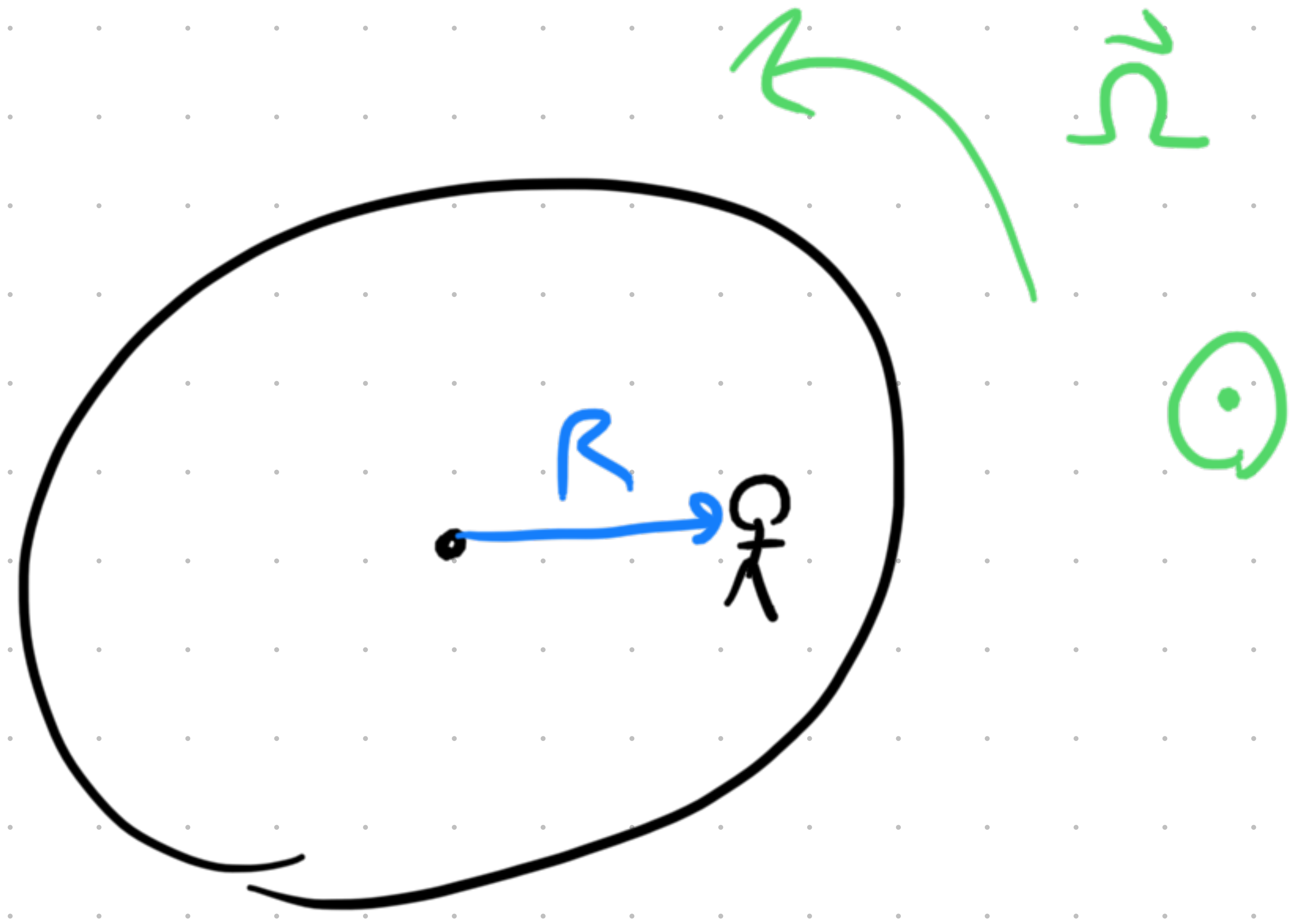
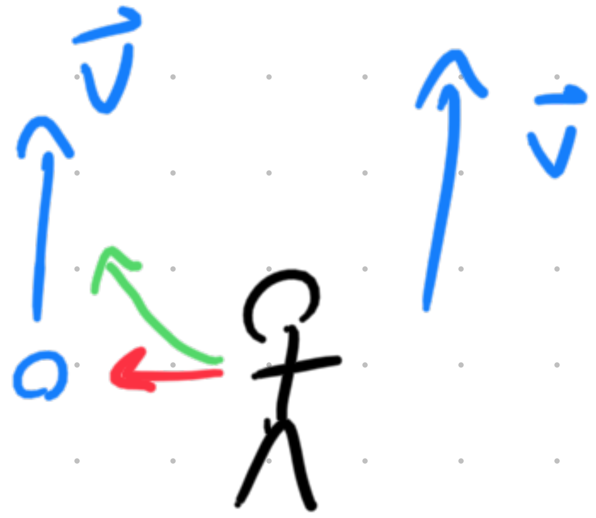
# Coriolis Effect

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

$\vec{\Omega}$ = rotational vel. of ref. frame

$\vec{v}$ = object vel. in ref. frame.




