

$$(3) m(\ddot{r} - r\dot{\phi}^2) = mg \cos \phi - S$$

$$m(2\dot{r}\dot{\phi} + r\ddot{\phi}) = -mg \sin \phi$$

$$r = l = -\frac{1}{2} \pi, \quad \dot{r} = \ddot{r} = 0 \text{ かつ } l^{\text{th}}$$

$$-m l \dot{\phi}^2 = mg \cos \phi - S$$

$$m l \ddot{\phi} = -mg \sin \phi$$

$$\therefore \ddot{\phi} = -\frac{g \sin \phi}{l}$$

$$S = mg \cos \phi + m l \dot{\phi}^2$$

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(4) 正確に $\dot{\phi} = 0$ のとき

$$\frac{1}{2} m v^2 = m g l$$

$$\therefore v = \sqrt{2gl}$$

$$v = l \dot{\phi}, \text{ かつ } \dot{\phi} = \sqrt{\frac{2g}{l}} \text{ かつ}$$

$$S = mg \cos 0 + m l \times \frac{2g}{l}$$

$$= 3mg$$

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$$(5) \ddot{\phi} = -\frac{g \sin \phi}{l} \text{ かつ } \phi \approx 0 \text{ のとき}$$

$$\ddot{\phi} = -\frac{g}{l} \phi$$

よって、角振動数 $\omega = \sqrt{\frac{g}{l}}$ の単振動となる。

周期は

$$\frac{2\pi}{\omega} = 2\pi \sqrt{\frac{l}{g}}$$

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