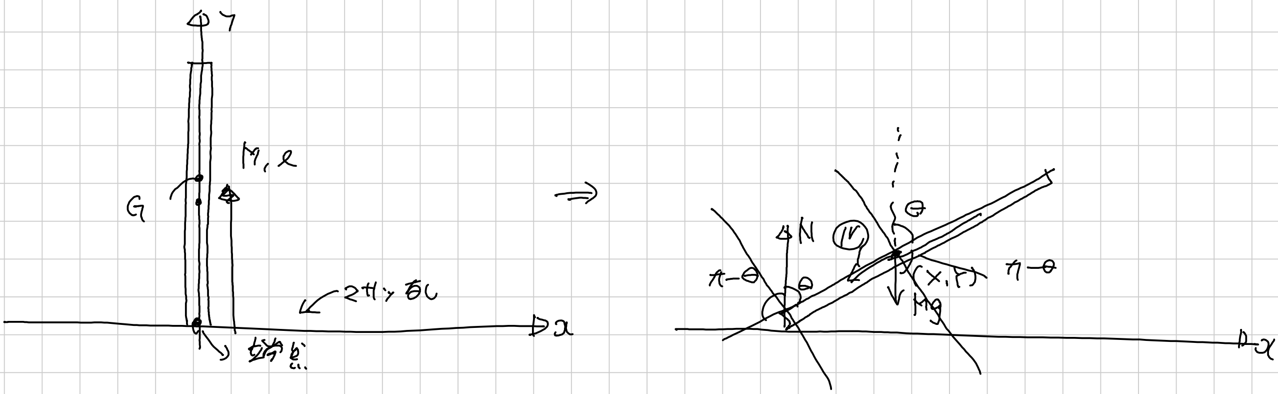


(1)

$$I_O = \int_0^l \rho x^2 dx \qquad \rho = \frac{M}{l}$$

$$= \frac{1}{3}x^3$$

$$= \frac{M}{3l}\cdot l^3 = \frac{1}{3}Ml^2$$

$$I_G = \int_{-l/2}^{l/2} \rho x^2 dx = \frac{M}{l}\cdot\frac{1}{3}\cdot\left(\frac{l^3}{8}+\frac{l^3}{8}\right) = \frac{M}{12}l^2 \qquad \left(\frac{l^3}{4}\right)$$

(2) 並進: $M\ddot{x} = 0$, $M\ddot{y} = -Mg + N$

回転の方程式: $\sum r\times F = I_G(-\ddot{\theta})$ ∴ $I_G\ddot{\theta} = \frac{l}{2}N\sin\theta$ ①

$-\frac{l}{2}\cdot N\cdot\sin\theta$

(3) 剛体の回転エネルギー.

$$T = \frac{1}{2}\omega^T I \omega = \frac{1}{2}(\dot{\theta})^2 I_G + \frac{1}{2}M(\dot{x}^2+\dot{y}^2)$$

$$U = Mgy$$

$$T_0 = 0$$

$$U_0 = Mg\cdot\frac{1}{2}l$$

$\ddot{x}=0$ より $\dot{x}=0$ ($\dot{x}(0)=0$)

$+\frac{1}{2}Mgl\cos\theta$

∴ $\frac{1}{2}(\dot{\theta})^2 I_G + \frac{1}{2}M(\dot{x}^2+\dot{y}^2) = Mg\cdot\frac{1}{2}l$

(4) ①より

$$\ddot{\theta} = \frac{l}{2I_G}N\sin\theta = \frac{6}{Ml}\cdot N\sin\theta$$

支点の方程式. $+\frac{l}{2}\cdot Mg\sin\theta = I_O\cdot(+\ddot{\theta})$ ∴ $\boxed{\ddot{\theta} = \frac{l}{2I_O}\cdot Mg\sin\theta}$

$$\frac{l}{2I_O}Mg\sin\theta = \frac{l}{2I_G}N\sin\theta \qquad N = \frac{I_G}{I_O}\cdot Mg$$

$$\ddot{\theta} = \cancel{\frac{3}{2Ml}Mg\sin\theta = \frac{3g}{2l}\sin\theta}$$

→ $\ddot{\theta}$ を考える!!

$$N = \frac{Ml\ddot{\theta}}{6\sin\theta} = \frac{Ml}{6\sin\theta}\dot{\omega} = \boxed{\quad}$$

(5)

$$N = \frac{\frac{M}{12}l^2}{\frac{1}{3}Ml^2}\cdot Mg = \frac{1}{4}Mg$$

→ $\dot{y}$ は、$y = \frac{l}{2}\cos\theta$ より $\dot{y} = -\frac{l}{2}\sin\theta\cdot\omega$ である!!

