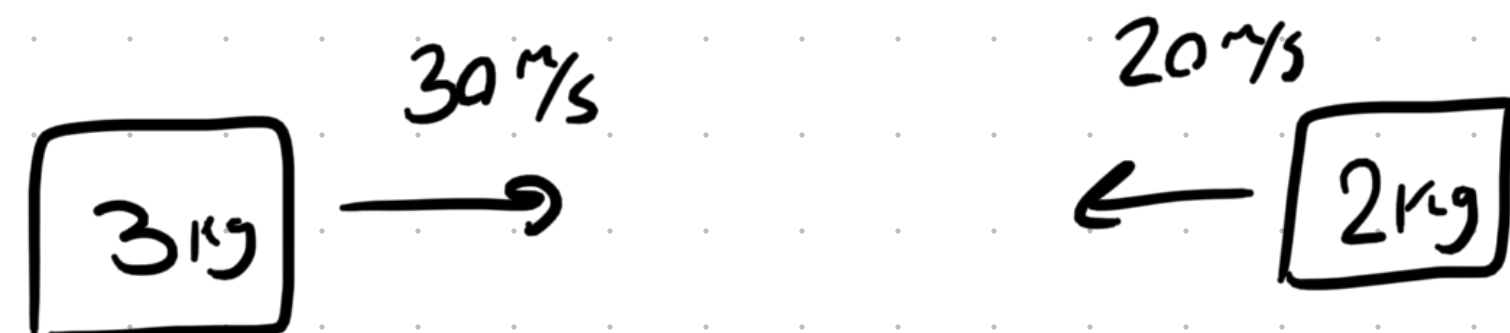


2018A #2

 $v_{cm} = ?$ after collision

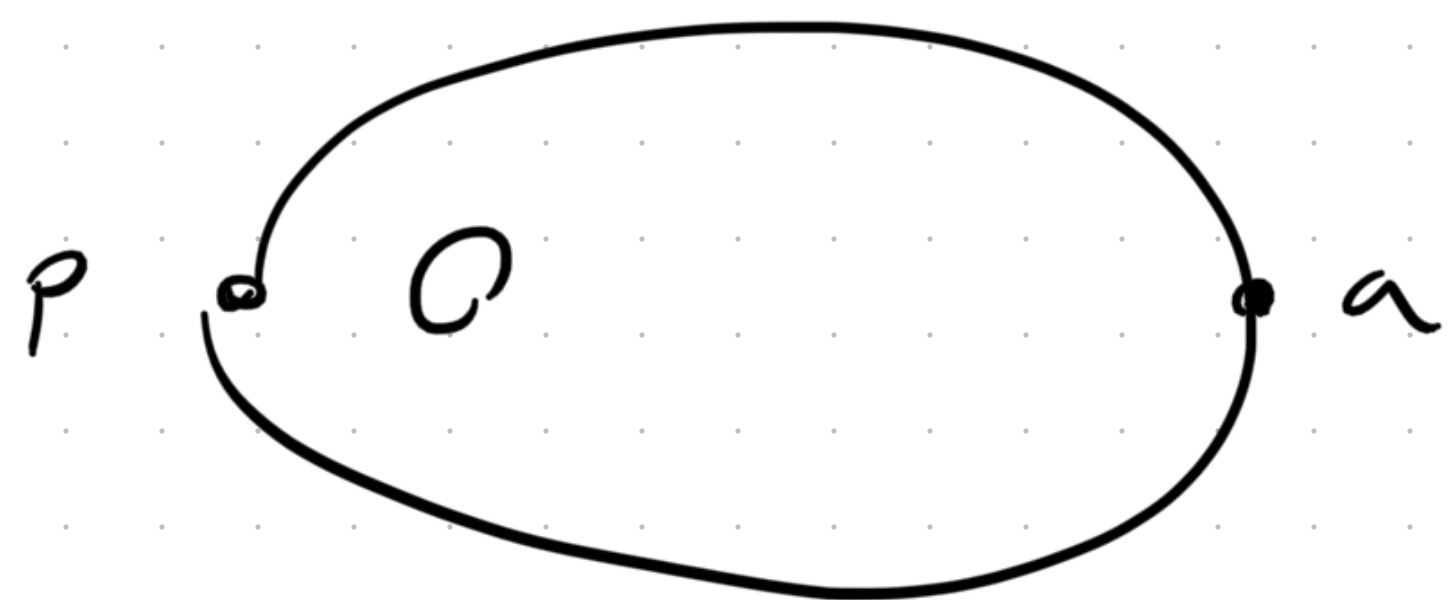
$$P_o = 3\text{kg}(30\text{m/s}) + 2\text{kg}(-20\text{m/s}) = +50\text{ kg m/s}$$

$$P_f = P_o \quad \text{momentum is conserved.}$$

$$v_{cm} = \frac{P_f}{M} = \frac{P_o}{M} = \frac{+50\text{ kg m/s}}{5\text{kg}} = +10\text{ m/s}$$

B

2018A #4



How to use an impulse
to maximize satellite energy?

