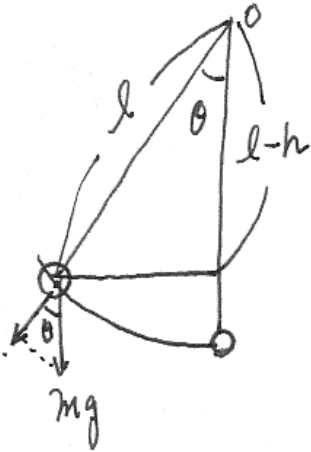


早稲田大学 (人間科学部) <物理>

[I].

問1) 張力 $T = mg \cos \theta = \frac{mg(l-h)}{l} = mg(1 - \frac{h}{l}) \quad \text{--- (c)}$



問2) $\frac{1}{2} m v_B^2 = mgh \therefore v_B = \sqrt{2gh} \quad \text{--- (b)}$

問3) $m v_B = m v_B' + M v_A' \quad \text{--- ①}$

$e = - \frac{v_B' - v_A'}{v_B - 0} \quad \text{--- ②}$

①, ②より $v_A' = \frac{(1+e)m v_B}{m+M} \quad \text{--- (b)}$

問4) $v_B' = v_A' - e v_B = \frac{(m-eM)v_B}{m+M}$

$\therefore v_B' \leq 0$ となる, $m \leq eM \quad \text{--- (g)}$

問5) $T = 2\pi \sqrt{\frac{l}{g}}, T = 2\pi \sqrt{\frac{M}{k}}$ より

$\frac{l}{g} = \frac{M}{k} \therefore kl = Mg \quad \text{--- (h)}$

問6) $mgh' = \frac{1}{2} m \left(\frac{m-eM}{m+M} \right)^2 v_B^2 = mgh \left(\frac{m-eM}{m+M} \right)^2$

$\therefore h' = \left(\frac{m-eM}{m+M} \right)^2 h \quad \text{--- (b)}$

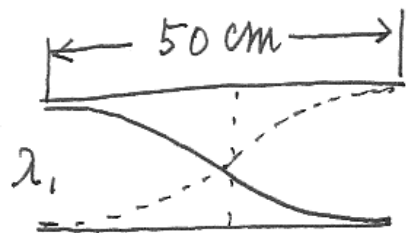
問7) --- (h)

問8) $-m v_B' - M v_A' = m v_B'' + M v_A'' \quad \text{--- ③}$

$e = - \frac{v_B'' - v_A''}{-v_B' - v_A'} \quad \text{--- ④}$

$\therefore v_A'' = - \frac{(1-e^2)m v_B'}{m+M} \quad \text{--- (b)}$

[II]. 問1)



$$\lambda_1 = 100(\text{cm}) = 1(\text{m})$$

$$f_1 = \frac{v}{\lambda_1} = \frac{340}{1} = 340 [\text{Hz}]$$



$$\lambda'_1 = 200(\text{cm}) = 2(\text{m})$$

$$f'_1 = \frac{340}{\lambda'_1} = 170 [\text{Hz}]$$

$$\frac{f'_1}{f_1} = 0.5 \quad \text{--- (b)}$$

問2) $\lambda'_n = \frac{\lambda_1}{2n-1}$ (n倍振動の波長)

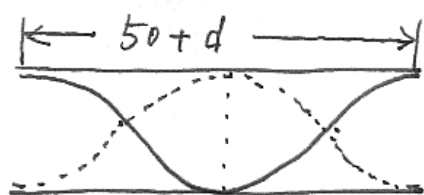
$$\therefore f'_n = \frac{v}{\lambda'_n} = (2n-1) \frac{v}{\lambda_1} = (2n-1) f_1 \quad \text{--- (c)}$$

問3)

$$0.8 f_1 = \frac{340}{\frac{50+d}{100} \times 2} \quad (f_1 = 340 [\text{Hz}])$$

$$\therefore d = 12.5 [\text{cm}] \quad \text{--- (b)}$$

問4)



$$d = 50(\text{cm}) \quad \text{--- (h)}$$

問5)

$$|f_1 - f_2| = 5 \quad \therefore f_2 = 335 \quad (\because f_1 > f_2)$$

$$335 = \frac{340}{\frac{50+d}{100} \times 2} \quad \therefore d = 0.75 [\text{cm}] \quad \text{--- (c)}$$

問6)

ドップラー効果を考慮して $\frac{340}{\frac{50+d}{100} \times 2} = f_1 \frac{340}{340+v}$

$d = 10(\text{cm})$ を代入

$$v = 68(\text{m/s}) \quad \text{--- (f)}$$

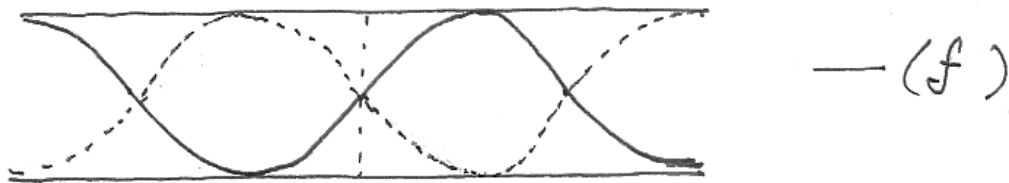
問7) $|\overline{QX} - \overline{PX}| = \begin{cases} m\lambda & (\text{強め合}) \\ (2m+1)\frac{\lambda}{2} & (\text{弱め合}) \end{cases} \quad (m=0,1,2,\dots)$

(1) $\overline{QX} - \overline{PX} = 1.5 = \frac{3}{2}\lambda \quad \text{--- (a)}$

(2) $\lambda_2 = \frac{75 \times 2}{100} = 1.5 \quad \text{--- (e)}$

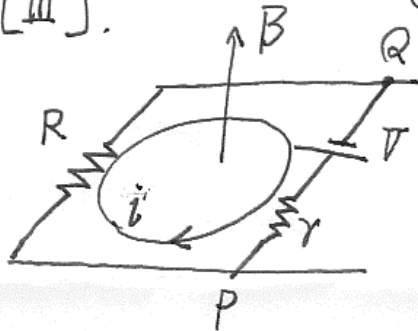
(3) $\lambda_3 = \frac{100 \times 2}{100} = 2 \quad \text{--- (d)}$
(位相のずれを教える)

問8)



[III].

(問1)



誘導起電力の発生を内部抵抗を含む電池の発生と考える。

$$- \frac{Blv}{R+r} \quad \text{--- (i)}$$

問2) $F = ilB = \frac{B^2 l^2 v}{R+r} \quad \text{--- (d)}$

問3) $P = i^2 r = \left(\frac{Blv}{R+r} \right)^2 r \quad \text{--- (c)}$

問4) 電流が流れていないので, $\quad \text{--- (e)}$

問5) $Q = -BlvC \quad \text{--- (i)}$

問6) --- (b)

問7) RとCは並列と考える,

(7)-(d), (1)-(g)