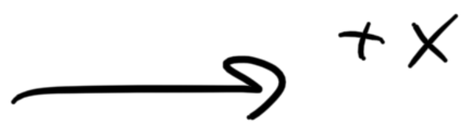
#2



momentum conservation

$$m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$$

$$V_{cm} = \frac{m_1 v_1 + m_2 v_2}{m_1 + m_2}$$

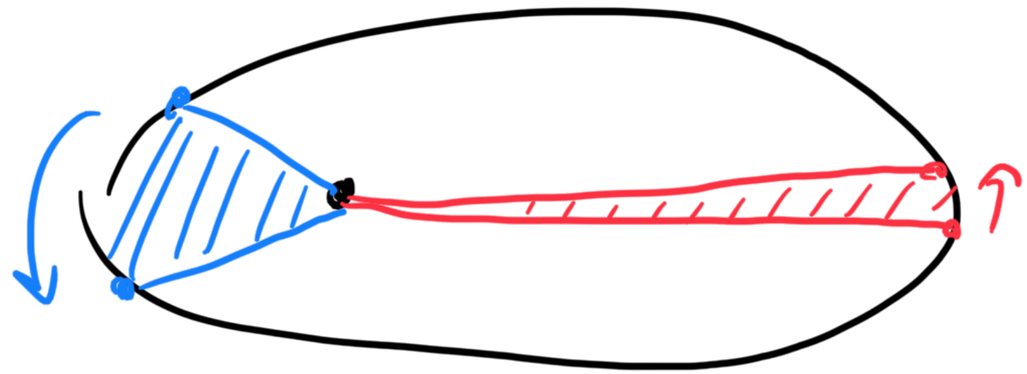
$$V_{cm} = V_{cm}'$$

$$V_{cm}' = \frac{m_1 v_1' + m_2 v_2'}{m_1 + m_2}$$

$$V_{cm} = \frac{m_1 v_1 + m_2 v_1}{m_1 + m_2}$$

$$= \frac{90\ kg\,m/s - 40\ kg\,m/s}{5\ kg} = 10\ m/s$$

#4



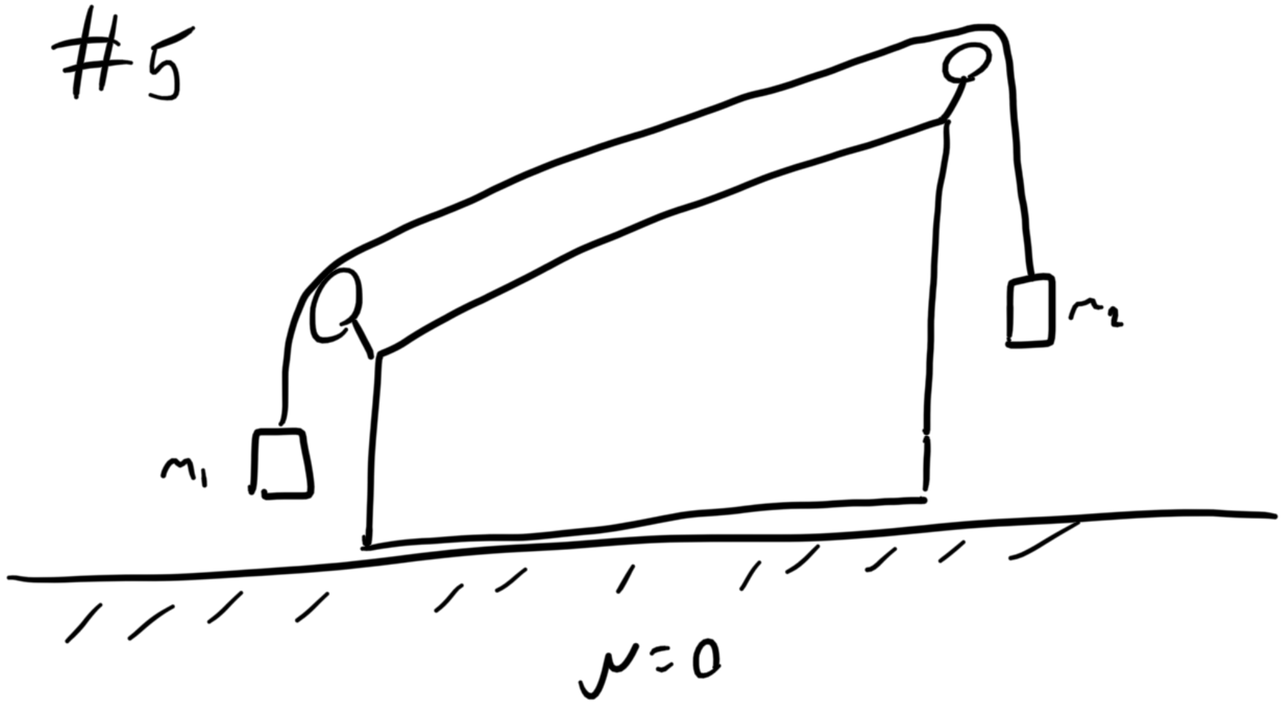
$$J = \Delta p = m \Delta v$$

$$\Delta KE = \underbrace{\left(\tfrac{1}{2} m (v_0 + \Delta v)^2\right)}_{KE_f} - \underbrace{\left(\tfrac{1}{2} m v_0^2\right)}_{KE_i} = \tfrac{1}{2} m \left[(v_0 + \Delta v)^2 - v_0^2 \right]$$

$$= \text{const.} + v_0 \Delta v$$