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

must be in direction of velocity

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

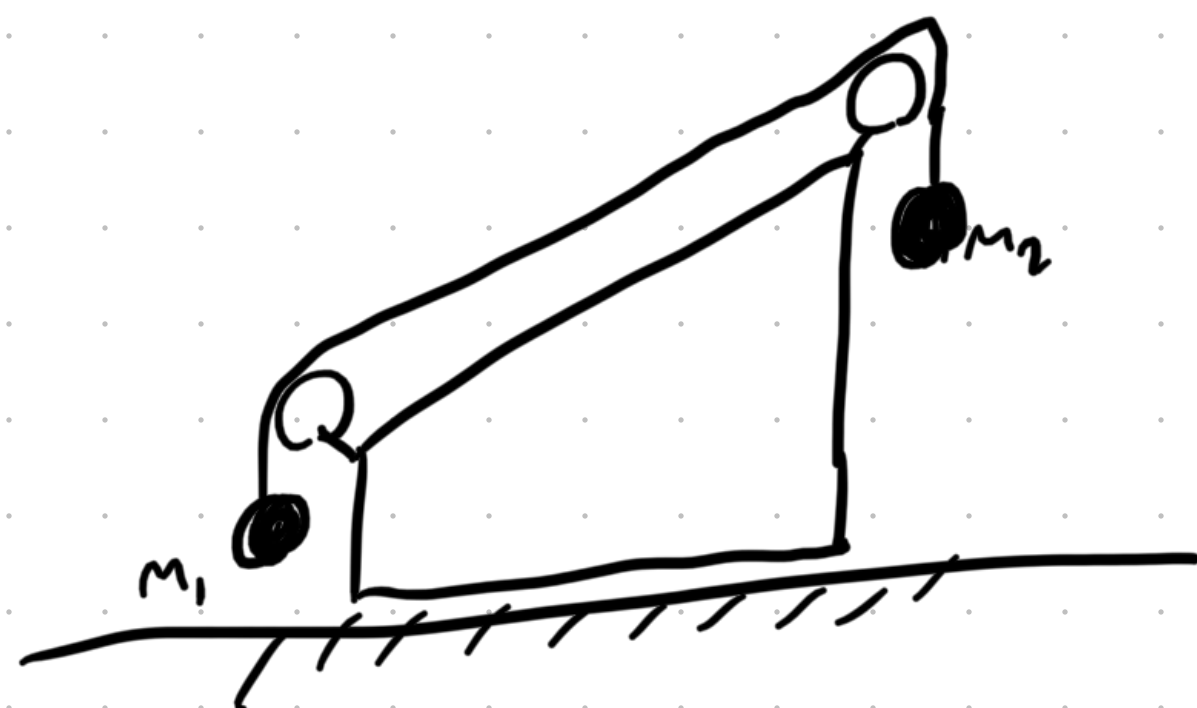
$$= \text{const} + m v_0 \Delta v$$

So, we want to apply
the impulse when v_c
is highest.

K2L: Says that
the satellite is fastest
at perigee

$\Rightarrow$ (A)

