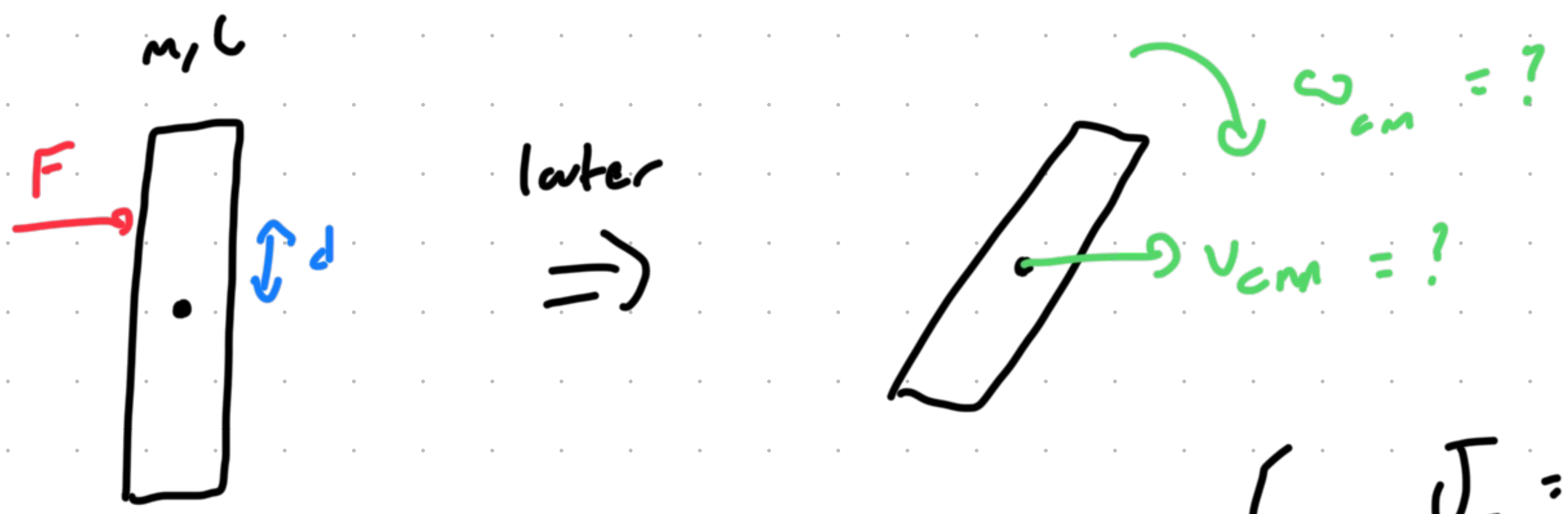
$$\boxed{J = F\Delta t}$$



Torque $= \vec{r}\times\vec{F} = rF\sin\theta$

F applied for a fixed Δt. } → Fixed impulse

$$F = ma = \frac{m\Delta v}{\Delta t} = \frac{\Delta p}{\Delta t}$$

$$F\Delta t = J = \Delta p$$

$m(\Delta v)$

$m(v_f - v_i)$

$$= ma\Delta t = m v_{cm}$$

$$\boxed{v_{cm} = \frac{F\Delta t}{m}}$$

$$J_\tau = \tau\Delta t = F d \Delta t$$

$$= I\alpha\Delta t = I\omega_{cm}$$

$$= \frac{1}{12} mL^2 \omega_{cm}$$

$$\boxed{\omega_{cm} = 12\frac{F\Delta t d}{mL^2}}$$

$$\Delta E = F\Delta r = J\,\frac{\Delta r}{\Delta t}$$

Δt is small, $\quad \Delta r \simeq \Delta x + d\Delta\theta$

$$a = J/m\Delta t \qquad \alpha = Jd/I\Delta t \qquad I = \frac{1}{12} m l^2$$

$$\Delta x = \frac{1}{2}a(\Delta t)^2 = \frac{J\Delta t}{2m} \qquad \Delta\theta = \frac{1}{2}\alpha(\Delta t)^2 = \frac{Jd\Delta t}{2I} = 12\,\frac{d}{l^2}\,\frac{J\Delta t}{2m}$$

$$\Delta r = \frac{J\Delta t}{2M}\left(1 + 12\,\frac{d^2}{l^2}\right) \Rightarrow \boxed{\Delta E = \frac{J^2}{2M}\left(1 + 12\,\frac{d^2}{l^2}\right)}$$

