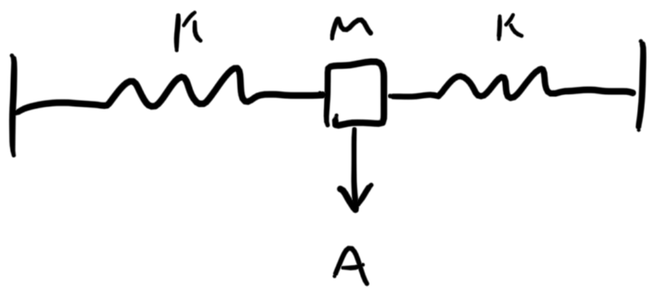
#7



$T \overset{?}{\propto} A$

no gravity

$E = 2 \cdot \frac{1}{2} k x^2 = k x^2$

$x = \sqrt{L^2 + A^2} - L = L\left(\sqrt{1 + \frac{A^2}{L^2}} - 1\right)$

$A \gg L$

$x \simeq A$

$E = kA^2$

harmonic

$T \not\propto A$

$A \ll L$

$\sqrt{1+h} \simeq 1 + \frac{1}{2}h$

$x \simeq L\left(1 + \frac{1}{2}\frac{A^2}{L^2} - 1\right)$

$\simeq A^2/2L$

$E_p \simeq kA^4/4L^2$

non-harmonic

$F = -\frac{d}{dA}E(A) \simeq -kA^3/L^2$

F grows faster than A

T decreases $\Rightarrow$ (C)

#13

$m_2 = \alpha m_1$

$v = 0$

Elastic

$$m_1 v_1 + m_2 v_2 = m_1 w_1 + m_2 w_2$$

$$m_1 v_1^2 + m_2 v_2^2 = m_1 w_1^2 + m_2 w_2^2$$

$$\left[\begin{aligned} w_1 &= \frac{v_1(m_1 - m_2) + 2m_2 v_2}{m_1 + m_2} \\ w_2 &= \frac{v_2(m_2 - m_1) + 2m_1 v_1}{m_1 + m_2} \end{aligned} \right]$$

v_2/v_0 bounds ?

Completely Inelastic

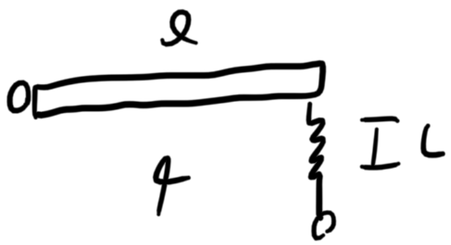
$$\left[w = \frac{m_1 v_1 + m_2 v_2}{m_1 + m_2} \right]$$

$v_2 = 0$

El. $r_2 = \left| \frac{w_2}{v_1} \right| = \frac{2m_1}{m_1 + m_2} = \frac{2}{1+\alpha}$

C.I. $r_2 = \left| \frac{w}{v_1} \right| = \frac{m_1}{m_1 + m_2} = \frac{1}{1+\alpha}$ $\Rightarrow$ (E)

#14



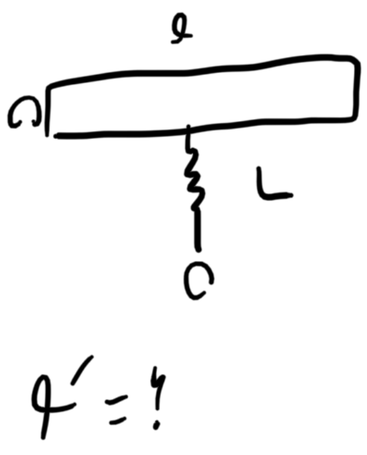
$x \Rightarrow a$, $T = 2\pi\sqrt{x/a}$

$x \Rightarrow a = \alpha r$ $r = l$ then $r = l/2$

$I\alpha = \tau = \kappa x r \Rightarrow a = \kappa x r^2 / I$

$T = 2\pi\sqrt{x/a} = 2\pi\sqrt{\frac{I}{\kappa r^2}} \propto \frac{1}{r} \Rightarrow q \propto r$

move spring



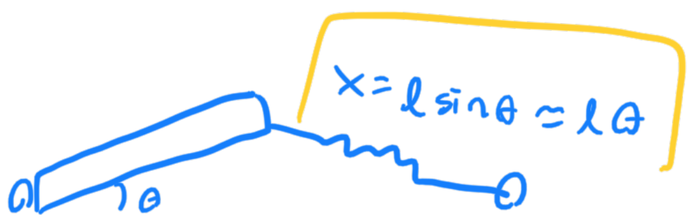
$r = l \Rightarrow r' = l/2$ $q' = q/2$ $\Rightarrow$ (A)