2018 A #5

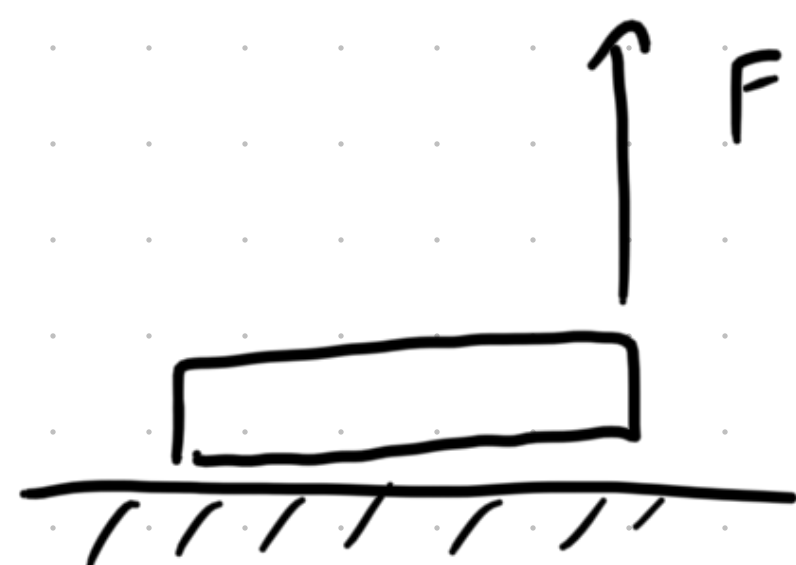


release masses from rest, how will the inclined plane move?

no external horizontal forces anywhere in this problem.

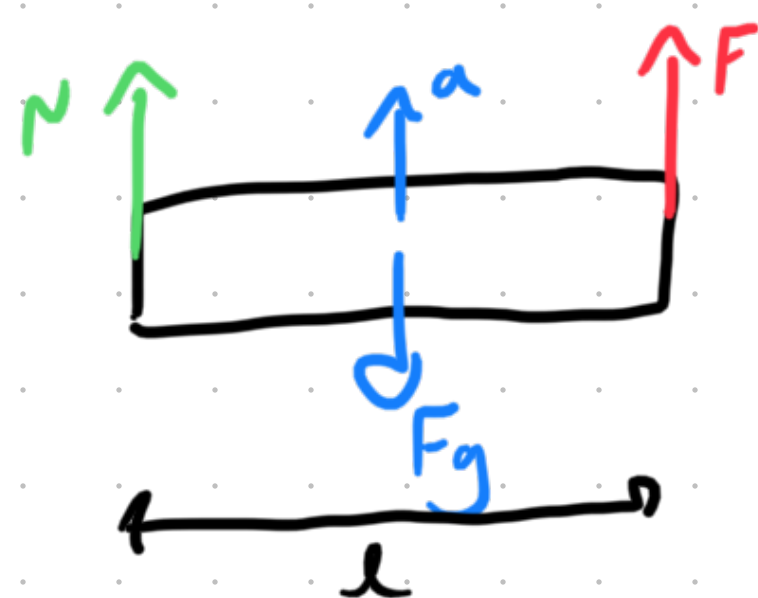
(E)

2018A#9

CM: $a < g$

N on right end of stick?

First, note the pivot is right edge.


 $N = ?$
 F, g given

$$a = r\alpha = a\frac{l}{2} \quad I = \frac{ml^2}{3}$$

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

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

$$2a = \alpha l = \frac{3}{m} F - \frac{3}{2} g$$

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

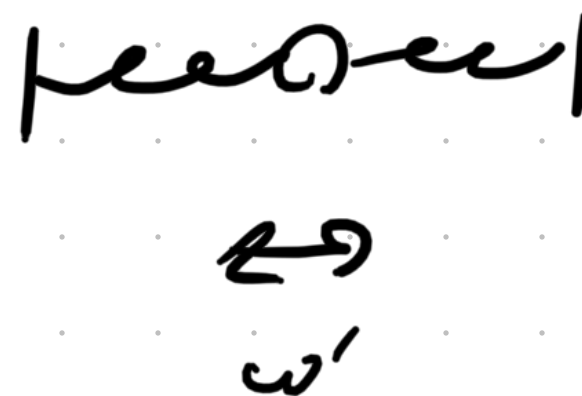
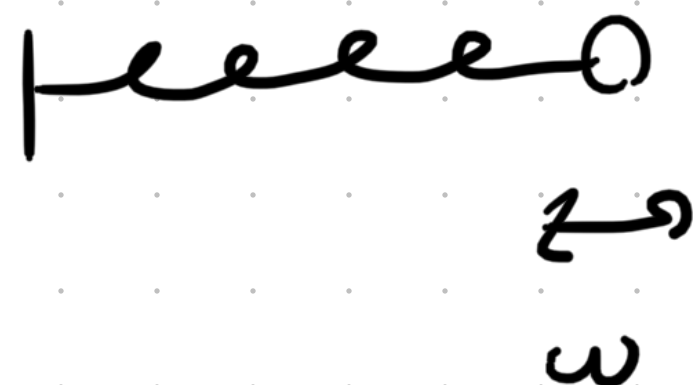
$$-2a + 3a = -\left(\frac{3}{m} F - \frac{3}{2} g \right) + 3\left(\frac{F}{m} - g + \frac{N}{m} \right)$$

$$a = 0F - \frac{3}{2}g + \frac{3}{m}N$$

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

$$mg > N > \frac{mg}{2} \quad \textcircled{B}$$

2018A #11



Springs Topic in F=ma Physics

 $K' = Nk$ when the spring is cut in N ths.