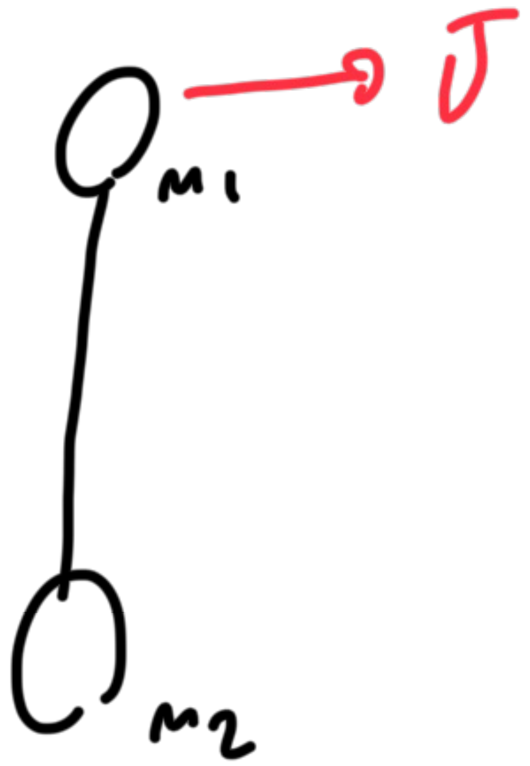
$$\boxed{\Delta E = \frac{J^2}{2m}\left(1 + 12\frac{d^2}{L^2}\right)}$$

$$KE_{\text{translation}} = \frac{1}{2} m v_{cm}^2 = \frac{1}{2} m \left(\frac{F\Delta t}{m}\right)^2 = \frac{F^2(\Delta t)^2}{2m} = \frac{J^2}{2m}$$

$$KE_{\text{rotation}} = \frac{1}{2} I \omega_{cm}^2 = \frac{1}{2}\left(\frac{1}{12}mL^2\right)\left(12\frac{Jd}{mL^2}\right)^2$$

$$= \frac{\cancel{mL^2}}{24}\cdot(12)^2\frac{J^2 d^2}{(mL)^{\cancel{2}}} = 6\frac{J^2 d^2}{2mL^2}$$

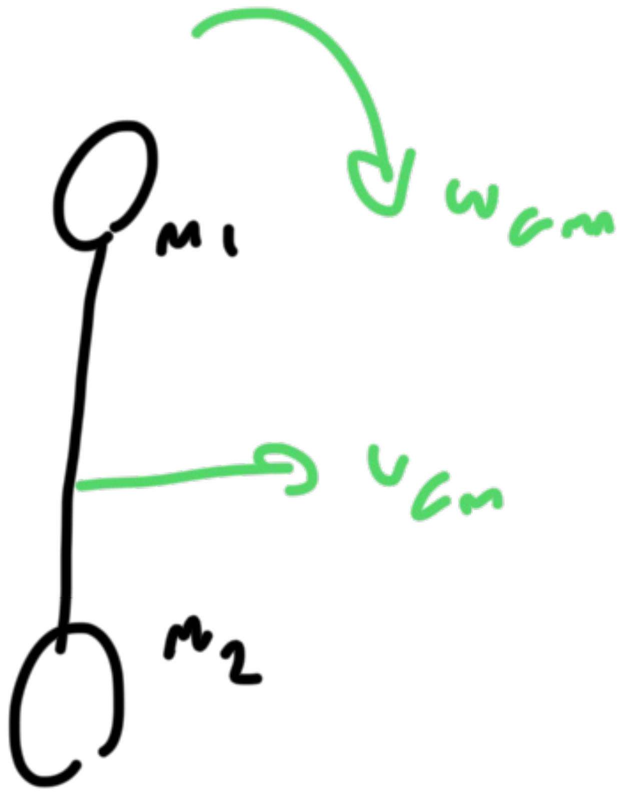
2018 B #23



$$v_{cm} = \frac{J}{m_1+m_2} = \frac{m_1 v}{m_1+m_2}$$

$$r_1 = \frac{m_2 L}{m_1+m_2} \qquad r_2 = \frac{m_1 L}{m_1+m_2}$$

) distances to cm from each mass



Two conditions:

