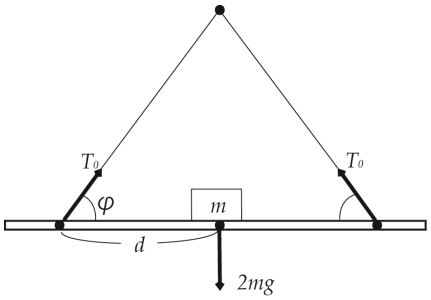
# 物　　理　解答用紙

解答作成：医学部予備校ウインダム物理科

| | | | | | |
|---|---|---|---|---|---|
| 第1問 | 問1 | $T_0 = \dfrac{L}{\sqrt{L^2-d^2}}mg$ | 問2 | $F = \dfrac{x}{\sqrt{L^2-d^2}}mg$ | |
| | 問3 | $T_1 = \dfrac{L(2d+x)}{2d\sqrt{L^2-d^2}}mg$ | | $T_2 = \dfrac{L(2d-x)}{2d\sqrt{L^2-d^2}}mg$ | |
| | 問4 | AB 方向　$T_3 \times \dfrac{d}{L} = T_4 \times \dfrac{d}{L} + 2mg\sin\theta$ | | | |
| | | PQ 方向　$T_3 \times \dfrac{\sqrt{L^2-d^2}}{L} + T_4 \times \dfrac{\sqrt{L^2-d^2}}{L} = 2mg\sin\theta$ | | | |
| | 問5 | $mg \times \sqrt{L^2-d^2}\sin\theta = mg \times \left(x\cos\theta - \sqrt{L^2-d^2}\sin\theta\right)$ | | | |
| | 問6 | $T_3 = \dfrac{L}{\sqrt{x^2+4L^2-4d^2}}\left(2+\dfrac{x}{d}\right)mg$ | | $T_4 = \dfrac{L}{\sqrt{x^2+4L^2-4d^2}}\left(2-\dfrac{x}{d}\right)mg$ | |
| | 問7 | $x = 2\sqrt{L^2-d^2}\tan\theta$ | 問8 | $U = -\dfrac{2mg\sqrt{L^2-d^2}}{\cos\theta}$ | |
| 第2問 | 問1 | $er\theta$ | 問2 | $2T\sin\dfrac{\theta}{2}$ | |
| | 問3 | $v = \sqrt{\dfrac{T}{e}}$ | 問4 | $f = \dfrac{3}{2L}\sqrt{\dfrac{w}{e}}$ | |
| 第3問 | 問1 | $\varepsilon SE_1$ | 問2 | $\sigma = \varepsilon E_1$ | |
| | 問3 | $\dfrac{1}{2}\varepsilon SdE_1^2$ | 問4 | $\dfrac{1}{2}\varepsilon E_1^2$ | |
| | 問5 | $R = e\dfrac{d}{s}$ | 問6 | $J = \dfrac{E_2}{e}$ | 問7　$J/\sigma = \dfrac{1}{\varepsilon e}$ |
| 第4問 | 問1 | $\dfrac{4P_0S}{3x_0}$ | 問2 | $\dfrac{P_0Sx_0}{R}$ | 問3　$\left(\dfrac{x_0}{x_0+x}\right)^r P_0$ |
| | 問4 | $A = \left(r+\dfrac{4}{3}\right)\dfrac{P_0S}{x_0}$ | 問5 | $2\pi\sqrt{\dfrac{mx_0}{\left(r+\dfrac{4}{3}\right)P_0S}}$ | 問6　$\dfrac{4}{3}$ |