$$K' = 2K$$

 but there are two of them! so $K' = 4K$

$$\omega = \sqrt{\frac{K}{m}} \quad \omega' = \sqrt{\frac{K'}{m}} = \sqrt{\frac{4K}{m}} = 2\omega$$

(D)

The diagram shows a tree structure with a central node connected to three other nodes. The leftmost node is enclosed in a yellow oval, with a blue double-headed arrow labeled d indicating a distance or displacement. The rightmost node is also enclosed in a yellow oval, with a yellow arrow labeled I pointing towards it. The bottom node is enclosed in a yellow oval, with a yellow arrow labeled I pointing towards it. A blue arrow labeled T_1 points left from the bottom node, with the text "push left" written below it. A blue arrow labeled T_2 points down from the bottom node, with the text "push into page" written to its right. A blue arrow labeled T_2 points up from the bottom node, with the text "push into page" written to its right.

$$\frac{T_1}{T_2} = ?$$

Topic 3

$$F = -kx$$

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

$$I_1 = 3md^2 *$$

$$I_2 = 1 \text{ m d}^2$$

Angular NZL:

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

Hook's Law:

$$F = -kx$$

$$\tau = -K\theta \Rightarrow K = -mgd$$

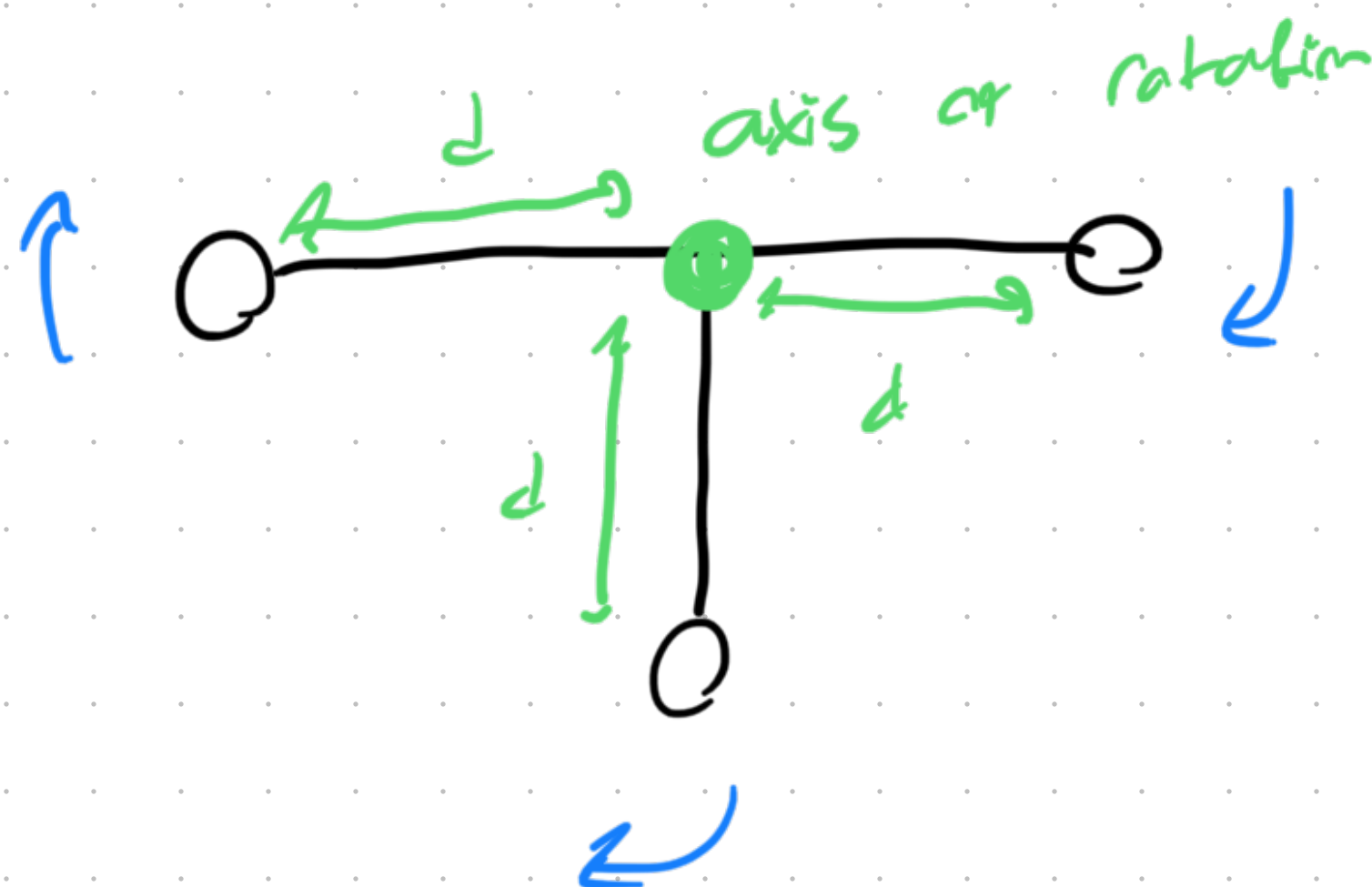
Oscillations:

$$\omega = \sqrt{k/m} = \sqrt{mg/L} \propto 1/\sqrt{I}$$

$$T \propto \sqrt{I} \Rightarrow \frac{T_1}{T_2} \propto \sqrt{\frac{I_1}{I_2}} = \sqrt{3}$$

cent.

①

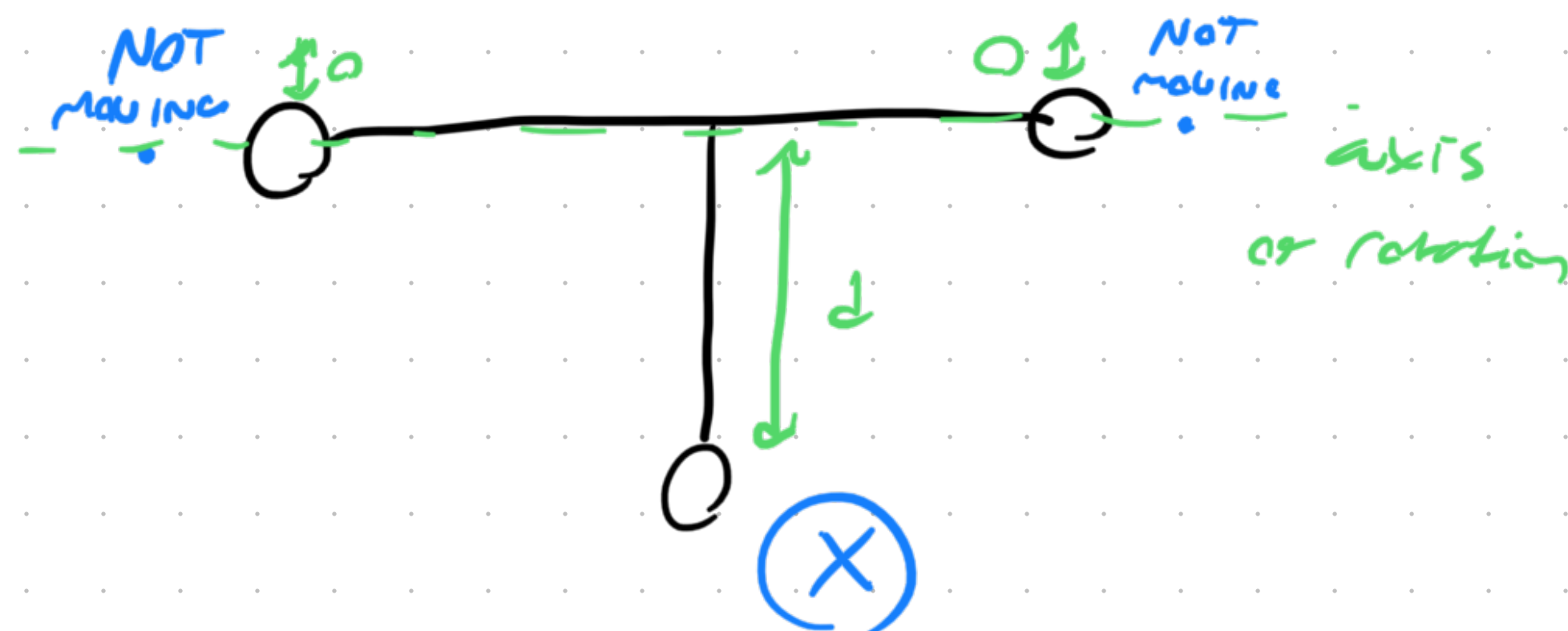


all are moving

$$I_1 = 3md^2$$

(three masses moving,
all d from axis
of rotation)