$v = v_{cm} + r_1 \omega_{cm}$ — m_1 starts at v

$0 = v_{cm} - r_2 \omega_{cm}$ — m_2 starts at rest

$$v = v_{cm} + r_1\omega_{cm}$$

$$= \frac{m_1 v}{m_1+m_2} + \frac{m_2 L\omega_{cm}}{m_1+m_2}$$

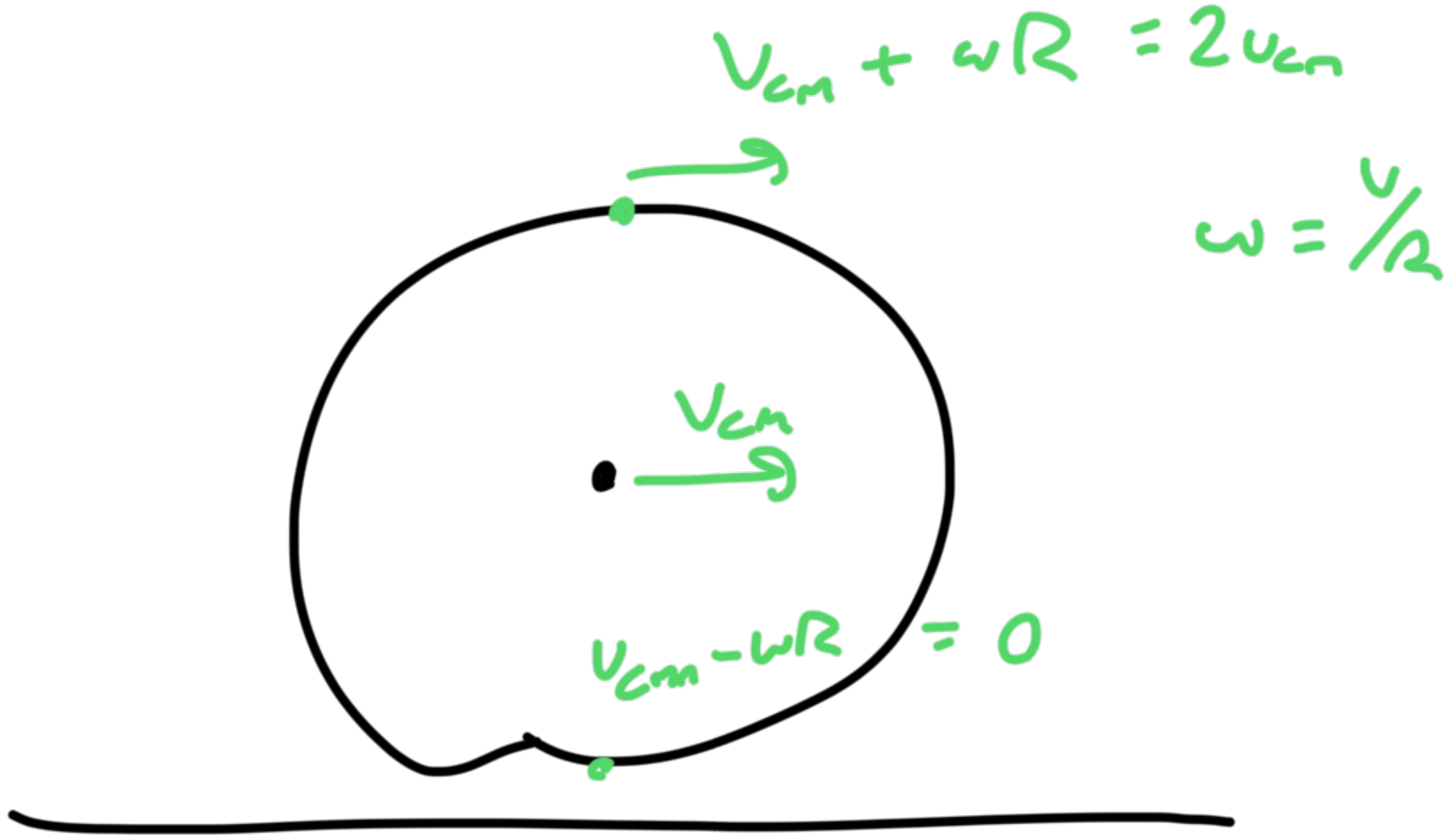
$$\omega_{cm} = v/L$$

$$0 = v_{cm} - r_2\omega_{cm}$$

$$v_{cm} = r_2\omega_{cm}$$

Next time m_2 is at rest is after 1 revolution.

