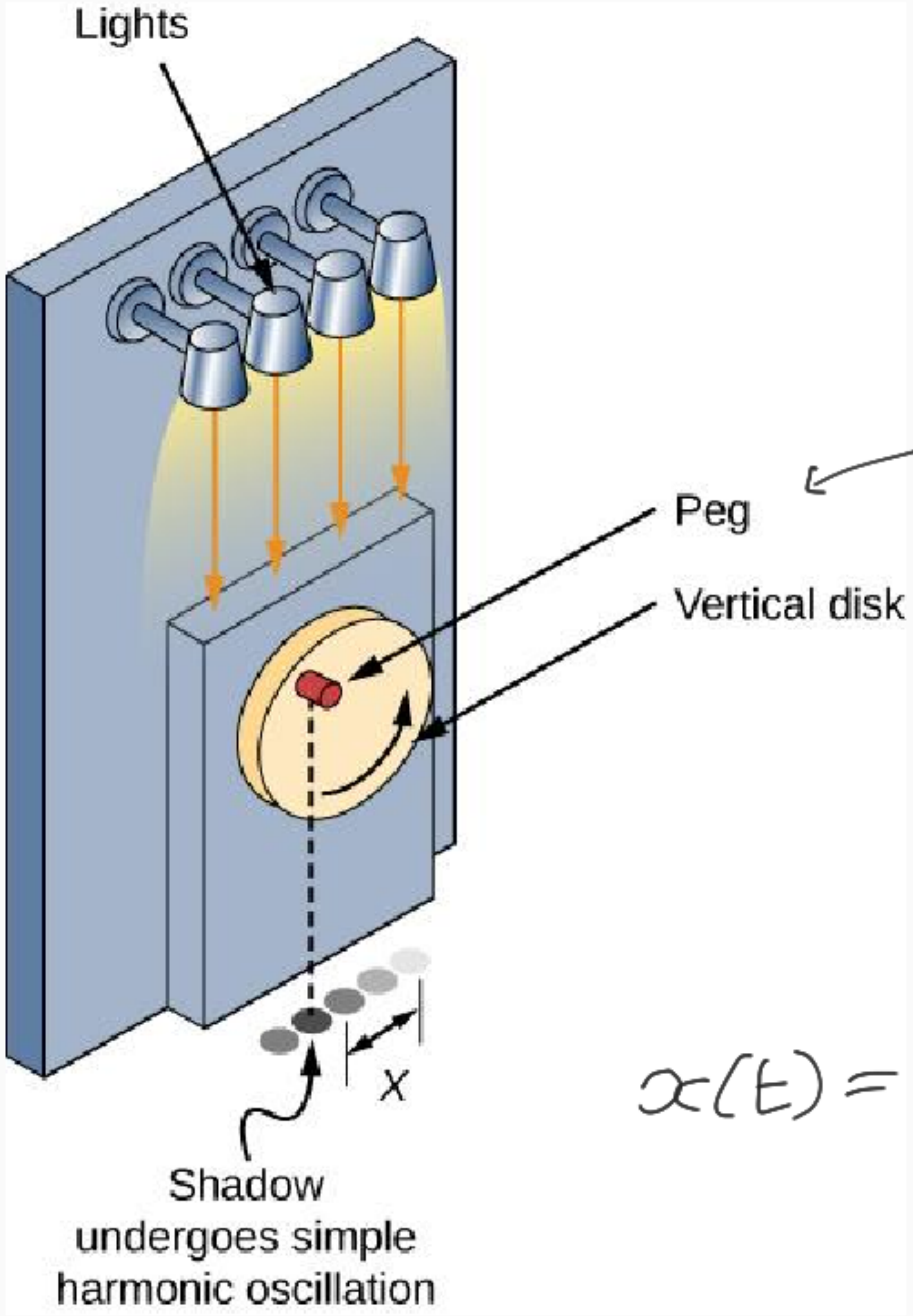
DESCRIBING OSCILLATION AS CIRCULAR MOTION.



angular freq. ω.