②

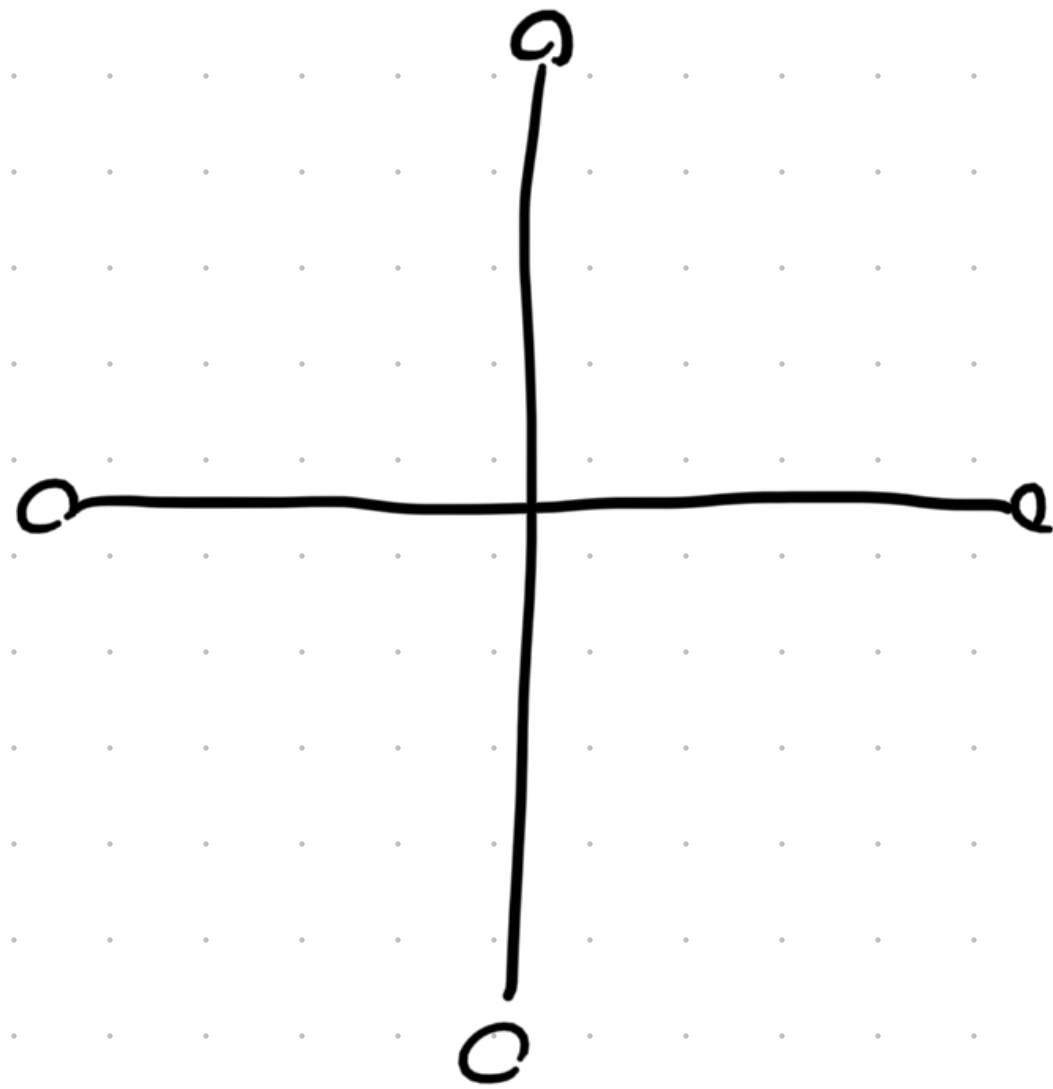


one is moving

$$I_2 = 1md^2$$

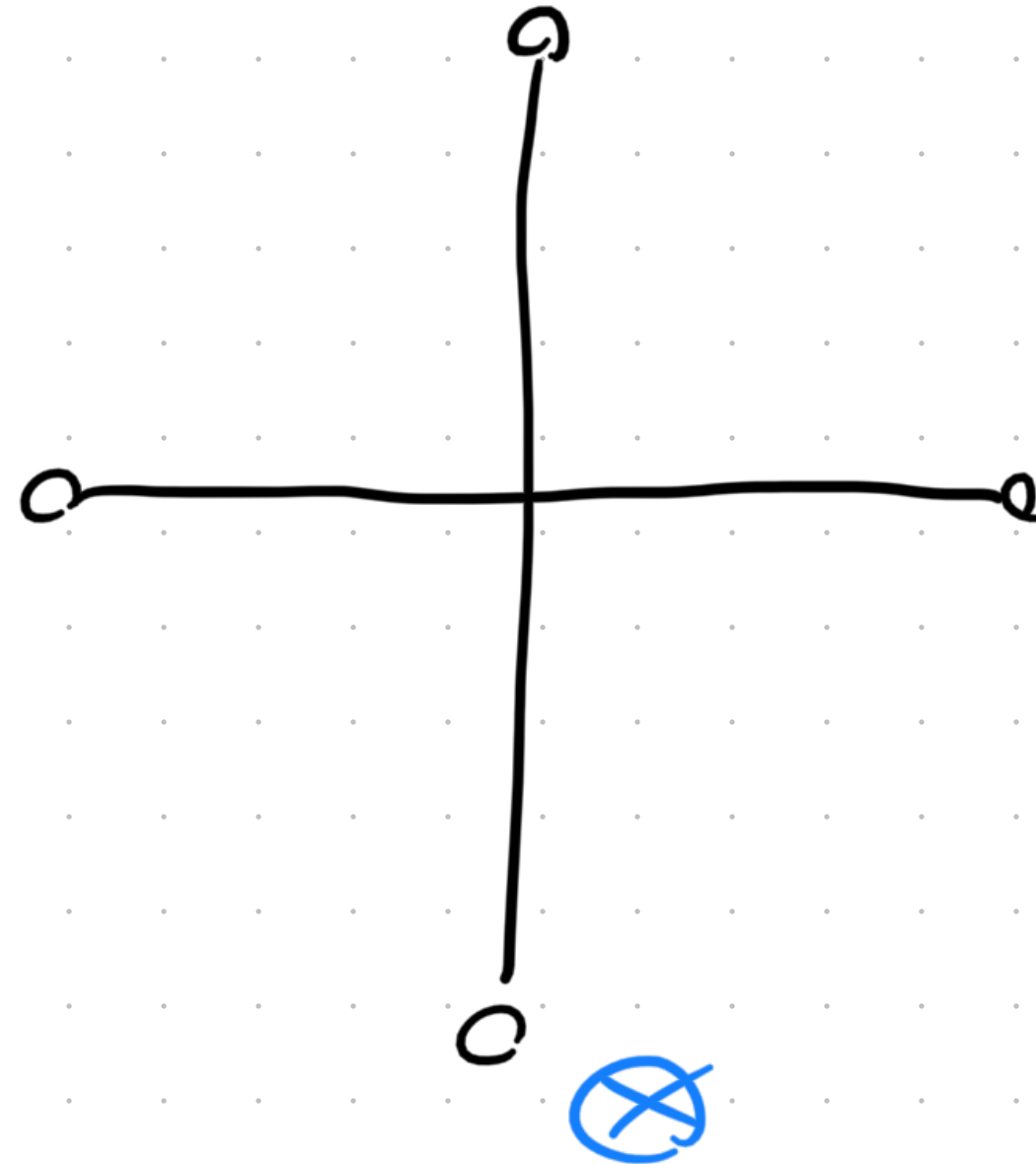
(one mass moving,
the other two
have $d=0$ from
axis of rotation)

Cont.

 T_1

$$I_1 = 4md^2$$

$$\frac{T_1}{T_2} = ?$$

 T_2

$$I_2 = 2md^2$$

$$\frac{T_1}{T_2} \propto \sqrt{\frac{I_1}{I_2}} = \sqrt{\frac{4md^2}{2md^2}} = \sqrt{2}$$