$$t = \frac{2\pi}{\omega_{cm}} = \frac{2\pi L}{v}$$ A



Coriolis Effect

$$\vec{F}_{coriolis} = -2m\vec{\Omega}\times\vec{v}$$

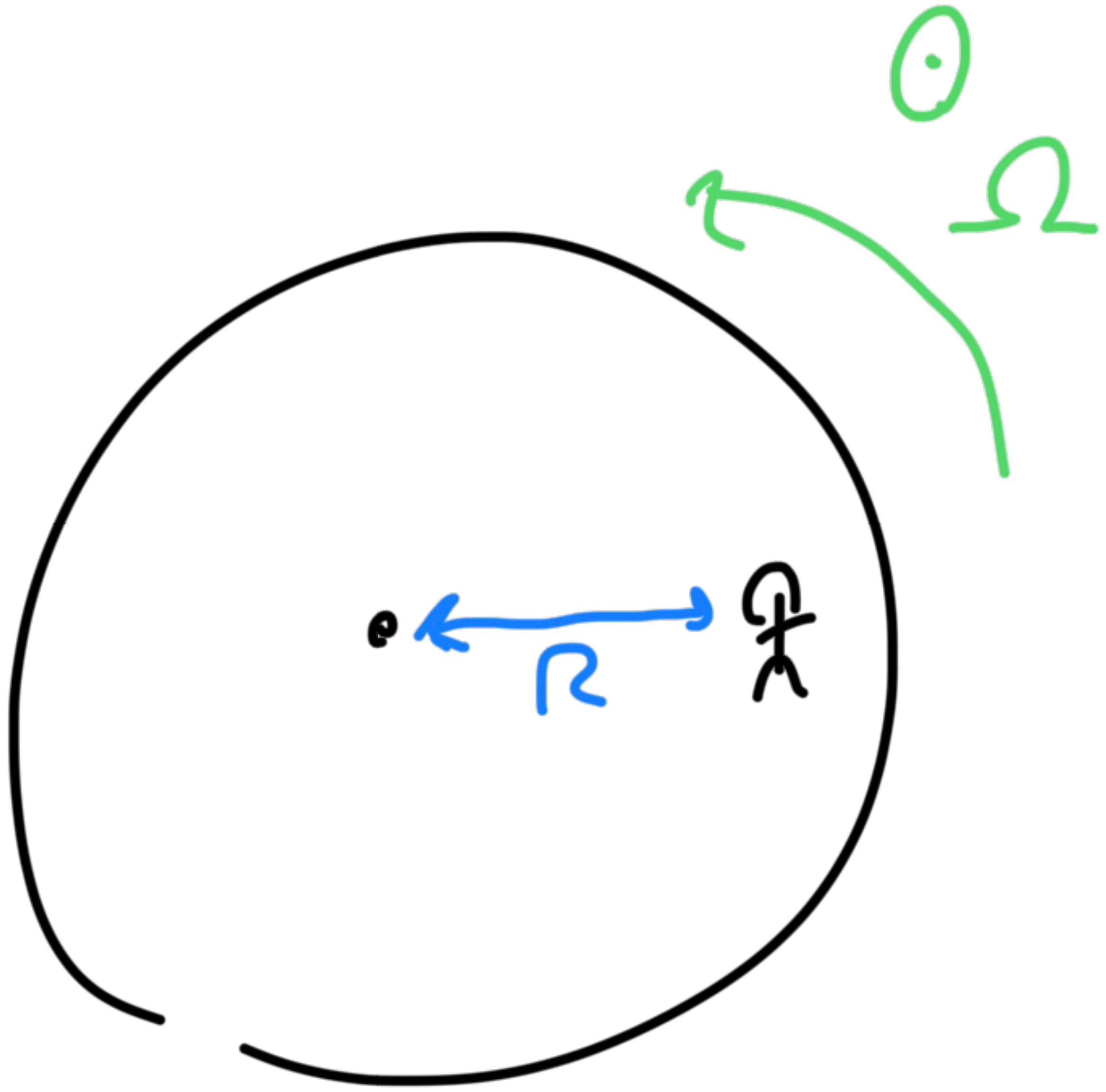
$$|F_{coriolis}| = 2m\Omega v$$

ccw

out of page

cw

into page



a) drop