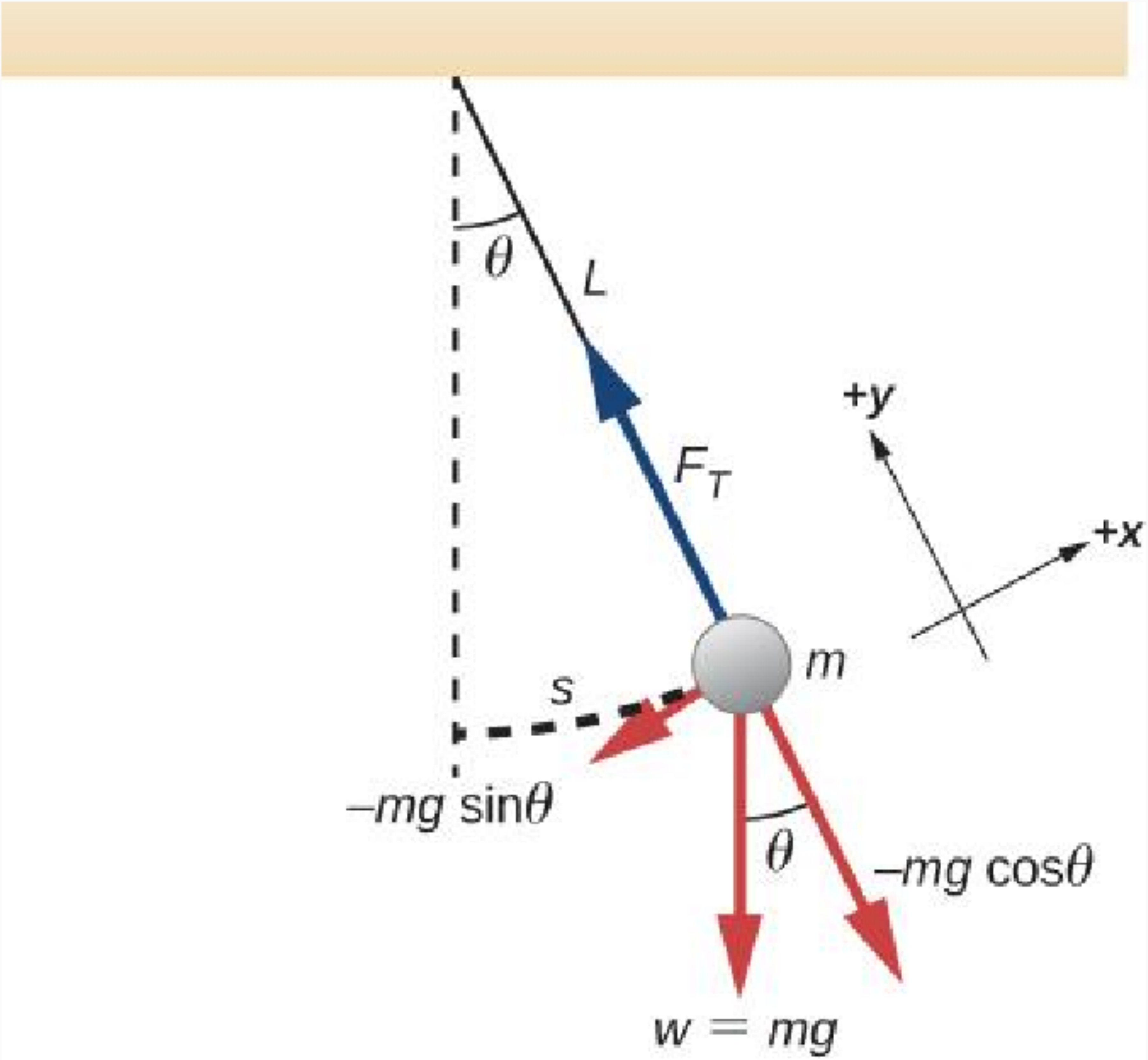
$$x(t) = A\cos\omega t$$

$$v(t) = -A\omega\sin\omega t$$

$$a(t) = -A\omega^2\cos\omega t$$

$$v_{max} = v_t = r\omega$$

PENDULUMS



For small θ, $\sin\theta \sim \theta$

Recall $\bar{\tau} = \bar{r} \times \bar{F}$

here $\bar{r} = \bar{L}$

$\bar{F} = m\bar{g}$

$\tau = -Lmg\sin\theta$

Recall $\tau = I\alpha$

Recall $I = mL^2$

$-\cancel{L}\cancel{m}g\sin\theta = \cancel{m}L^{\cancel{2}} \dfrac{d^2\theta}{dt^2}$

$\dfrac{d^2\theta}{dt^2} = -\dfrac{g}{L}\sin\theta \approx -\dfrac{g}{L}\theta$

Pendulum at small θ

$\theta \ll 1$ radian

$$\frac{d^2\theta}{dt^2} = -\frac{g}{L}\theta.$$

Mass on a spring

$$\frac{d^2x}{dt^2} = -\frac{k}{m}x$$

Solution $\theta(t) = A\cos(\omega t)$

$$\boxed{\omega = \sqrt{\frac{g}{L}}} \qquad \boxed{T = 2\pi\sqrt{\frac{L}{g}}}$$

Pendulum with a period of $\boxed{T = 1s}$ on Earth.

What would its period be on the Moon.

