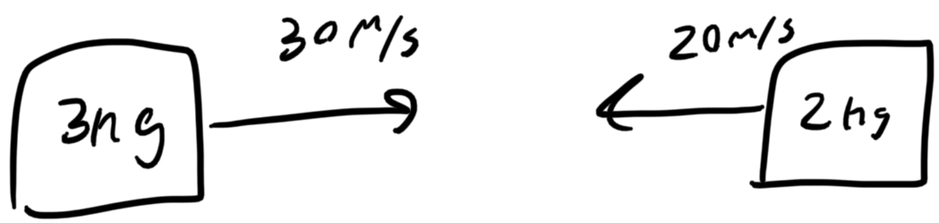
2018A # 2, 4, 5, 9, 11, 14, 19, 25

2.



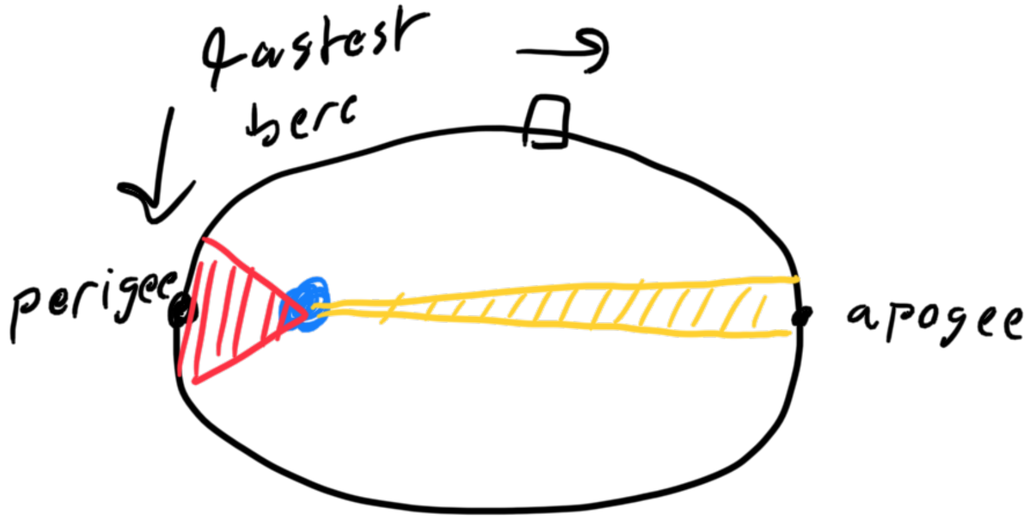
$$\rightarrow |v_{cm}| = ? = \left| \frac{m_1 v_1' + m_2 v_2'}{m_1 + m_2} \right|$$

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

$$\frac{1}{2} m v_1^2 + \frac{1}{2} m v_2^2 = \frac{1}{2} m (v_1')^2 + \frac{1}{2} m_2 (v_2')^2$$

$$|v_{cm}| = \left| \frac{m_1 v_1 + m_2 v_2}{m_1 + m_2} \right| = \cdots 10 \, m/s \Rightarrow B$$

4.