No effect, falls normally

b) throw to center

F_{cor} points ahead, so the coin gets ahead of the child

c) throw vertically up

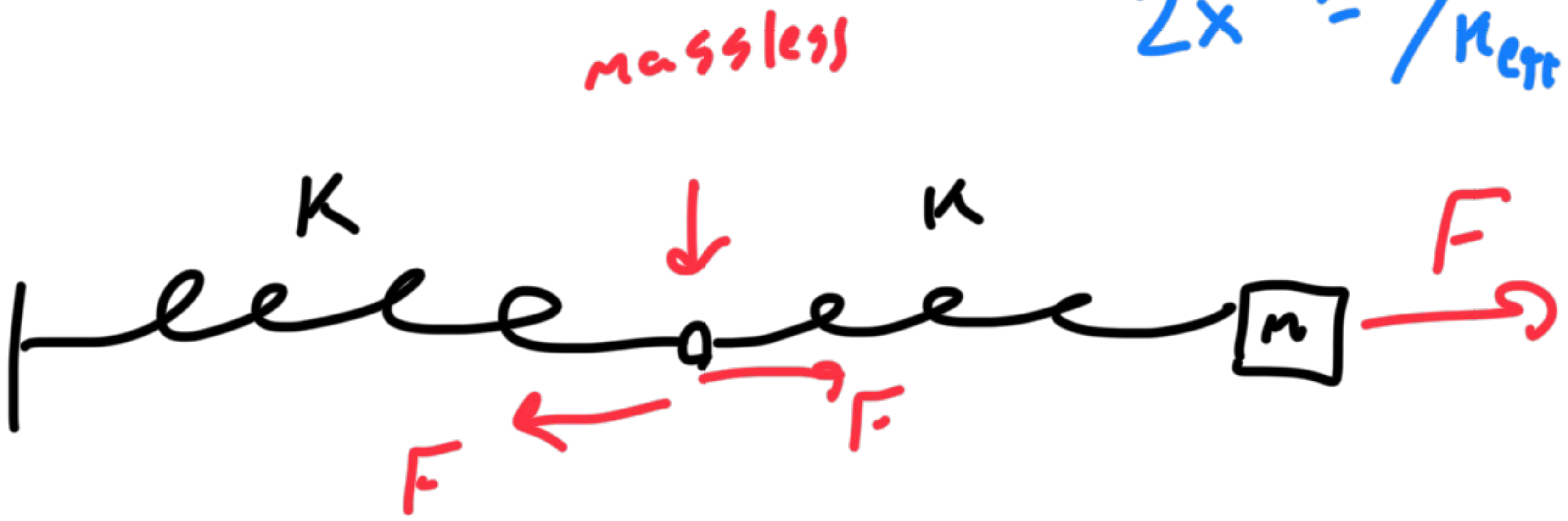
No effect

2018 B #12

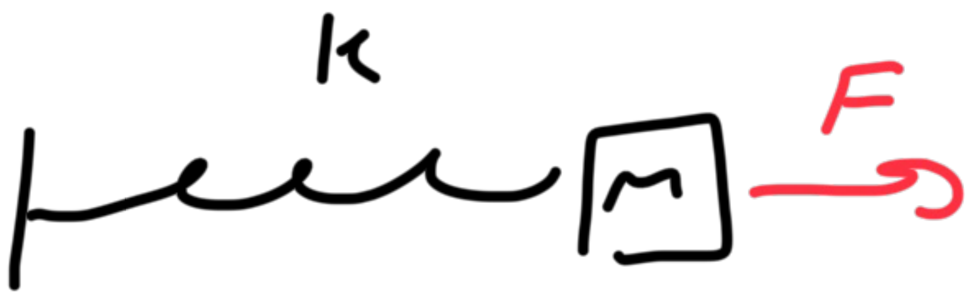
Springs

Series