$q' = ?$

#15

$q'' = ?$

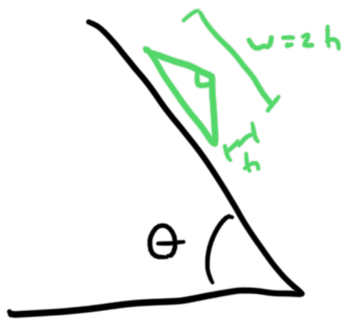
$T = 2\pi\sqrt{x/a}$



$I\alpha = \tau = F\sin\theta\, l \simeq \kappa l\theta l \simeq \kappa x l$

$\alpha = \frac{\kappa x l}{I} \Rightarrow q'' = q \Rightarrow$ (C)

#20



min N so it topples before sliding?

When slide?

$F_s = NF_n = N mg\cos\theta$

$F_{w\parallel} = mg\sin\theta$

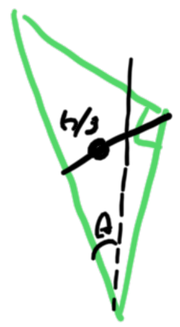
$mg\sin\theta = N mg\cos\theta$

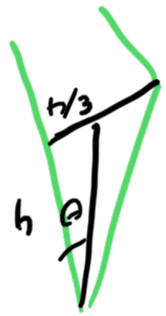
$N = \tan\theta$

$N = 3$

(E)

When topple?

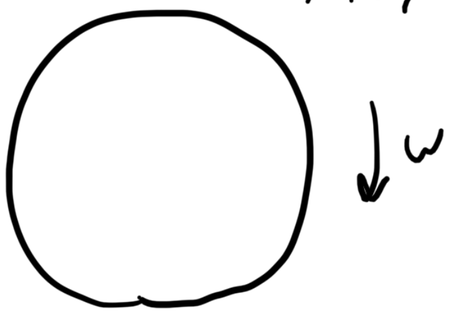




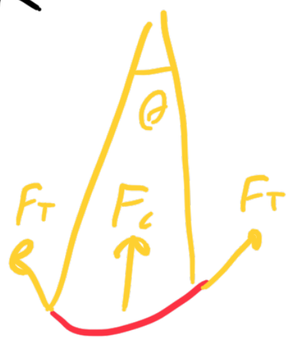
$\tan\theta = \frac{h}{h/3}$

$\tan\theta = 3$

#23



$R' = ?$



small pieces

$m = M/n$

$\theta = 2\pi/n$

$T = k\Delta x = 2\pi k(R'-R)$

$2T\sin\frac{\theta}{2} = m\omega^2 R'$

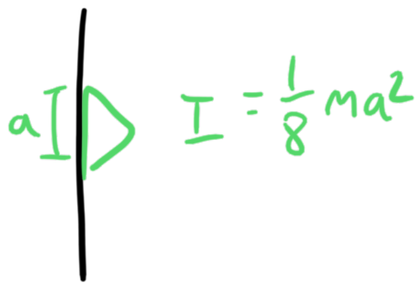
$\simeq 2T\frac{\theta}{2}$

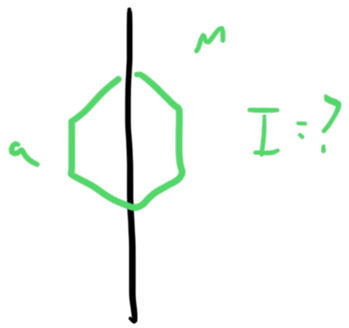
$\Rightarrow T\cdot\frac{2\pi}{n} = \frac{M}{n}\omega^2 R'$

$4\pi^2 k(R'-R) = M\omega^2 R'$

$R' = \frac{4\pi^2 kR}{4\pi^2 k - M\omega^2}$ (D)

#24





Parallel axis thm.

$I' = I + md^2$

$I_S = \frac{1}{3} ma^2 \qquad h = \frac{a\sqrt{3}}{2}$

$I_C = I_S - \left(\frac{1}{3}h\right)^2 = \frac{1}{24} ma^2$

$I_U = I_C + \left(\frac{2}{3}h\right)^2 = \frac{3}{8} ma^2$

mass $= m/6$

$4\left[\frac{1}{8}\frac{m}{6}a^2\right] + 2\left[\frac{3}{8}\frac{m}{6}a^2\right]$

$= \frac{5}{24} ma^2$ (B)

#25

Alice: 2 mm

Bob: $\Delta(x+y) = \sqrt{(\Delta x)^2+(\Delta y)^2} = \sqrt{8} = 2\sqrt{2}$ mm

Christina: " $\sqrt{2}$ mm

(A)