When is v_0 greatest? Perigee!

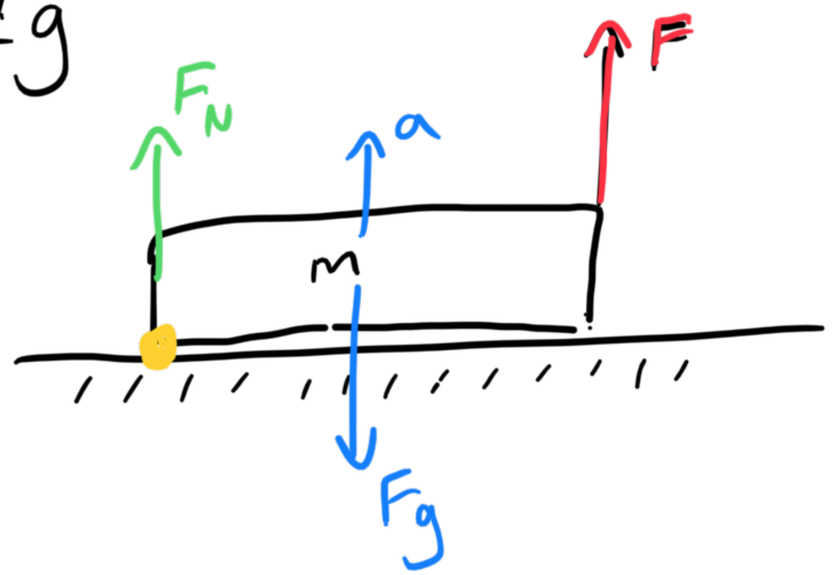
#5



No external forces

horizontally

#9



$F = ?$ $F_N = ?$

$a = r\alpha = a\ell/2$

$I = m\ell^2/3$

$\Sigma F = ma$

$\Sigma \tau = I\alpha$

$ma = F + F_N - mg$

$I\alpha = F\ell - mg\ell/2$

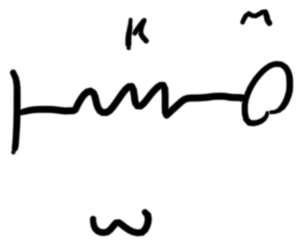
$a = \frac{F}{m} - g + \frac{F_N}{m}$

$\alpha = \frac{1}{\ell}\left(\frac{3}{m}F - \frac{3}{2}g\right)$

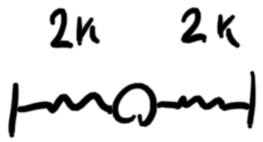
$2a = \alpha\ell = \left(\frac{3}{m}F - \frac{3}{2}g\right)$

$-2a + 3a = -\left(\frac{3}{m}F - \frac{3}{2}g\right) + 3\left(\frac{F}{m} - g + \frac{F_N}{m}\right) \Rightarrow a = \frac{-3}{2}g + \frac{3}{m}F_N \Rightarrow F_N = \frac{1}{3}ma + \frac{1}{2}mg$

