sqrt{\frac{T_1}{T_0}} - 1\right) \cdot \frac{4mN}{\upsilon \rho S}.$$

$mN \approx M$

$$\upsilon_{disk} = 2\upsilon\left(\sqrt{\frac{T_1}{T_0}} - 1\right)$$

we see that when $\upsilon \to \upsilon_{disk}$, $\Delta T \ll T_1$ and so.

$\upsilon_{max} \lesssim \upsilon$, $\upsilon_{max} \approx 0{,}8\upsilon$

answer $\upsilon_{max} \approx 0{,}8\upsilon$.