(a) drops the coin $\vec{v}_{coin}$ is downward $\vec{\Omega} \times \vec{v}_{coin} = 0$

(b) throws the coin towards the center

$\vec{v}_{coin}$ to left so $\vec{F}_{cor}$ is forward $(+\hat{\theta})$

(c) throws the coin vertically upwards

# 2018B #12

can't be A or E since the child catches it.


Since the child is moving left and throws the ball up somewhat, it must be C.

# Springs (Topic 4)


any displacement $X$ of the mass

$X_{green} = X/2$

The green point must have F exerted on it in both directions.

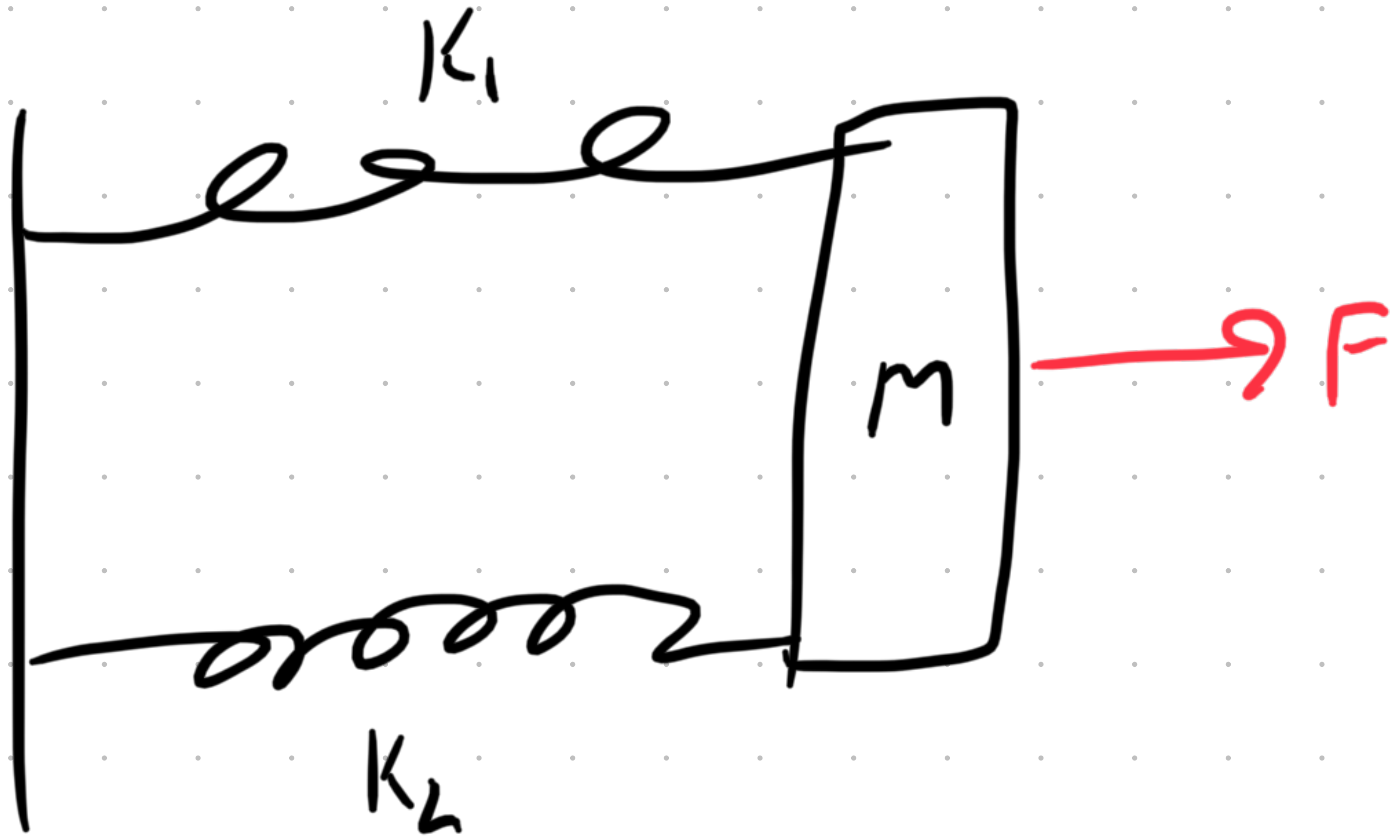
$$\frac{X}{2} = \frac{F}{K} \Rightarrow X = 2F/K \qquad K_{eq} \equiv \frac{F}{X}$$