$$2x = F/k_{eff}$$

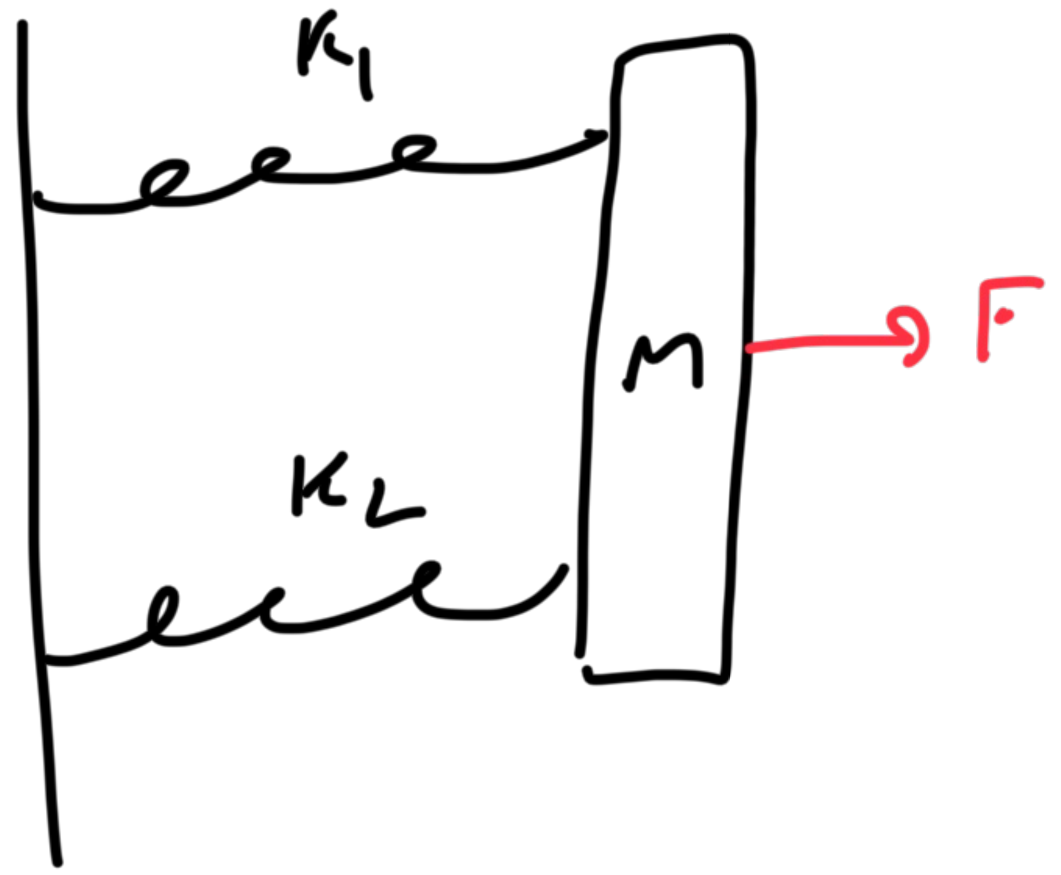


$$x = F/k$$



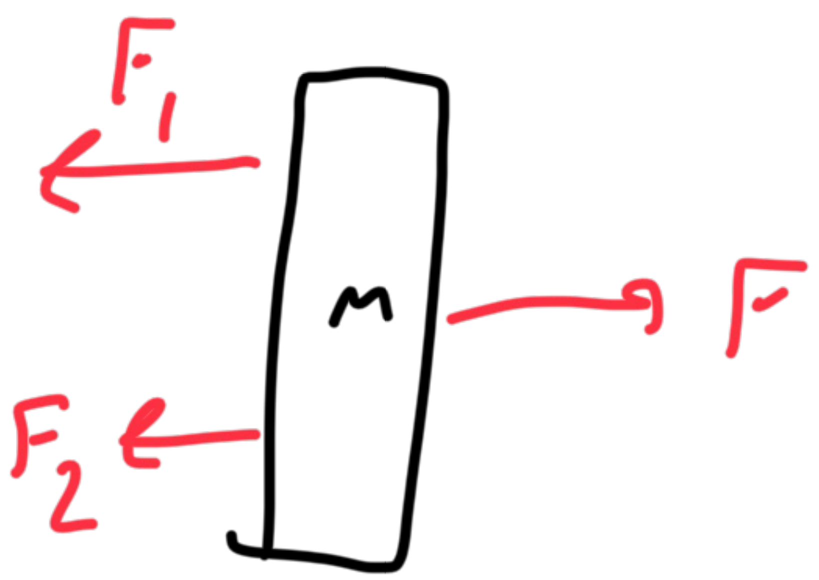
$$K_{eff} = K/2$$

parallel



$$x = \frac{F_1}{k_1} = \frac{F_2}{k_2}$$

$$F = F_1 + F_2$$

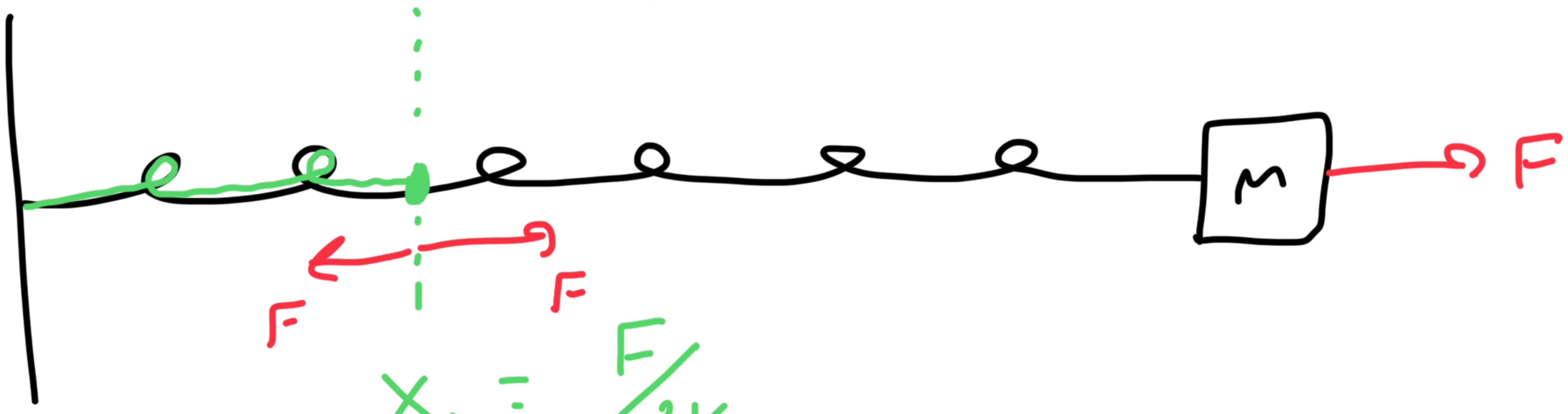


