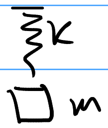
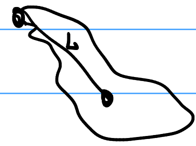
$$\ddot{x} = -\omega^2 x \quad \Rightarrow \quad x = A\cdot\cos(\omega t + \varphi)$$

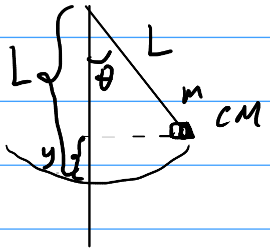


$$\omega = \sqrt{\frac{k}{m}}$$



$$\omega = \sqrt{\frac{mgL}{I}}$$

$$\theta(t) = \theta_A \cdot \cos(\omega t + \varphi)$$



$$U(y) = mgy = mg(L - L\cos\theta)$$
$$= mgL(1-\cos\theta)$$

$$v = L\dot{\theta} = L\cdot\frac{d}{dt}\left(\theta_A\cdot\cos(\omega t+\varphi)\right) =$$
$$= L\cdot\theta_A\,\frac{d}{dt}\left(\cos(\omega t+\varphi)\right) =$$
$$= L\,\theta_A\left(-\sin(\omega t+\varphi)\right)\frac{d\,(\omega t+\varphi)}{dt} =$$
$$= -L\,\theta_A\,\omega\cdot\sin(\omega t+\varphi)$$

speed

$$I\frac{\omega_s^2}{2} \Leftrightarrow \omega_s = \cancel{L}\,\theta_A\,\omega\,\sin(\omega t+\varphi)$$

$$E_K = \frac{mv^2}{2} = \frac{m(L\theta_A\omega)^2}{2}\cdot\sin^2(\omega t+\varphi)$$

$\theta_A\cdot\cos(\omega t+\varphi)$

$$E_t = E_K + U = \frac{m(L\theta_A\omega)^2}{2}\sin^2(\omega t+\varphi) + mgL(1-\cos\theta)$$

$$\theta \ll 1 \longrightarrow \sin\theta \approx \theta$$
$$\cos\theta = \sqrt{1-\sin^2\theta} \approx \sqrt{1-\theta^2} = 1 - \frac{1}{2}\theta^2$$

$$E_t = \frac{\cancel{m}I\,(\theta_A\,\omega)^2}{2}\sin^2(\omega t+\varphi) + \frac{mgL}{2}\underbrace{\theta_A^2\cos^2(\omega t+\varphi)}_{\theta^2}$$

$$\theta_A^2\, I\cdot(\omega)^2 = \theta_A^2\,\cancel{I}\cdot\frac{mgL}{\cancel{I}}$$

$$E_t = \frac{mgL}{2}\theta_A^2\sin^2(\omega t+\varphi) + \frac{mgL}{2}\theta_A^2\cos^2(\omega t+\varphi)$$
$$= \frac{mgL}{2}\theta_A^2$$

$$T = \frac{\frac{21.5 + 21.2}{2}}{5} = \frac{21.35}{5} = 4.27$$

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

$$T^2 = \frac{4\pi^2}{g} L$$

$$\cancel{L = \frac{4\pi^2}{T^2 \cdot g} = \frac{4 \cdot 3.14^2}{(4.27)^2 \cdot 9.8} = \frac{4 \cdot 10}{17 \cdot 10} = \frac{4}{17} =}$$

$$L = \frac{T^2 \cdot g}{4\pi^2} = 4.5 \text{ m}$$

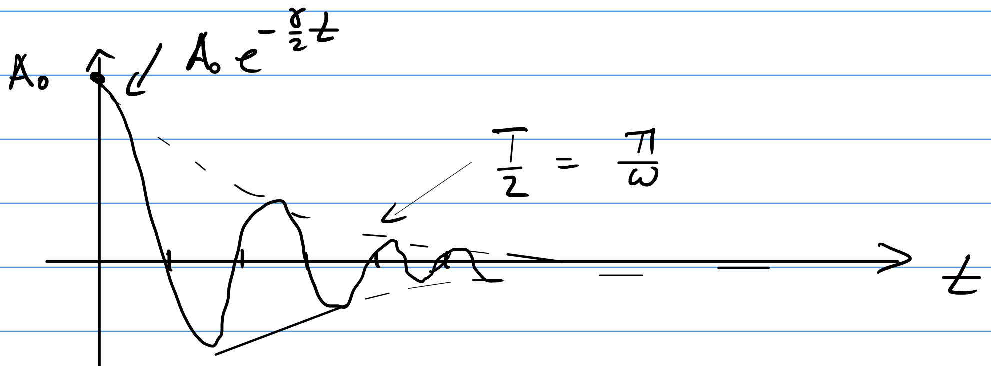
$$\ddot{x} = -\omega^2 x - \gamma \dot{x}$$

$$x(t) = A(t)\cdot\cos(\omega t + \varphi)$$

$$= \left(A_0 e^{-\frac{\gamma}{2}t}\right)\cos(\omega t + \varphi)$$

$$\boxed{\omega = \sqrt{\frac{g}{L}} - ?}$$

$$\boxed{\omega = \sqrt{\omega_0^2 - \left(\frac{\gamma}{2}\right)^2}, \quad \omega_0 = \sqrt{\frac{g}{L}}}$$



$$A(t_e) = \frac{A_0}{e} = A_0 e^{-1}$$

$$e^{-\frac{\gamma}{2}t_e} = e^{-1}$$

$$t_e = \frac{2}{\gamma}$$

$$N\cdot T = t_e$$

$$N\cdot\frac{2\pi}{\omega} = \frac{2}{\gamma}$$

$$Q_{\text{uality factor}} = N = \frac{2}{2\pi}\frac{\omega}{\gamma} = \frac{\omega}{\pi\gamma}$$