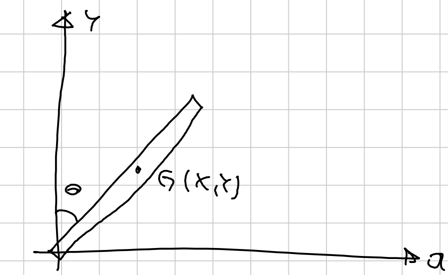
$$\frac{1}{24}\omega^2 Ml^2 + \frac{1}{2}Mgl\cos\theta + \frac{1}{8}Ml^2\sin^2\theta\,\omega^2 = \frac{1}{2}Mgl$$

$$\omega^2(l + 3l\sin^2\theta) = 12g - 12g\cos\theta$$

$$\omega = \sqrt{\frac{12g}{l}\cdot\frac{1-\cos\theta}{1+3\sin^2\theta}}$$

$$\dot{\omega} = \frac{1}{2}(\quad)^{-1/2}$$

[B]



(6) すべっている場合でもすべっていない場合でも同じなので、エネ保より

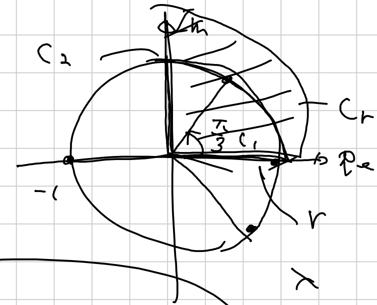
$$Mg\cdot\frac{1}{2}l = \frac{1}{2}\underbrace{(\dot{\theta})}_{\omega_f}{}^2\cdot I_G + \frac{1}{2}Mv_f^2 \qquad \therefore\ \frac{1}{2}Mgl = \frac{1}{2}\omega_f^2\cdot\frac{M}{12}l^2 + \frac{1}{2}Mv_f^2$$

$\boxed{\frac{1}{2}l\omega_f = v_f}$

(7) (ウ)：v_fの値は2つの場合で異なるため

[2]

(A) $f(z) = \dfrac{1}{z^3+1} = \dfrac{1}{(z+1)(z-e^{\frac{\pi}{3}i})(z-e^{-\frac{\pi}{3}i})}$

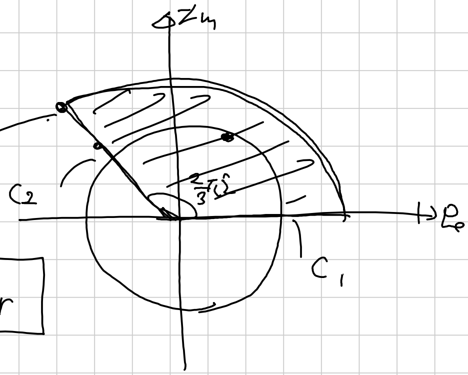


右図の領域での積分を考えて留数定理を使うことを考える

$$\int_C f(z)\,dz = 2\pi i\, Res(z=e^{\frac{\pi}{3}i}) = 2\pi i \dfrac{1}{(e^{\frac{\pi}{3}i}+1)(e^{\frac{\pi}{3}i}-e^{-\frac{\pi}{3}i})}$$

$$\int_{Cr}|f(z)dz| \le \int_{Cr} \frac{1}{r^3-1}dr \sim O(r^{-2}) \to 0 \ (r\to\infty)$$

$$|z|^3-1 \le |z^3+1| \ (\le |z|^3+1)$$



$$C_2 = \int_{re^{\frac{2}{3}\pi i}}^{0} \frac{1}{z^3+1}dz = \int_r^0 \frac{1}{r^3+1}\cdot e^{i\frac{2}{3}\pi}dr$$