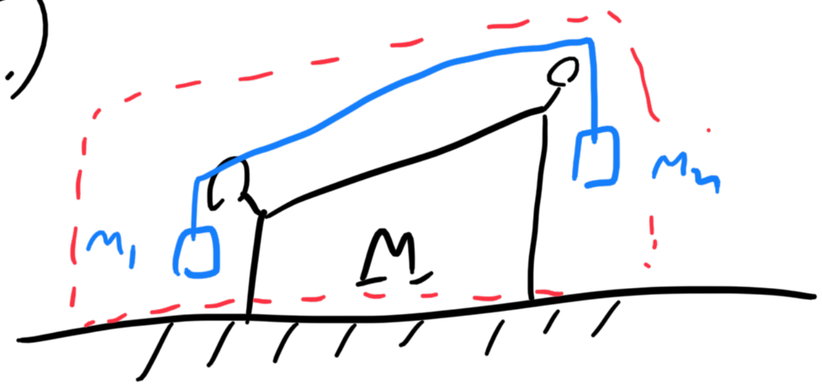


$$J = \Delta P = m\Delta v$$

maximize $\Delta KE = \frac{1}{2}m\left[(v_0+\Delta v)^2 - v_0^2\right]$

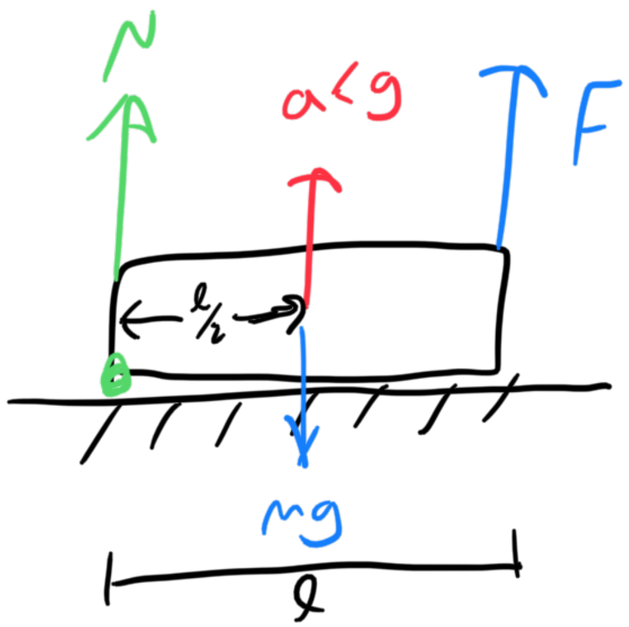
$= \text{const} + mv_0\Delta v \quad \Rightarrow A$

5.



No net external forces $\Rightarrow$ $\vec{F}$

9.



$$a = r\alpha = \frac{al}{2}$$

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

$$\tau = Fl - \frac{1}{2}mgl = I\alpha$$

$$\alpha = \tau / I = \frac{1}{l}\left(\frac{3}{m}F - \frac{3}{2}g\right)$$

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

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

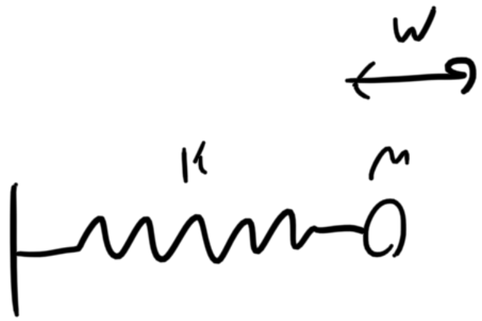
$$-2a + 3a = -\left(\frac{3}{m}F - \frac{3}{2}g\right) + 3\left(\frac{F}{m} - g + \frac{N}{m}\right)$$

$$a = \frac{3}{2}F - \frac{3}{2}g + \frac{3}{m}N$$

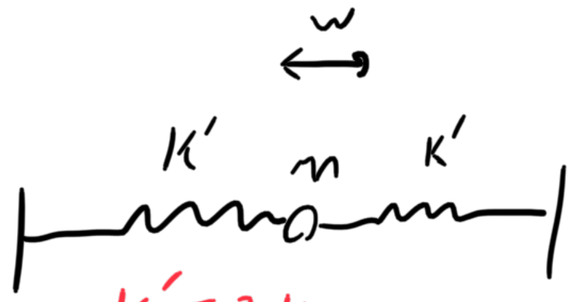
$$\Rightarrow N = \frac{1}{3}ma + \frac{1}{2}mg$$

$$\Rightarrow B$$

11.