# 第 1 問




問 1　鉛直方向のつり合いの式は,

$$2\times T_0\sin\varphi = 2mg$$

$$\therefore T_0 = \frac{mg}{\sin\varphi}$$

$$= \frac{L}{\sqrt{L^2-d^2}}mg$$

問 2　問 3

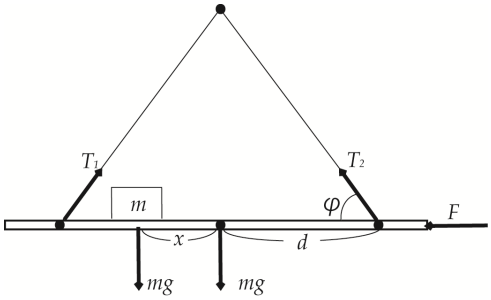
力のつり合いの式は,

鉛直；　$T_1\sin\varphi + T_2\sin\varphi = 2mg$

水平；　$T_1\cos\varphi = T_2\cos\varphi + F$

C 点まわりのモーメントのつり合いの式より,

$$T_2\sin\varphi\times 2d = mg\times d + mg\times(d-x)$$




$$\therefore\quad T_1 = \frac{2dtx}{2d\sin\varphi}mg = \frac{L(2d+x)}{2d\sqrt{L^2-d^2}}mg$$

$$T_2 = \frac{2d-x}{2d\sin\varphi}mg = \frac{L(2d-x)}{2d\sqrt{L^2-d^2}}mg$$

$$F = \frac{x}{d\tan\varphi}mg = \frac{x}{\sqrt{L^2-d^2}}mg$$

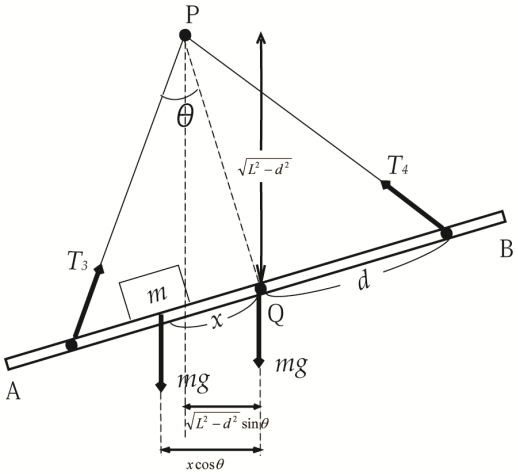
問 4　力のつり合いの式は,

AB 方向；　$T_3\cos\varphi = T_4\cos\varphi + 2\times mg\sin\theta$ より,

$$T_3\times\frac{d}{L} = T_4\times\frac{d}{L} + 2mg\sin\theta$$

PQ 方向；　$T_3\sin\varphi + T_4\sin\varphi = 2\times mg\cos\theta$ より,

$$T_3\times\frac{\sqrt{L^2-d^2}}{L} + T_4\times\frac{\sqrt{L^2-d^2}}{L} = 2mg\cos\theta$$




問 5　P 点まわり力のモーメントのつり合いの式は,

$$mg\times\sqrt{L^2-d^2}\sin\theta = mg\times\left(x\cos\theta - \sqrt{L^2-d^2}\sin\theta\right)$$

問 6　問 7

$$x = 2\sqrt{L^2-d^2}\tan\theta$$

$$T_3 = \frac{L}{\sqrt{x^3+4L^2-4d^2}}\left(2+\frac{x}{d}\right)mg$$

$$T_4 = \frac{L}{\sqrt{x^2+4L^2-4d^2}}\left(2-\frac{x}{d}\right)mg$$

問 8

$$U = -mg\times\sqrt{L^2-d^2}\cos\theta - mg\times\left(\sqrt{L^2-d^2}\cos\theta + x\sin\theta\right)$$

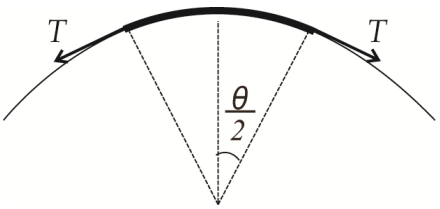
$$= -mg\left(2\sqrt{L^2-d^2}\cos\theta + 2\sqrt{L^2-d^2}\tan\theta\sin\theta\right)$$

$$= -2mg\sqrt{L^2 - d^2}\,\frac{\cos^2\theta + \sin^2\theta}{\cos\theta}$$

$$= -\frac{2mg\sqrt{L^2 - d^2}}{\cos\theta}$$

# 第 2 問

問 1　円弧 AB の質量 $m = er\theta$




問 2　向心力 $F = 2T\sin\dfrac{\theta}{2}$

問 3　$m\dfrac{v^2}{r} = F$

$$\therefore v = \sqrt{\frac{rF}{m}} = \sqrt{\frac{r \times 2T\sin\dfrac{\theta}{2}}{er\theta}} = \sqrt{\frac{T \times \sin\dfrac{\theta}{2}}{e \times \dfrac{\theta}{2}}} \to \sqrt{\frac{T}{e}} \quad (\theta \to 0)$$

