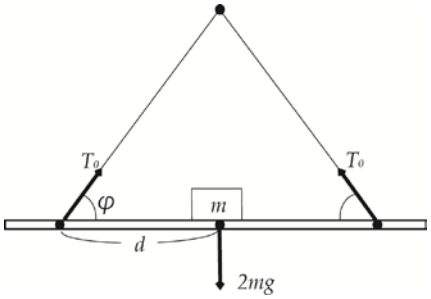
物　　理　解答用紙

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	εSE_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

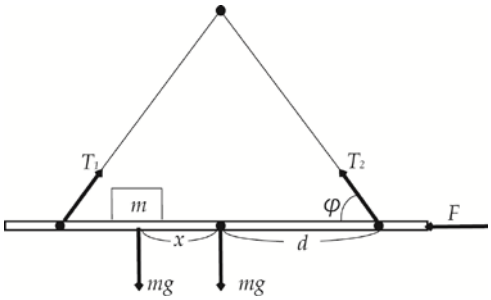
力のつり合いの式は,

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,

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



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

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

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

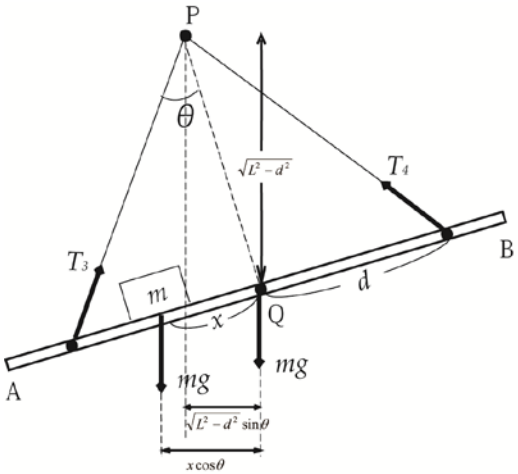
問 4　力のつり合いの式は,

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

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

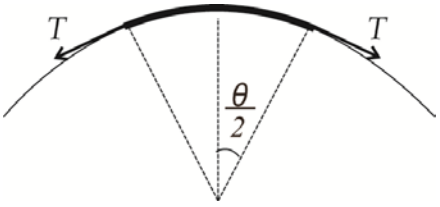
$$= -mg\left(2\sqrt{L^2-d^2}\cos\theta + 2\sqrt{L^2-d^2}\tan\theta\sin\theta\right)$$

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

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

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

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

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

第 4 問

問 1　力のつり合いの式は，（ばね定数 k ）

$$k\times\frac{3}{4}x_0=P_0S$$

$$\therefore k=\frac{4P_0S}{3x_0}$$

問 2　状態方程式は，（温度 T ）

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

$$\therefore\quad T=\frac{P_0Sx_0}{R}$$

問 3　$PV^r=$（一定）より，

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

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

問 4　$ma=PS-P_0S-kx$

$$=\left\{\left(\frac{x_0}{x_0+x}\right)^r-1\right\}P_0S-kx$$

$$=\left\{\left(\frac{x_0+x}{x_0}\right)^{-r}-1\right\}P_0S-\frac{4P_0Sx}{3x_0}$$

$$=\left\{\left(1-r\frac{x}{x_0}\right)-1\right\}P_0S-\frac{4x}{3x_0}P_0S$$

$$=-\left(r+\frac{4}{3}\right)\frac{P_0S}{x_0}x$$

$$\therefore A=\left(r+\frac{4}{3}\right)\frac{P_0S}{x_0}$$

問 5　周期　$T = 2\pi\sqrt{\dfrac{m}{A}}$

$$= 2\pi\sqrt{\frac{mx_0}{\left(r+\frac{4}{3}\right)P_0S}}$$

問 6　$\dfrac{\pi}{10} = 2\pi\sqrt{\dfrac{mx_0}{\left(r+\dfrac{4}{3}\right)P_0S}}$

$$\therefore r = 20^2 \times \frac{mx_0}{P_0S} - \frac{4}{3}$$

$$= 20^2 \times \frac{4.0\times5.0\times10^{-1}}{1.0\times10^5\times3.0\times10^{-3}} - \frac{4}{3}$$

$$= \frac{8}{3} - \frac{4}{3} = \frac{4}{3}$$