$$k_1 x_1 + k_2 x_2 = F$$

$$x = \frac{F}{k_1 + k_2}$$

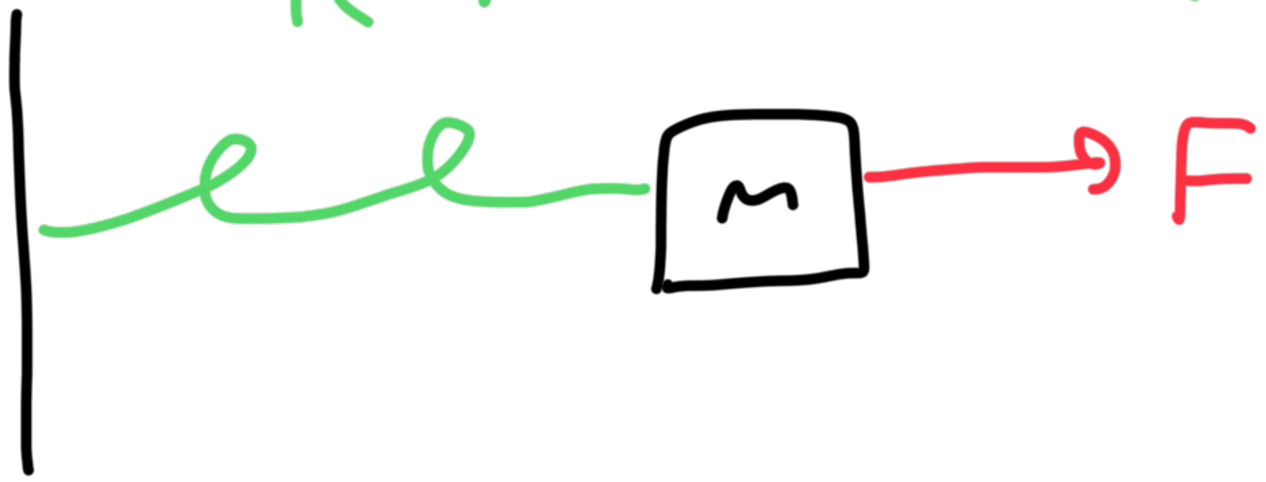
$$k_{eff} = k_1 + k_2$$

K $\qquad x = F/K$



$x_c = F/3K$

$k = ?$ $\qquad x = F/3K$

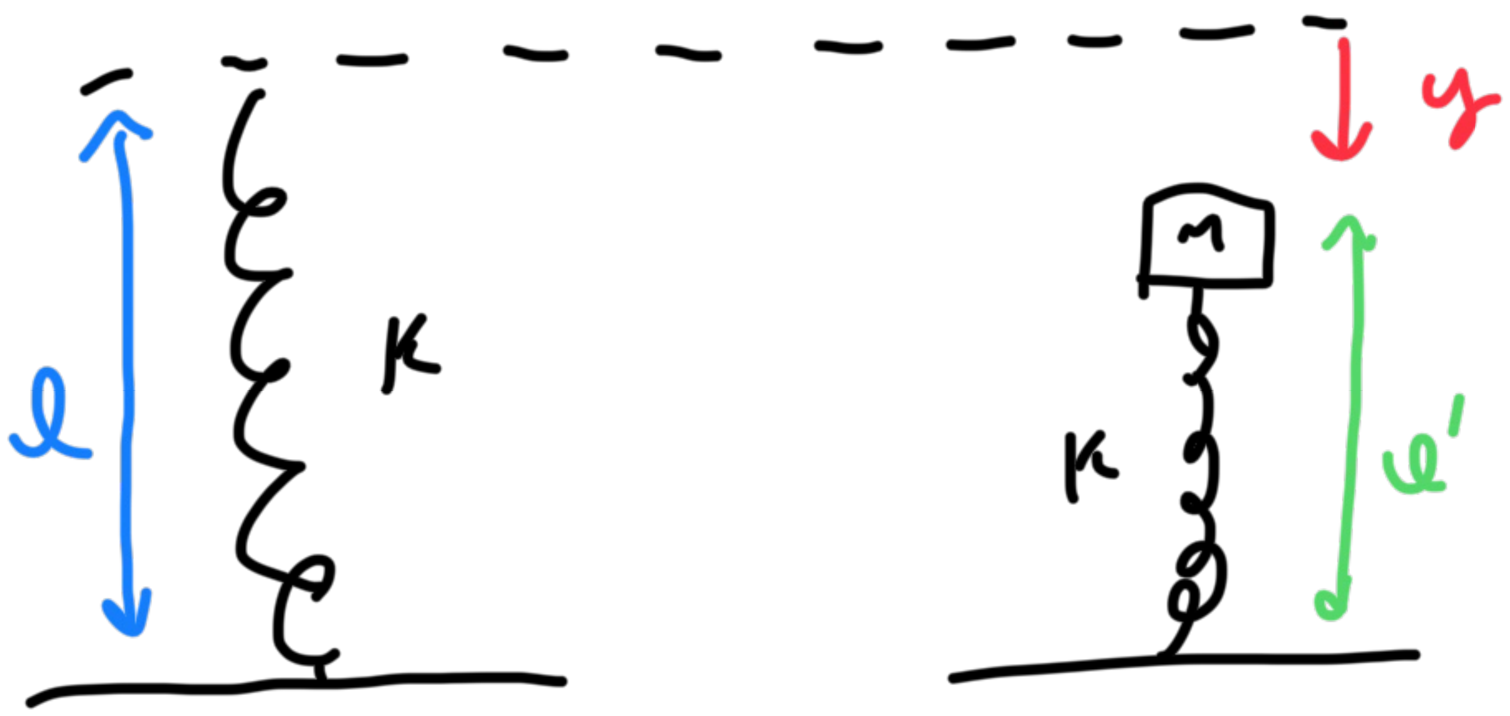


$K_c = 3K$

original spring L $\Rightarrow$ cut to $\frac{L}{N}$

original constant k $\Rightarrow$ constant Nk

gravity



$\omega = ?$

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

No change to ω!

$mg = ky \Rightarrow y = \frac{mg}{k}$

$$\boxed{\ell' = \ell - mg/k}$$