$$r\cdot e^{i\frac{2}{3}\pi} = z \ : \ e^{i\frac{2}{3}\pi}dr = dz$$

$$\boxed{-e^{i\frac{2}{3}\pi}\int_0^r \frac{1}{r^3+1}dr}$$

$$C_1 = \int_0^r \frac{1}{r^3+1}dr$$

$$\therefore \ (1-e^{i\frac{2}{3}\pi})\int_0^\infty \frac{1}{x^3+1}dx =$$

$$e^{\frac{\pi}{3}i} = \frac{1}{2}+\frac{\sqrt{3}}{2}i$$

$$e^{-\frac{\pi}{3}i} = \frac{1}{2}-\frac{\sqrt{3}}{2}i$$

$$e^{i\frac{2}{3}\pi} = -\frac{1}{2}+\frac{\sqrt{3}}{2}i$$

$$\left(\frac{3}{2}-\frac{\sqrt{3}}{2}i\right)(\quad) = \frac{2\pi i}{(\frac{3}{2}+\frac{\sqrt{3}}{2}i)(\sqrt{3}i)}$$

$$(\quad) = \frac{2\pi}{\underbrace{(\frac{9}{4}+\frac{3}{4})}_{3}\cdot\sqrt{3}} = \boxed{\frac{2}{9}\sqrt{3}\,\pi}$$

[B]

$$F(k) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} f(x)e^{-ikx}dx$$

(2) $\displaystyle\int_{-\infty}^{\infty} F(k)\cdot(G(k))^* dk = \int_{-\infty}^{\infty} f(x)(g(x))^* dx$ を示す

$$\frac{1}{2\pi}\int_{-\infty}^{\infty}\left[\left(\int_{-\infty}^{\infty} f(x)e^{-ikx}dx\right)\left(\int_{-\infty}^{\infty} g^*(y)e^{iky}dy\right)\right]dk$$

$\infty \quad \infty$

$f(x)=1$の時

$$F(x) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} e^{-ikx}dx$$

$$1 = \frac{1}{2\pi}\int_{-\infty}^{\infty} F(k)\, e^{ikx}dk$$

$$\int_{-\infty}^{\infty} e^{-ikx}$$

$$\int_{-\infty}^{\infty} f(x)\cdot\Big(\underbrace{\int_{-\infty}^{\infty} G^*(k) e^{-ikx} dk}_{g^*(x)}\Big) dx = \int_{-\infty}^{\infty} dk \int_{-\infty}^{\infty} dx\ G^*(k)\ f(x) e^{-ikx} dx$$

$$= \int_{-\infty}^{\infty} dk\ G^*(k)\cdot F(k)\ \text{ok}$$

(別に $\int \frac{dk}{2\pi} e^{i(y-x)k} dk = \delta(y-x)$ 使ってやっても良い)

(3)

$$F(k) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} e^{-|x| - ikx} dx = \frac{1}{\sqrt{2\pi}} \int_{0}^{\infty} e^{-x-ikx} dx + \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{0} e^{x-ikx} dx$$

$$\frac{1}{\sqrt{2\pi}} \Big[-\frac{1}{1-ik} e^{-x-ikx} \Big]_0^{\infty} = \frac{1}{\sqrt{2\pi}} \Big(\frac{1}{1+ik} \Big)$$

$|\ | \to 0$

$$\frac{1}{\sqrt{2\pi}} \Big[\frac{1}{1-ik} e^{x-ikx} \Big]_{-\infty}^{0} = \frac{1}{\sqrt{2\pi}} \Big(\frac{1}{1-ik} \Big)$$

$$\therefore F(k) = \frac{1}{\sqrt{2\pi}} \Big(\frac{1}{1+ik} + \frac{1}{1-ik} \Big) = \frac{2}{1+k^2} \cdot \frac{1}{\sqrt{2\pi}}$$

$$\frac{4}{2\pi}$$

(4)

$$F(k) = \frac{2}{1+k^2}\frac{1}{\sqrt{2\pi}}\ G^*(k) = \frac{2}{1+k^2}\frac{1}{\sqrt{2\pi}}\ \text{とする.}$$

$$\frac{2}{\pi} \int_{-\infty}^{\infty} \frac{1}{(1+k^2)^2} dk = \int_{-\infty}^{\infty} e^{-2|x|} dx = 2 \int_0^{\infty} e^{-2x} dx = 2 \Big[-\frac{1}{2} e^{-x} \Big]_0^{\infty}$$

$$= 1$$

$$\therefore \int_{-\infty}^{\infty} \frac{1}{(1+k^2)^2} dk = \frac{\pi}{2}$$

1.(1)

$$\exp\Big(\frac{x}{2}\big(z - \frac{1}{z}\big) \Big) = \sum_{n=-\infty}^{\infty} J_n(x) z^n \to e^{ix\sin\theta} = \sum_{n=-\infty}^{\infty} J_n(x) e^{in\theta}$$