#11



$\Rightarrow$

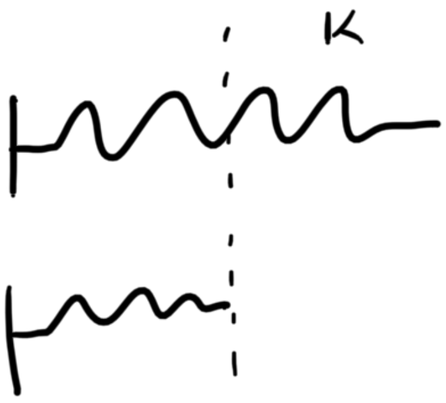


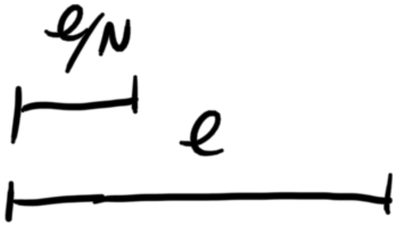
$\omega' = ?$

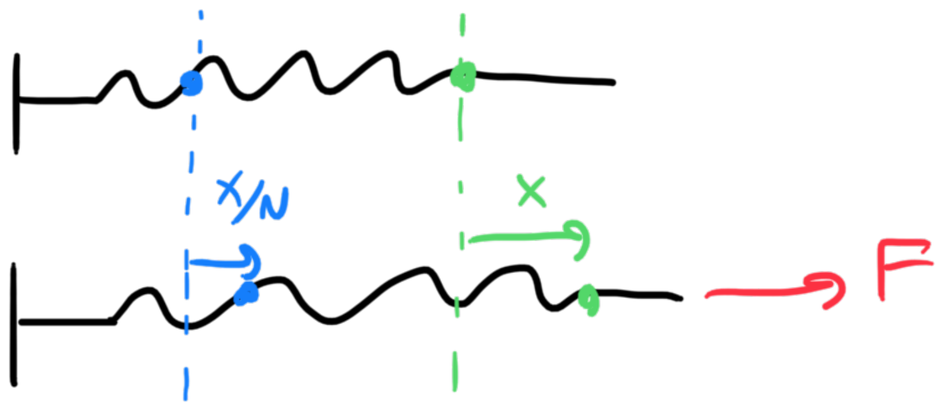
$\omega = \sqrt{\frac{K}{m}}$

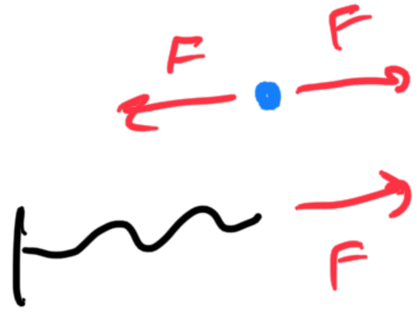
$K \to 2K \quad \omega \to \sqrt{2}\,\omega$

$K_{total} = 4K, \quad \omega \to \sqrt{4}\,\omega = 2\omega$





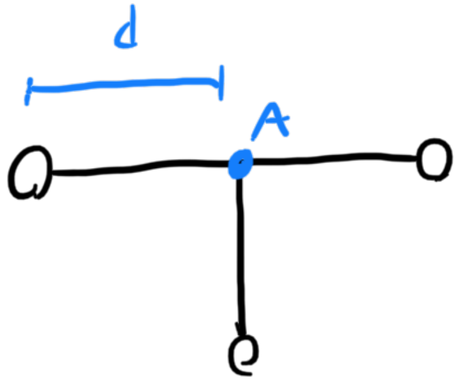




$F = -k'x$

$F = -k'\frac{x}{N} \Rightarrow k' = Nk$

#14



$I_{\text{each mass}} = md^2$

$I_1 = 3I_{\text{e.m.}} = 3md^2$

$I_2 = 1I_{\text{e.m.}} = md^2$

$\tau = I\alpha = -mgd\sin\theta \approx -mgd\theta$

Hooke's Law: $F = -kx$ $\quad \omega = \sqrt{k/m}$ $\qquad \tau = -k\theta$ $\qquad \omega = \sqrt{mgd/I}$ $\quad \alpha \propto 1/\sqrt{I}$

$T \propto \sqrt{I}$ $\qquad \frac{T_1}{T_2} = \sqrt{\frac{3}{1}} = \sqrt{3}$

#25

$$\Delta(x_1 + x_2) = \frac{1}{2}\sqrt{(\Delta x_1)^2 + (\Delta x_2)^2}$$

$$\Delta(x_1 + x_2 + x_3) = \frac{1}{3}\sqrt{(\Delta x_1)^2 + (\Delta x_2)^2 + (\Delta x_3)^2}$$

$$\Delta a = 0.008\,s$$

$$\Delta(a+b) = \frac{1}{2}\sqrt{(\Delta a)^2 + (\Delta b)^2} = 0.00395$$

$$\Delta(4a+b) = \frac{1}{5}\sqrt{(4\Delta a)^2 + (\Delta b)^2} = 0.00725$$