問 4　$f \times \dfrac{2}{3}L = \sqrt{\dfrac{w}{e}}$

$$\therefore f = \frac{3}{2L}\sqrt{\frac{w}{e}}$$

# 第 3 問

問 1　電荷の大きさ　$Q = CV$

$$= \varepsilon \cdot \frac{s}{d} \times E_1 d$$

$$= \varepsilon S E_1$$

問 2　$a = \dfrac{Q}{S}$

$$= \varepsilon E_1$$

問 3　静電エネルギー　$U = \dfrac{1}{2} CV^2$

$$= \frac{1}{2} \times \varepsilon \cdot \frac{S}{d} \times (E_1 d)^2$$

$$= \frac{1}{2} \varepsilon S d E_1^2$$

問 4　単位体積あたりの静電エネルギー

$$\frac{U}{Sd} = \frac{1}{2} \varepsilon E_1^2$$

問 5　$R = e\dfrac{d}{s}$

問 6　$J = \dfrac{V/R}{S} = \dfrac{E_2 d / e\dfrac{d}{S}}{S} = \dfrac{E_2}{e}$

問 7　$\dfrac{J}{\sigma} = \dfrac{E_2 / e}{\varepsilon E_1} = \dfrac{1}{\varepsilon e}$　　$(\because E_1 = E_2)$

# 第 4 問

問 1　力のつり合いの式は，（ばね定数 $k$ ）

$$k \times \frac{3}{4} x_0 = P_0 S \qquad \therefore k = \frac{4P_0 S}{3x_0}$$

問 2　状態方程式は，（温度 $T$ ）

$$P_0 \times Sx_0 = 1 \times R \times T$$

$$\therefore \quad T = \frac{P_0 S x_0}{R}$$

問 3　$PV^r$ ＝（一定）より，

$$P \times \left\{ S \times (x_0 + x) \right\}^r = P_0 \times (Sx_0)^r$$

$$\therefore P = \left( \frac{x_0}{x_0 + x} \right)^r P_0$$

問 4　$ma = PS - P_0 S - kx$

$$= \left\{ \left( \frac{x_0}{x_0 + x} \right)^r - 1 \right\} P_0 S - kx = \left\{ \left( \frac{x_0 + x}{x_0} \right)^{-r} - 1 \right\} P_0 S - \frac{4P_0 S x}{3x_0}$$

$$= \left\{ \left( 1 - r \frac{x}{x_0} \right) - 1 \right\} P_0 S - \frac{4x}{3x_0} P_0 S = -\left( r + \frac{4}{3} \right) \frac{P_0 S}{x_0} x$$

$$\therefore A = \left( r + \frac{4}{3} \right) \frac{P_0 S}{x_0}$$

問 5　周期　$T = 2\pi \sqrt{\dfrac{m}{A}} \quad = 2\pi \sqrt{\dfrac{mx_0}{\left( r + \dfrac{4}{3} \right) P_0 S}}$

問 6　$\dfrac{\pi}{10} = 2\pi \sqrt{\dfrac{mx_0}{\left( r + \dfrac{4}{3} \right) P_0 S}}$

$$\therefore r = 20^2 \times \frac{mx_0}{P_0 S} - \frac{4}{3}$$

$$= 20^2 \times \frac{4.0 \times 5.0 \times 10^{-1}}{1.0 \times 10^5 \times 3.0 \times 10^{-3}} - \frac{4}{3} = \frac{8}{3} - \frac{4}{3} = \frac{4}{3}$$