(5)

$$\frac{1}{2\pi} \int_{-\pi}^{\pi} e^{ix\sin\theta - in\theta} d\theta = \frac{1}{2\pi} \sum_{n'=-\infty}^{\infty} J_{n'}(x) \underbrace{\int_{-\pi}^{\pi} \big(e^{in'\theta - in\theta}\big)}_{} d\theta$$

$\delta(n', n)$ に比例 (?) してい

$$\int_{-\pi}^{\pi} \exp(i(n'-n)\theta) d\theta = \frac{1}{i(n'-n)} \Big[\exp(i(n'-n)\theta) \Big]_{-\pi}^{\pi} = 0 \ (\text{for } n' \neq n)$$

$$\exp(in\pi) - \exp(-in\pi)$$

$$(-1)^n - (-1)^{-n} = (-1)^n (1 - (-1)^{-2n}) = 0$$

$$= 2\pi \ (\text{for } n' = n)$$

$$\therefore \quad = \sum_{n'=-\infty}^{\infty} J_{n'}(x) \delta(n', n) = J_n(x)\quad \text{ok}$$

(6)

$$J_0(x) = \frac{1}{2\pi}\int_{-\pi}^{\pi} e^{i x \sin\theta}\, d\theta$$

$$F(k) = \frac{1}{\sqrt{2\pi}} \cdot \frac{1}{2\pi} \int_{-\infty}^{\infty} dx \int_{-\pi}^{\pi} e^{i x \sin\theta}\, d\theta \cdot e^{-ikx}$$

$F(k) = \delta(k-k')$ 일 때

$$f(x) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} \delta(k-k') \cdot e^{+ikx} = \frac{1}{\sqrt{2\pi}} e^{+ik'x}$$

$$\delta(k-k') = \cancel{\frac{1}{\sqrt{2\pi}}}\ \frac{1}{2\pi} \int_{-\infty}^{\infty} e^{-i(k-k')x}\, dx$$

$$F(k) = \frac{1}{(2\pi)^{3/2}} \cdot \int_{-\pi}^{\pi} \left[\boxed{\int_{-\infty}^{\infty} e^{-i(k-\sin\theta)x}\, dx} \right] d\theta$$

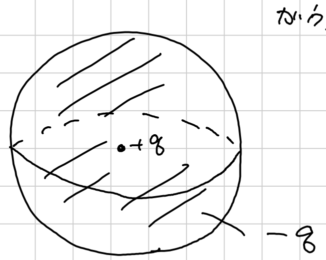
$$= \cancel{\frac{1}{2\pi}}\ \frac{1}{\sqrt{2\pi}} \cdot \int_{-\pi}^{\pi} \delta(k - \sin\theta)\, d\theta$$

$k = \sin\theta$ 일 때 $\theta' = \sin^{-1}(k)$

$$\begin{cases} -\pi \le \sin^{-1}(k) \le \pi \text{ 일 때} & F[J_0] = \frac{1}{\sqrt{2\pi}} \\ \text{그 외에} & F[J_0] = 0 \end{cases}$$

3

(1)



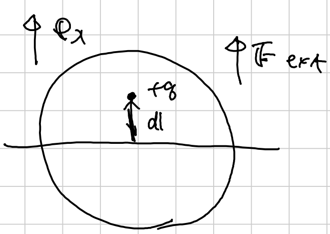
ガウスの法則より $\int E\cdot dS = \int \frac{\rho}{\varepsilon_0} dV$

$+q$に関して. $E_{+,r}\cdot 4\pi r^2 = \frac{1}{\varepsilon_0} q$ ∴ $\underline{E_{+,r} = \frac{q}{4\pi r^2 \varepsilon_0}}$ //

$-q$に関して. $\int E ds = \int \frac{\rho}{\varepsilon_0} dv = \begin{cases} \frac{1}{\varepsilon_0}\cdot\left(\frac{r}{a}\right)^3\cdot(-q) & (r \le a) \\ \frac{1}{\varepsilon_0}(-q) & (r \ge a) \end{cases}$

∴ $E\cdot 4\pi r^2 = \begin{cases} \frac{1}{\varepsilon_0}\left(\frac{r}{a}\right)^3(-q) \\ \frac{1}{\varepsilon_0}(-q) \end{cases} \longrightarrow E_{-,r} = \begin{cases} -\frac{1}{4\pi\varepsilon_0}\cdot\frac{r}{a^3}q & (r \le a) \\ -\frac{1}{4\pi\varepsilon_0}\cdot\frac{1}{r^2}q & (r \ge a) \end{cases}$ //