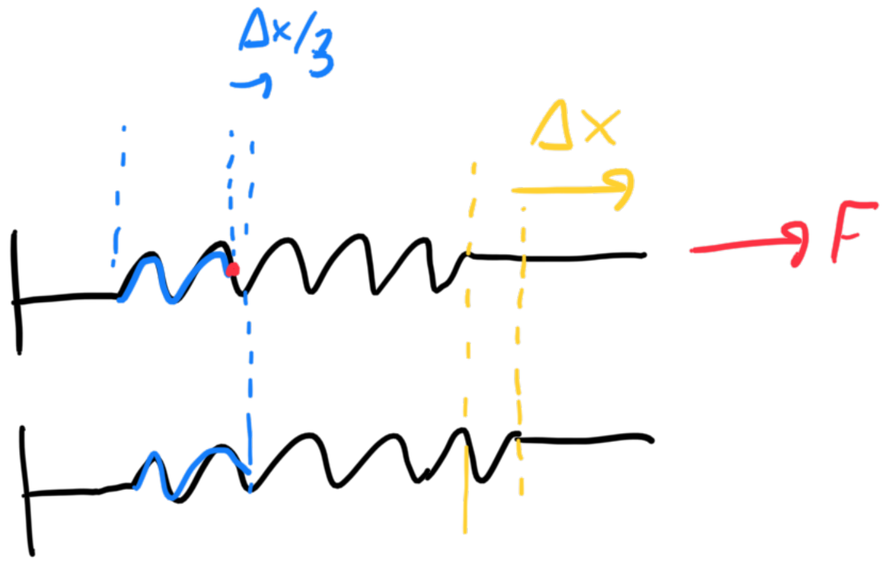


$\Rightarrow$



$k' = 2k$

$k_{eff} = 4k$ $\quad \omega = \sqrt{k_{eff}/m} = 2\omega_0$

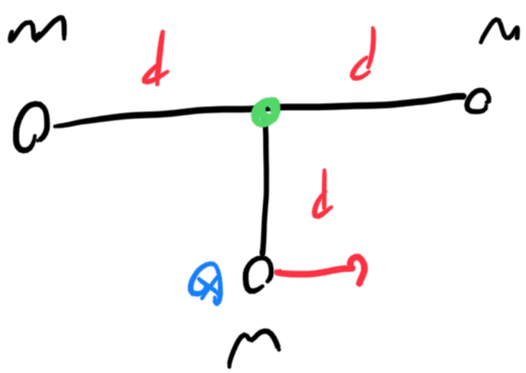


$F_b = F$

$\Delta x_b = \Delta x/3$

$k_b = F_b/\Delta x_b = 3k = 3F/\Delta x$

14.



$I_{right} = 3md^2$

$I_{in} = 2md^2$

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

$F = -kx \Rightarrow \tau = -k\theta$

$k = mgd$ $\quad \omega = \sqrt{k/m} \Rightarrow \omega = \sqrt{mgd/I} \propto 1/\sqrt{I}$

$T \propto \sqrt{I}$ $\quad \frac{T_1}{T_2} = \sqrt{\frac{3}{1}} = \sqrt{3} \Rightarrow C$

19.

Spherical raindrops

$n, r_0, v_0 \Rightarrow P_0$

n: $\times 2$, r_0: $\times 1/2$, v_0: $\times 1/2$, P_0: $\times ?$

Volume $\Rightarrow \frac{1}{8}$

number density $\Rightarrow 2$

velocity $\Rightarrow \frac{1}{4}$

$J = PA\Delta t = \rho N v \Delta t$ $\Rightarrow 1/16 \Rightarrow E$

$P = \frac{\rho N v}{A} = \frac{4\pi}{3} r^3 \cdot \rho \cdot n \cdot v^2$

v factor as v

$(1/2)^3 \cdot 2 \cdot (1/2)^2 = 2 \cdot (1/2)^5 = 1/16$

25.

$a \pm \Delta a$

$b \pm \Delta b$

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

$\Delta a = 0.008\,s$

$\Delta(a+b) = \frac{1}{2}\sqrt{(\Delta a)^2+(\Delta b)^2} = 0.0089\,s$

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

$= 0.0072\,s$