$$g_{Moon} = \frac{g_{Earth}}{6} = 1.62 \ m/s$$

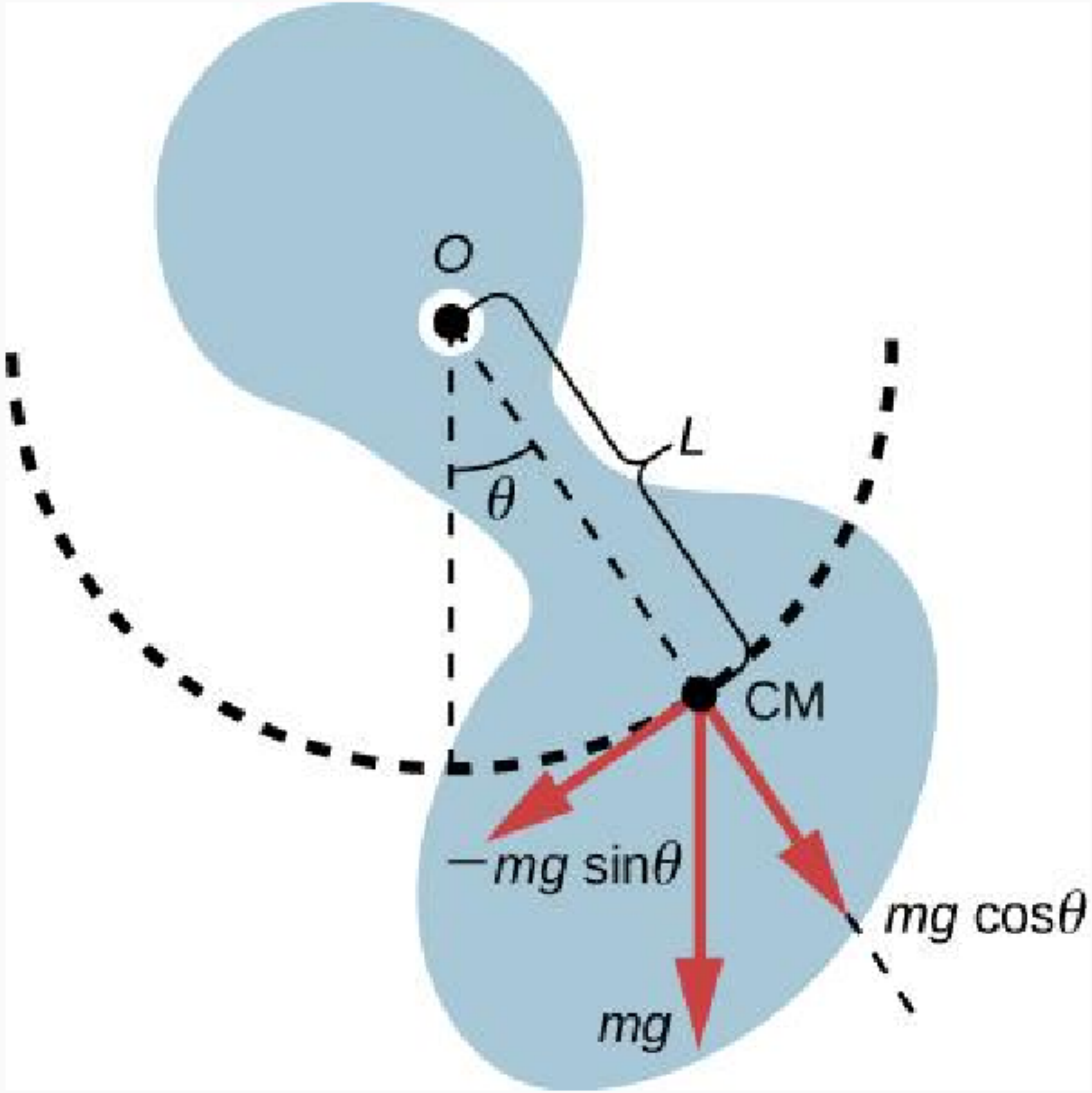
$$T = 2\pi\sqrt{\frac{L}{g}}$$

$$T_E = 2\pi\sqrt{\frac{L}{g_E}}$$

$$T_M = 2\pi\sqrt{\frac{L}{g_M}}$$

$$T_M = T_E\sqrt{\frac{g_E}{g_M}} = \sqrt{6}\,T_E \simeq 2.4s.$$

PHYSICAL PENDULUM



$$I = \int r^2 dm = \beta m r^2$$

some number.

Equation of motion

$$\tau = I\alpha$$

$$-Lmg\,\theta = I\frac{d^2\theta}{dt^2}$$

$$\frac{d^2\theta}{dt^2} = -\underbrace{\boxed{\frac{Lmg}{I}}}_{\omega^2}\,\theta.$$