(2)



$+q$が動かないつり合う力は $F = qE_{-,in}$ 故

$F = -q\cdot\frac{1}{4\pi\varepsilon_0}\cdot\frac{d}{a^3} q\, e_x$

∴ $0 = \left(-\frac{q^2}{4\pi\varepsilon_0 a^3} d + qE_{ext}\right) e_x$

∴ $E_{ext} = \frac{qd}{4\pi\varepsilon_0 a^3}$ $\quad (4\pi a^3)\varepsilon_0 E_{ext} = qd$

$\Downarrow$

α ∴ $\underline{\alpha = 4\pi a^3}$ //

$f'(x) = n(1+ax)^{n-1}\cdot a$

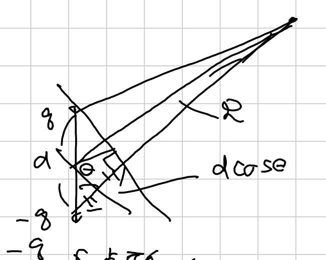
$f''(x) = n(n-1)(1+ax)^{n-2}a^2$

$(1+ax)^n$

$\simeq 1 + a\cdot nx$

$+ \frac{1}{2!}\cdot(n)(n-1)a^2x^2$

(3)



−q ↑点電荷とみなしてよい。

$\phi_P = -\int_\infty^r E(r)dr \quad -\int_\infty^r \frac{1}{4\pi\varepsilon_0}\cdot\frac{1}{r^2}(-q)dr$

$\frac{1}{4\pi\varepsilon_0}\int_\infty^r \frac{1}{r^2}dr = -\frac{q}{4\pi\varepsilon_0 r}$

$\phi_P = -\frac{q}{4\pi\varepsilon_0(R + d/2\cos\theta)} + \frac{q}{4\pi\varepsilon_0(R - d/2\cos\theta)} = \frac{q}{4\pi\varepsilon_0}\Big($

$R \gg d$より $\longrightarrow \frac{q}{4\pi\varepsilon_0}\frac{1}{R}\cdot\left(-\left(1 - \frac{d}{2R}\cos\theta\right) + \left(1 + \frac{d}{2R}\cos\theta\right)\right)$

$= \frac{q}{4\pi\varepsilon_0}\left(-\left(R - \cancel{\frac{d}{2}\cos\theta}\right) + R\left(+\frac{d}{2}\cos\theta\right)\right) = \boxed{\frac{q}{4\pi\varepsilon_0}\cdot\frac{d}{R^2}\cos\theta}$ //

(4) $E_P = \left(-\frac{q}{4\pi\varepsilon_0(R + d/2\cos\theta)^2} + \frac{q}{4\pi\varepsilon_0(R - \frac{d}{2}\cos\theta_1)^2}\right) e_R$

$\simeq \frac{q}{4\pi\varepsilon_0}\cdot\frac{1}{R^2}\left(-\left(1 - \frac{d}{R}\cos\theta\right) + \left(1 + \frac{d}{R}\cos\theta\right)\right)$

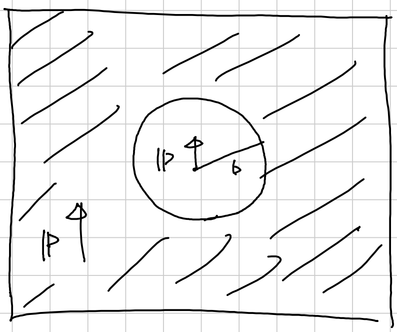
$p\cdot E_P = (\quad) e_R\cdot d\, e_x = (\quad) d\cos\theta_1$

$= \frac{q}{4\pi\varepsilon_0 R^2}\cdot\frac{2d^2}{R}\cos^2\theta_1 = \cancel{0 \text{ となる}}$ $\quad \longleftarrow \quad = \frac{q}{4\pi\varepsilon_0 R^2}\cdot\frac{2d}{R}\cos\theta_1$

$\cos\theta_1 = 0$??

[B]

(5)



??

(6) ??

② → 家にかえって教科書を読む.

