~~296. 8-9~~

$\cancel{p = \frac{2}{3} n \bar{\varepsilon}_t, \quad \bar{\varepsilon}_t = \frac{1}{2} m \overline{v_x^2} \Rightarrow p = \frac{1}{3} n m \overline{v_x^2}}$

$\cancel{\overline{v_x^2} = \int_0^\infty v_x^2 f(v_x) dv / \int_0^\infty f(v_x) dv =}$

291. 8-9

$$p(v_x) = \frac{F(v_x)}{dA}, \quad F(v_x) = \frac{dI(v_x)}{dt}, \quad dI(v_x) = 2 m v_x \cdot dn$$

$$dn = n \cdot f(v_x) \cdot v_x dt \cdot dA$$

$$\therefore dI = 2mn v_x^2 f(v_x) dt dA \quad P(v_x) = 2mn v_x^2 f(v_x).$$

$$p = \int_0^\infty p(v_x) dv_x = mn \int_{-\infty}^{+\infty} v_x^2 f(v_x) dv_x = mn \overline{v_x^2} = \frac{1}{3} mn \overline{v^2}$$

$$= \frac{1}{3} mn \cdot \frac{3k_BT}{m} = nk_BT.$$

296. 8-10

(1) $v_p = \sqrt{\frac{2k_BT}{m}}$. $v_{p_1} = 394 m/s$, $v_{p_2} = 558 m/s$

(2) $\frac{\Delta N}{N_1} = f(v_{p_1}) \cdot 1 = 4\pi v_{p_1}^2 \left(\frac{m_{O_2}}{2\pi k_B T_1}\right)^{\frac{3}{2}} e^{-\frac{m v_{p_1}^2}{2k_BT_1}} = 0.21\%$

$\frac{\Delta N}{N_2} = 0.15\%$

(3) $\frac{\Delta N}{N} = f(2v_p) \cdot 1 = 0.042\%$

296.8-12

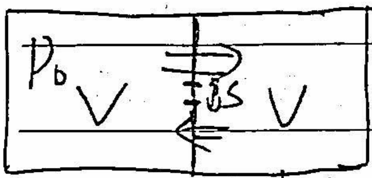
$pV = Nk_BT \Rightarrow p \propto N$. 当 $p=\frac{1}{e}p_0$ 时 $N=\frac{1}{e}N_0$

$dN = \frac{1}{4} n\bar{v}\, dt\cdot S$, $n=\frac{N}{V}$ ∴ $dN = \frac{S}{4}\frac{N}{V}\bar{v}\,dt$

$\Rightarrow \ln N = \frac{S\bar{v}}{4V}t + C \Rightarrow N = \cancel{\otimes}\, e^{\frac{t}{3600}} N_0$.

∴ $t=3600s$

297.8-13



$dN=\frac{1}{4} n\bar{v}\, dt\cdot S$，左右两边温度始终相同.

$pV=Nk_BT$，共有$N_0=\frac{p_0V}{k_BT}$个粒子.

在dt内,从左边到右边的个数 $dN = \frac{1}{4}\bar{v}\, dt\cdot S\left(\frac{N_左}{V}-\frac{N_0-N_左}{V}\right)$

∴ $Vdp = k_BT dN \Rightarrow$, $p_1=\frac{N_左 k_BT}{V} \Rightarrow p_1 = \frac{p_0}{2}+\frac{p_0}{2}e^{-S\sqrt{\frac{2k_BT}{\pi m}}t/2V}$

$p_1V+p_2V = N_0k_BT = p_0V \Rightarrow p_2 = \frac{p_0}{2}-\frac{p_0}{2}e^{-S\sqrt{\frac{2k_BT}{\pi m}}t/2V}$

297.8-14

$\cancel{f(\varepsilon)=4\pi\left(\frac{M}{2\pi k_BT}\right)^{\frac{3}{2}}e^{-\frac{\varepsilon}{k_BT}}\cdot\frac{2\varepsilon}{M}}$

∴ $\cancel{f'(\varepsilon)=0}$ ~~时.~~ $\cancel{\varepsilon_p = k_BT}$

$\cancel{\bar\varepsilon=\int_0^\infty \varepsilon f(\varepsilon)d\varepsilon = 16\pi\left(\frac{M}{2\pi k_BT}\right)^{\frac{3}{2}} k_B^3T^3}$

记 $g(\varepsilon)$，$\varepsilon_i=\frac{1}{2}Mv_i^2$ ∴ $d\varepsilon = Mv\,dv$

$f(v)dv = f(\varepsilon)d\varepsilon \Rightarrow 4\pi\left(\frac{M}{2\pi k_BT}\right)^{\frac{3}{2}}e^{-\frac{Mv^2}{2k_BT}}\cdot v^2dv = 4\pi\left(\frac{M}{2\pi k_BT}\right)^{\frac{3}{2}}\sqrt{\frac{2\varepsilon}{M}}\cdot\frac{d\varepsilon}{M}e^{\cdots}$

∴ $f(\varepsilon) = 4\sqrt{2}\pi\left(\frac{1}{2\pi k_BT}\right)^{\frac{3}{2}}\sqrt{\varepsilon}\, e^{-\frac{\varepsilon}{k_BT}}d\varepsilon$

∴ $\varepsilon_p=\frac{1}{2}k_BT$

$\bar\varepsilon=\int\varepsilon f(\varepsilon)d\varepsilon = \frac{3}{2}k_BT$

297.8-16

$v_p=\sqrt{\frac{2k_BT}{m}}=\sqrt{\frac{2RT}{M}}$ ∴ $T_1:T_2=\frac{v_{p_1}^2 M_{He}}{v_{p_2}^2 M_{H_2}}=\frac{1}{2}$