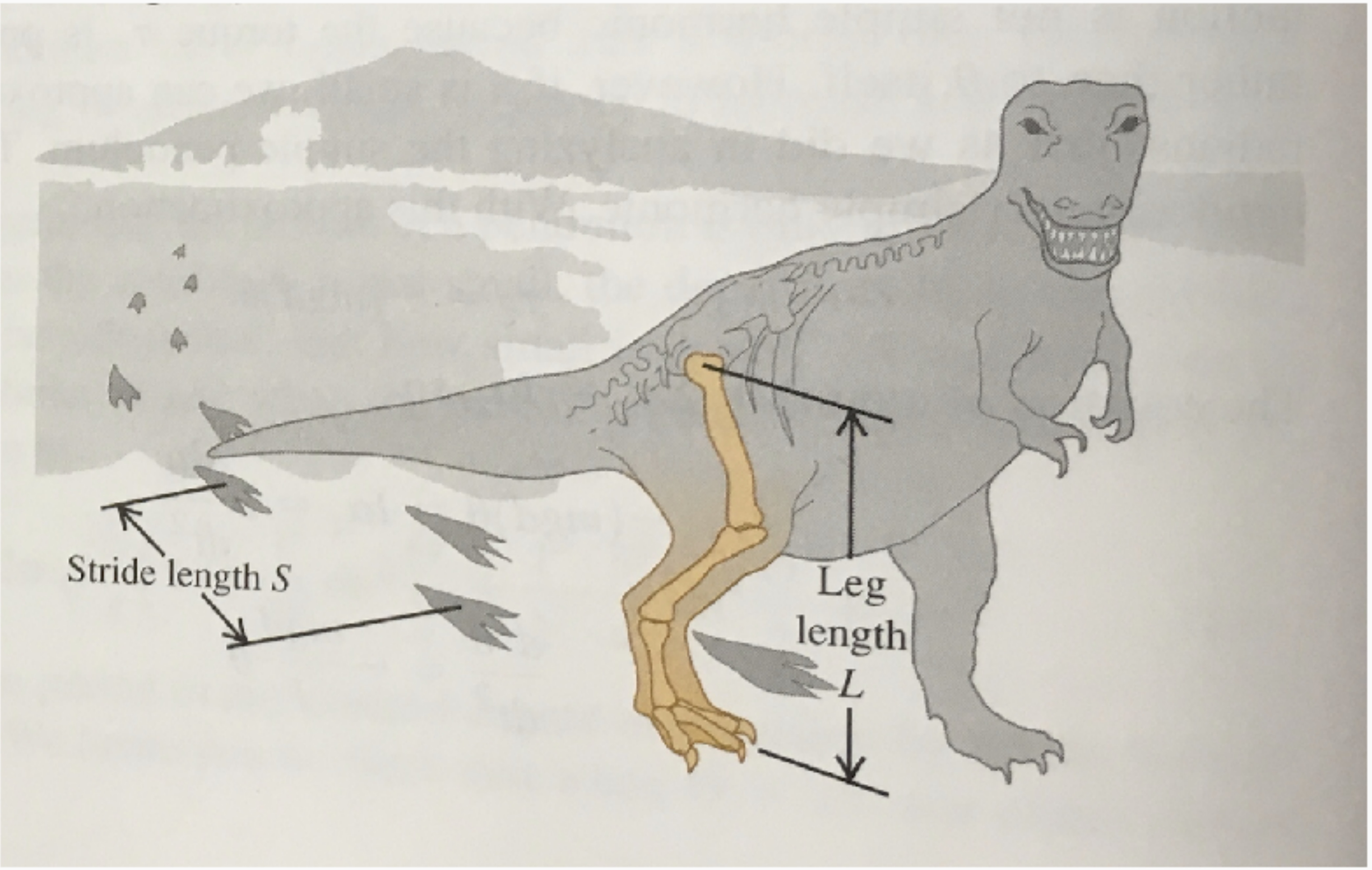
$$\omega = \sqrt{\frac{Lmg}{I}} \quad \Big| \quad T = 2\pi\sqrt{\frac{I}{Lmg}}$$

DINOSAUR LEGS

T-rex leg length $L = 3.1\,m$
Stride length $S = 4.0\,m$ } how fast does it walk.

Model leg as uniform rod.