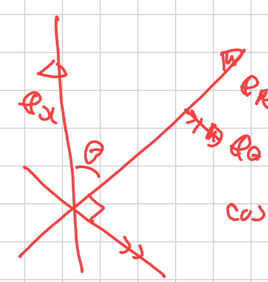
⇒ (4) $\mathbb{E}_p = -\nabla_{R,\theta}\phi_p$ である

$$-\left(e_R\partial_R + \frac{1}{R}e_\theta\partial_\theta\right)\frac{qd}{4\pi\epsilon_0}\cdot\frac{1}{R^2}\cos\theta = +e_R\left(\frac{2qd}{4\pi\epsilon_0}\frac{1}{R^3}\cos\theta\right)$$

$$+\frac{1}{R}e_\theta\cdot\frac{qd}{4\pi\epsilon_0}\cdot\frac{1}{R^2}\sin\theta$$

$$=\frac{qd}{4\pi\epsilon_0}\cdot\frac{1}{R^3}\left(2\cos\theta\, e_R + \sin\theta\, e_\theta\right)$$

$e_R\cdot e_x = \cos\theta \qquad e_\theta\cdot e_x = -\sin\theta$



$\cos(\theta+90^\circ) = -\sin$

$\mathbb{E}_p\cdot e_x = \sim(2\cos^2\theta - \sin^2\theta) = 0$ なので

$2\cos^2\theta - (1-\cos^2\theta) = 0$

$\cos\theta = \pm\frac{1}{\sqrt{3}}$

$\frac{1}{\sqrt{2\pi}}\int_{-\pi}^{\pi} d\theta\ \delta(\sin\alpha - k)$

$-1 < k < 1$

$\hat{j}_k(k) = \frac{1}{\sqrt{2\pi}}\int_{-\pi}^{\pi} d\theta\ \frac{1}{\sqrt{1-k^2}}\left(\delta(\theta-\theta_1) + \delta(\theta-(\pi-\theta_1))\right)$

$\cos\theta\big|_{\sin\theta=k} = \sqrt{1-k^2}$

IV

(1) $I = \int r^2 dm$. $\therefore I_0 = \frac{Ml^2}{3}$. $I_G = \frac{Ml^2}{12}$

$\rightarrow I_0 = I_G + M(\frac{l}{2})^2$: 平行軸の定理

(2) $M\ddot{x} = 0$. $M\ddot{y} = Mg - N$

$\rightarrow -\frac{l}{2}\sin\theta N = (-\ddot{\theta}) \Rightarrow \underline{\frac{l}{2}\sin\theta N = \ddot{\theta}}$ //

(3)

$\therefore \frac{Mg}{2}l = \frac{M}{2}(\dot{x}^2 + \dot{y}^2) + \frac{1}{2}I_G\dot{\theta}^2 + \frac{Mgl\cos\theta}{2}$ //

(4)

$\int \mathbb{D} \cdot dS = Q_{true}$.

$\varepsilon_0 \int \mathbb{E} \cdot dS = Q_{true} - \int \mathbb{P} \cdot dS$. $\int \rho_{por} dS \rightarrow Q_{por}$

$\boxed{\rho_{por} = -\nabla \cdot \mathbb{P} = 0\ ??}$

(6) $\mathbb{P} = n\mathbb{p}$

午後

[II]

(1) $H = -af \times N_A$. ($N_A \sim 0, 1, 2, \cdots N$)

$$\cancel{\therefore Z_1 = \mathrm{Tr}\exp(-\beta H) = \sum_{N_A = 0 \sim N} \exp(\beta a f N_A) = \frac{1-\exp((1+N)af\beta)}{1-\exp(\beta af)}}$$

$\beta = \frac{1}{k_B T}$

(1/2?)

$$Z_1 = \exp(-\beta(-af\,1)) = \underline{\exp(\beta af) + 1}$$

(2) 互いに独立に $Z_N = (\exp(\beta af)+1)^N$

$$\underline{G = -k_B T N \log(\exp(\beta af)+1)}$$

(3) $F = U - TS$ $\therefore dG = dU - T\cancel{dS} - SdT \to \cancel{dG = fdL - SdT}$

$-fL$ と変換

$dU = \cancel{fdL} + \cancel{TdS}$ $-dfL - \cancel{fdL}$

$$\underline{= -Ldf - SdT}$$

$$\therefore \frac{\partial G}{\partial f} = -L \quad \therefore \quad \frac{\partial G}{\partial f} = -k_B T N \cdot \frac{\beta a \exp(\beta af)}{\exp(\beta af)+1} = -L$$

(4) $$\therefore L = \cancel{k_B T} N \cdot \frac{\cancel{\beta} a \exp(\beta af)}{\exp(\beta af)+1}$$

$$L = k_B T N \frac{\beta a \exp\left(\frac{af}{k_B T}\right)}{\exp\left(\frac{af}{k_B T}\right)+1}$$