2018A #19

Raindrops with number density n (m^{-3}) and radius r_0 hit ground with speed v_0 . Resulting pressure is P_0

$$n' \rightarrow 2n \quad r \rightarrow r_0/2 \quad v \rightarrow v_0/2$$

$$J_{\text{surface}} = P A \Delta t = \rho N v \Delta t$$

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

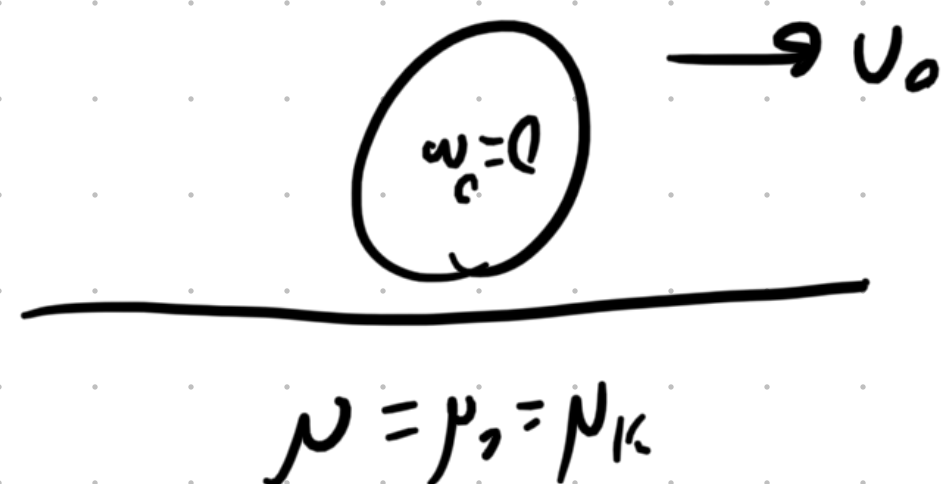
$$N = \frac{4\pi}{3} n A v r^3$$

$$P' = P_0 \cdot 2 \cdot \left(\frac{1}{2}\right)^2 \cdot \left(\frac{1}{2}\right)^3 = \frac{P_0}{16} \quad \textcircled{E}$$

$$P = ?$$

$$\left[\begin{array}{l} \rho = \text{density} \\ N = \text{volumetric flow} \\ v = \text{velocity} \\ \Delta t = \text{splat time} \end{array} \right.$$

2018A #21



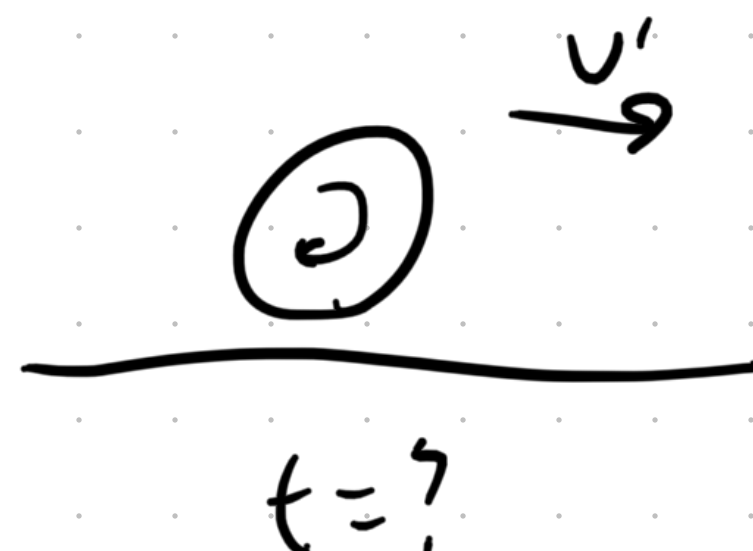
$$F = -\mu mg$$

$$a = -\mu g$$

$$I = \frac{2}{3} mr^2$$

$$\tau = I\alpha$$

$$\alpha = \frac{\tau}{I} = \frac{\mu mgr}{\frac{2}{3} mr^2} = \frac{3}{2} \mu g / r$$



$$v(t) = v_0 - \mu g t$$

$$\omega(t) = \frac{3}{2} \mu g t / r$$

$$v(t) = r\omega(t)$$

$$v_0 - \mu g t = \frac{3}{2} \mu g t$$

$$t = \frac{2}{5} \frac{v_0}{\mu g}$$

(A)

2018 A #25

$$a \pm \Delta a = 1.013 \pm 0.008 \text{ s}$$

$$b \pm \Delta b = 0.997 \pm 0.016 \text{ s}$$

$$\textcircled{1} \quad \Delta a = 0.008 \text{ s}$$

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

$$\textcircled{3} \quad \Delta(4a+b) = \frac{1}{5} \sqrt{4(\Delta a)^2 + (\Delta b)^2} = 0.0072 \text{ s}$$

$$\textcircled{B}$$