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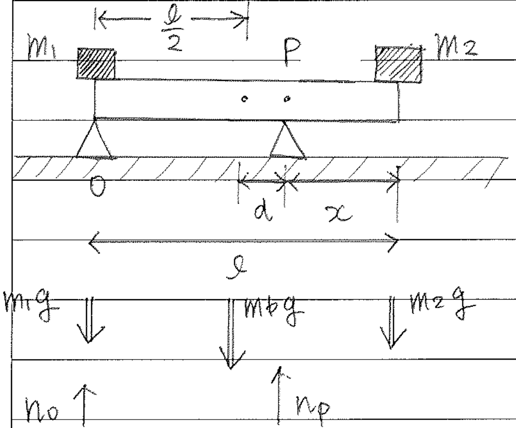
DATE

No.

# 物理学 I レポート問題 ⑩ 解答編

## [10-1]




Pに於けるトルクを求める

$$\sum \tau_P = -n_0\left(\frac{l}{2}+d\right) + m_1 g\left(\frac{l}{2}+d\right) + m_b g d - m_2 g x = 0$$

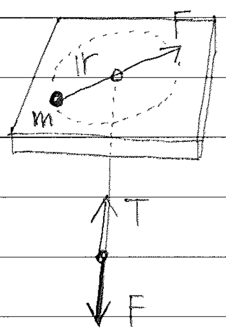
$n_0 = 0$ のとき

$$x = \frac{(m_1 g + m_b g)d + m_1 \frac{l}{2} g}{m_2 g} = \frac{(m_1 + m_b)d + m_1 \frac{l}{2}}{m_2}$$

∵ $d = l - x$ を代入.

$$\left( = \frac{\left(m_1 + \frac{m_b}{2}\right) l}{m_1 + m_2 + m_b} \right)$$

## [10-2]




回転の中心に於けるトルク

$\tau = |\mathbf{r} \times \mathbf{F}| = |\mathbf{r}| \cdot |\mathbf{F}| \sin 180^\circ = 0$ より

$\frac{d}{dt}\mathbf{L} = 0$ (角運動量は保存する)

$\mathbf{L} = \mathbf{L}_i$

(a) $m r_i v_i = m r v$ 　 $v = \left(\frac{r_i}{r}\right) v_i$

(b) $|\mathbf{T}| = -|\mathbf{F}| = \frac{m v^2}{r} = \frac{m (r_i v_i)^2}{r^3}$

(c) (解1) $W = \int \mathbf{F} \cdot d\mathbf{l} = -\int \mathbf{T} \cdot d\mathbf{r}'$

$$= -\int_{r_i}^{r} \frac{m (r_i v_i)^2}{r'^3} dr' = \left[\frac{m (r_i v_i)^2}{2 (r')^2}\right]_{r_i}^{r}$$

$$= \frac{m (r_i v_i)^2}{2}\left(\frac{1}{r^2} - \frac{1}{r_i^2}\right) = \frac{1}{2} m v_i^2 \left(\frac{r_i^2}{r^2} - 1\right)$$

(解2) エネルギー保存則より

$$W = \Delta K = \frac{1}{2} m v^2 - \frac{1}{2} m v_i^2 = \frac{1}{2} m v_i^2 \left(\frac{r_i^2}{r^2} - 1\right)$$

[10-3] 鉛直方向の運動方程式

$$\sum F_y = mg - T = ma. \qquad a = \frac{mg-T}{m} \quad \cdots ①$$

トルク $\sum \tau = I\alpha$

$$\alpha = \frac{\sum \tau}{I} = \frac{TR}{I}$$

$$a = R\alpha = \frac{TR^2}{I} \quad \cdots ②$$

(a) ①=② より $T = \dfrac{mg}{1+(mR^2/I)}$

(b) $\alpha = \dfrac{TR}{I} = \dfrac{Rmg}{I+mR^2} \quad \left(= \dfrac{g}{I/mR+R}\right)$

(c) $a = R\alpha = \dfrac{R^2mg}{I+mR^2} \quad \left(= \dfrac{g}{I/mR^2+1}\right)$

[10-4] 系のエネルギー保存則

$$K_f + U_f = K_i + U_i$$

$$\left(\frac{1}{2}m_1v_f^2 + \frac{1}{2}m_2v_f^2 + \frac{1}{2}I\omega_f^2\right) + (m_1gh - m_2gh) = 0 + 0.$$

↑ $v_f = R\omega_f$.

$$\frac{1}{2}\left(m_1+m_2+\frac{I}{R^2}\right)v_f^2 = (m_2-m_1)gh$$

(1) $v_f = \sqrt{\dfrac{2(m_2-m_1)gh}{m_1+m_2+I/R^2}}$

(2) $\omega_f = \dfrac{v_f}{R} = \dfrac{1}{R}\sqrt{\dfrac{2(m_2-m_1)gh}{m_1+m_2+I/R^2}}$

お詫びと訂正. 前回講義の板書の誤り.

質量中心の運動方程式 (2質点系)

$$(m_1+m_2)\frac{d^2}{dt^2}\underbrace{\frac{m_1\mathbf{r}_1+m_2\mathbf{r}_2}{m_1+m_2}}_{\mathbf{r}_{CM}} = \mathbf{F}_{1ex}+\mathbf{F}_{2ex} = \mathbf{F}_{ex}$$

↑ $(m_1+m_2)$ 書き忘れました。 （$\mathbf{F}_{ex}$: 外力）

(一般化)

$$M\frac{d^2}{dt^2}\mathbf{r}_{CM} = \mathbf{F}_{ex}$$

↑ total mass $m_1+m_2+\cdots$