(5)

$$\frac{\frac{a}{k_B T}\exp(\,)}{\exp(\,)+1} = \frac{\frac{a}{k_B T}}{1+\exp(-\,)} \sim \frac{a}{k_B T} \quad \therefore L \sim k_B \cancel{T} \cdot N \cdot \frac{a}{\cancel{k_B T}}$$

$\exp(-\,) \to -\infty$

$= aN$ = Const

$af = 0 \to a = 0$?? じゃないとおかしい → (ウ)

$af = \frac{1}{3} \to$ (イ)

$af = 3 \to$ (ア)

高度増加とともに小さく

f大きいほど、a伸び切る。

$$\frac{\partial G}{\partial T} = -k_B N \log\left(\exp\left(\frac{af}{k_B T}\right)+1\right) - \cancel{k_B} T N \cdot \frac{1}{\exp\left(\frac{af}{k_B T}\right)+1} \cdot \left(-\frac{af}{k_B T^2}\right) \cdot \left(\exp(\ )\right)$$

4

$$S = +k_B N \log\left(\exp\left(\frac{af}{k_B T}\right)+1\right) - \frac{1}{T} af \frac{N}{1+\exp\left(-\frac{af}{k_B T}\right)} \to 無$$

$\underset{\downarrow}{\frac{1}{T}}$ 0

$af = 0 \longrightarrow$ (ウ)

$af = \frac{1}{3}$ の時. $\longrightarrow$ (エ)

$af = 3 \longrightarrow$ (カ) ← たちあがりが大きい

$$\sim \cancel{k_B} N \cdot \frac{af}{\cancel{k_B} T} = \frac{afN}{T}\left(1 - \frac{1}{1+\exp(-1)}\right)$$

$T \to \infty$ で: $\underline{k_B N \log 2}$ //

$$\frac{afN}{T} \frac{1}{\exp(f)+1}$$

(8) : $Q_{out} = \Delta U - Q_{in}$??

$\Downarrow$

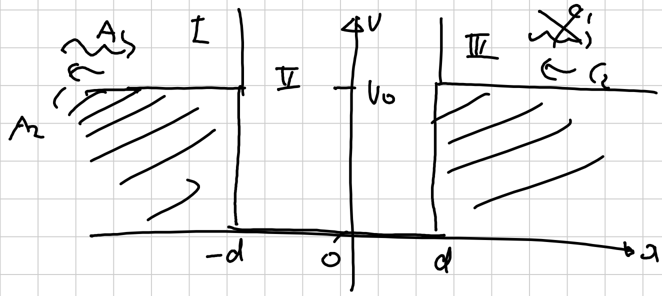
Need to study about Entropy and it's

$\Delta Q_{in} = T\Delta S$ より. $\Delta Q = T\left[S\left(L=\frac{Na}{2}\right) - S\left(L=\frac{2Na}{3}\right)\right]$

$= N k_B\left[\frac{5}{2}\ln 2 - \ln 3\right]$ //

$\Delta S = \int_A^B \frac{dQ}{T} = \frac{\Delta Q}{T}$ ＜ $\boxed{T が一定の時}$

[2]



(1) 接続条件より

$$\varphi''(x) = \frac{2m}{\hbar^2}\cdot(V_0 - E)\varphi(x)$$

$$\alpha = \sqrt{\frac{2m}{\hbar^2}(V_0-E)}, \quad \beta = \sqrt{\frac{2mE}{\hbar^2}} \;/\!/$$

$m\ddot{x} = -kx$

$\ddot{x} = -\frac{k}{m}x = -\omega^2 x$

$x = A\sin(\sqrt{\frac{k}{m}}$

, $C_1 = A_2 = 0$ //

(2) $$\varphi'(d+\varepsilon) - \varphi'(d-\varepsilon) = \frac{2m}{\hbar^2}\int_{d-\varepsilon}^{d+\varepsilon}(V(x) - E)\varphi(x)\,dx$$

$$\simeq \frac{2m}{\hbar^2}\varphi(d)\left(\int_{d-\varepsilon}^{d+\varepsilon}V(x) - E\cdot(2\varepsilon)\right)$$