$$I = \frac{1}{3} m L^2$$



DINOSAUR LEGS

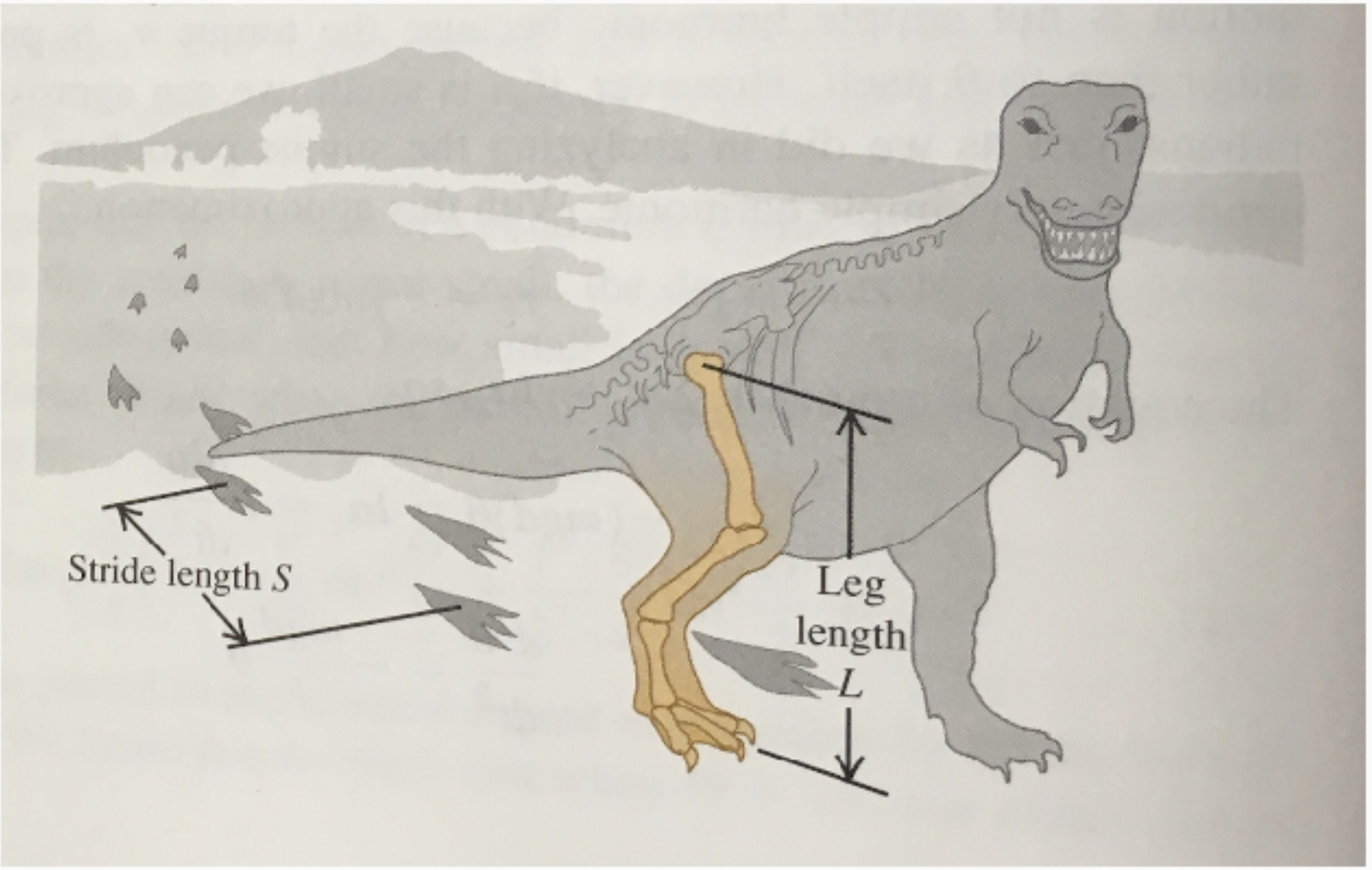
$$I = \frac{1}{3}mh^2$$

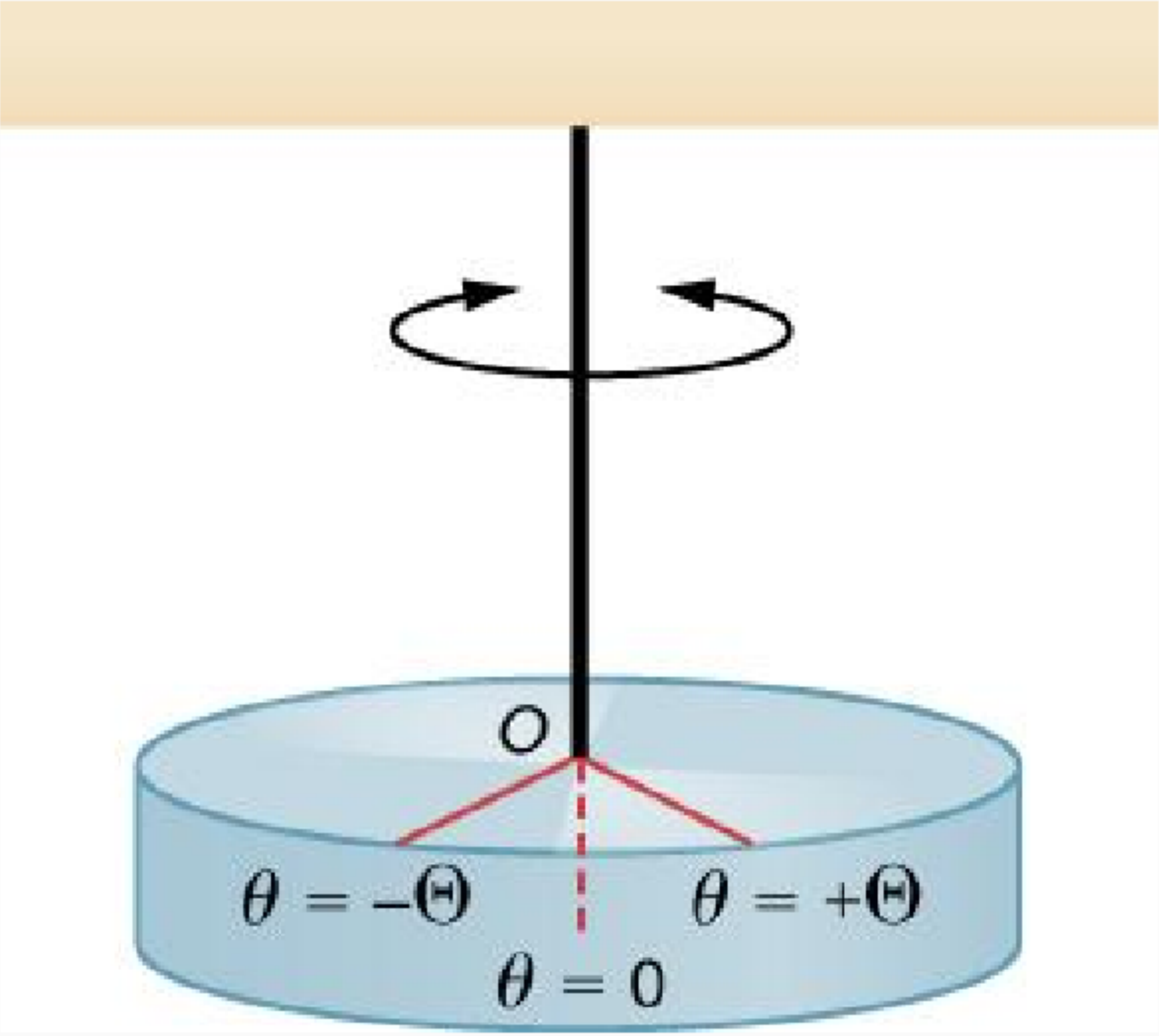
$$T = 2\pi\sqrt{\frac{I}{mgh}}$$

$$= 2\pi\sqrt{\frac{\frac{1}{3}\cancel{m}h^{\cancel{2}}}{\cancel{m}g\cancel{h}}}$$

$$= 2\pi\sqrt{\frac{L}{3g}} = 2.0s$$

$$v = \frac{2S}{T} = \frac{8.0m}{2.0s} = 4 m/s$$





Turns out

$$\tau = -K\theta$$

$$\Rightarrow \omega = \sqrt{\frac{K}{I}}$$

Use to measure $\underline{\underline{K}}$.

