

Rocking chair

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Solution: *The moment of inertia is $I = \frac{1}{3}ML^2$. The equation of motion is,*

$$I\vec{\alpha} = \vec{\tau} = \vec{L} \times \vec{F}_{ml} + (-\vec{L}) \times \vec{F}_{ml} = \vec{L} \times (-k\vec{x}) + (-\vec{L}) \times k\vec{x} .$$

Hence,

$$\begin{aligned} \frac{1}{3}MR^2\ddot{\theta} &= -2Lkx = -2Lk\ell\theta \\ \ddot{\theta} + \frac{6k}{M}\theta &= 0 \\ \omega_0 &= \sqrt{\frac{6k}{M}} . \end{aligned}$$