$$\rightarrow 0 \;/\!/$$

(3)
$$\begin{cases} A_1 e^{-\alpha d} = B_1\sin(-\beta d) + B_2\cos(-\beta d) & ① \\ C_2 e^{-\alpha d} = B_1\sin(\beta d) + B_2\cos(\beta d) & ② \\ \alpha A_1 e^{-\alpha d} = \beta B_1 \cos(-\beta d) - \beta B_2\sin(-\beta d) & ③ \\ -\alpha C_2 e^{-\alpha d} = \beta B_1\cos(\beta d) - \beta B_2\sin(\beta d) & ④ \end{cases}$$

$$\begin{cases} \varphi(x) = A_1 e^{\alpha x} \\ \varphi(x) = B_1\sin\beta x + B_2\cos\beta x \\ \varphi(x) = \cancel{C_1 e^{\alpha x}} + C_2 e^{-\alpha x} \end{cases}$$

A_1, B_1, B_2, C_2 4つ ok

(4) $$B_1\sin(-\tilde\beta) + B_2\cos(-\tilde\beta) = \frac{\beta}{\alpha}B_1\cos(-\tilde\beta) - \frac{\beta}{\alpha}B_2\sin(-\tilde\beta)$$

$$B_2\left(\cos(-\tilde\beta) + \frac{\beta}{\alpha}B_2\sin(-\tilde\beta)\right) = B_1\cdot\left[\frac{\beta}{\alpha}\cos(-\tilde\beta) - \sin(-\tilde\beta)\right]$$

?

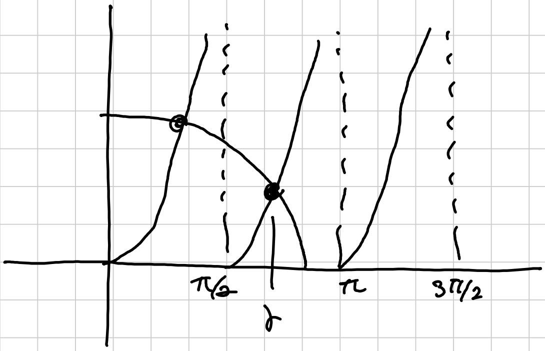
何を示せばいい??

①, ③より, $-B_1\sin\tilde\beta + B_2\cos\tilde\beta = \frac{\tilde\beta}{\tilde\alpha}[B_1\cos\tilde\beta + B_2\sin\tilde\beta]$ —⑤

②, ④より, $B_1\sin\tilde\beta + B_2\cos\tilde\beta = -\frac{\tilde\beta}{\tilde\alpha}[B_1\cos\tilde\beta - B_2\sin\tilde\beta]$ —⑥

$$\boxed{\tilde\alpha = \tilde\beta\tan\tilde\beta, \quad \tilde\alpha = -\tilde\beta\cot\tilde\beta}$$

$\tilde{\gamma}^2 = \tilde{\alpha}^2 + \tilde{\beta}^2$



求める個数は $\left[\frac{2}{\pi}\tilde{\gamma}\right]$

(6) $\tilde{\gamma} \ll 1$ では. $\tilde{\alpha} = \tilde{\beta}\tan\tilde{\beta}$ が成立 $\tilde{\alpha}, \tilde{\beta} \ll 1$ より

$\tilde{\alpha} \simeq \tilde{\beta}^2$. , $\tilde{\gamma}^2 \simeq \tilde{\beta}^2 \simeq \tilde{\alpha}$

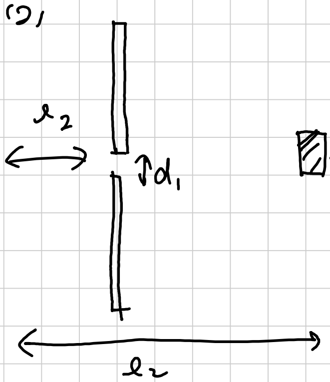
$$\frac{V_0 - E}{V_0} = \frac{\tilde{\alpha}^2}{\tilde{\gamma}^2} \simeq \frac{\tilde{\gamma}^4}{\tilde{\gamma}^2} = 1\,\tilde{\gamma}^2$$

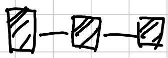
$\boxed{3}$

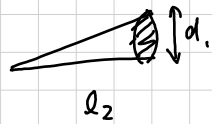
(2)

$$R \times \frac{\pi\left(\frac{d_1}{2}\right)^3}{l_2^{\,3}} \times \frac{1}{4\pi} \times \frac{10^8}{A} \times \underset{=:\eta}{0.2} = \frac{60}{P}$$

グラフ







$\therefore R =$