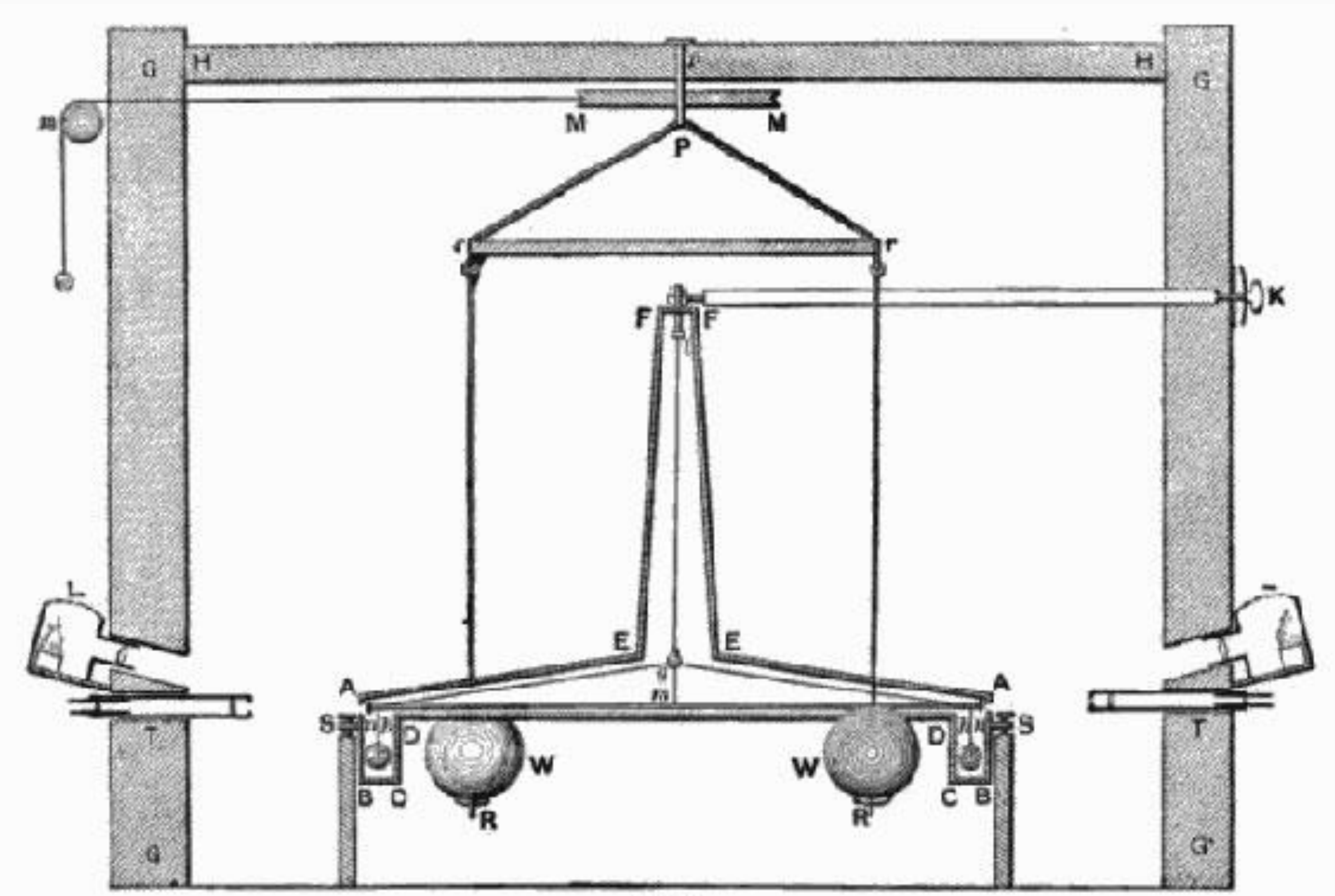


Fig. 1

Need to know K
to measure
G.