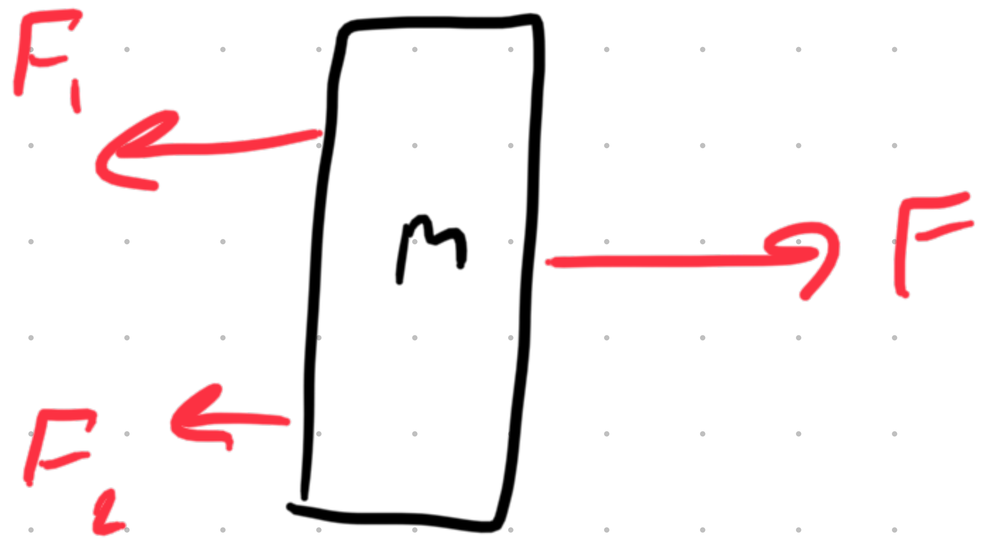
$$K_{series} = K/2$$

**Exercise:**

$K_1 \neq K_2$

Hint: equilibrium condition is the same.



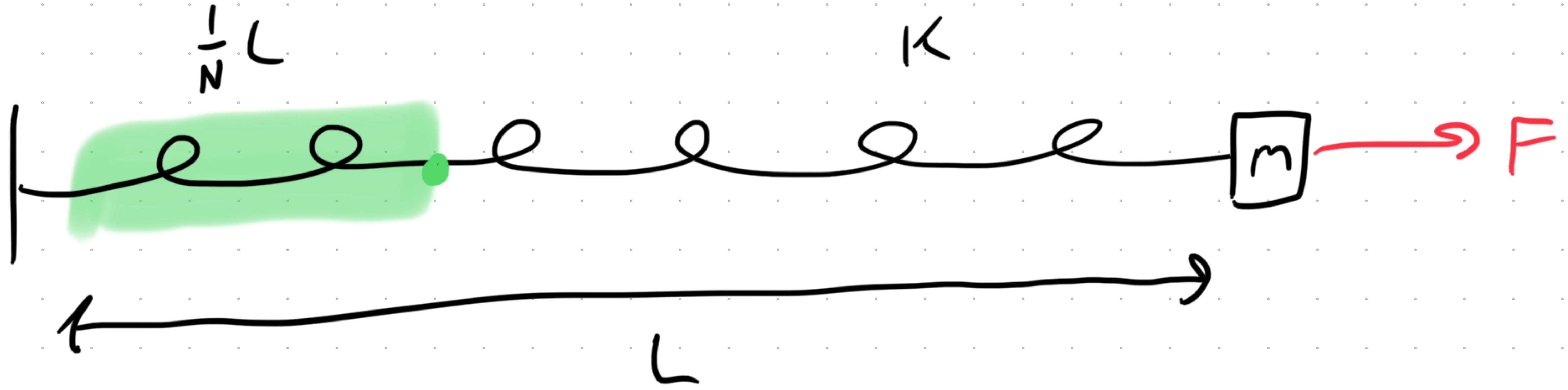




$$x_1 = x_2 = x$$

$$x = \frac{F_1}{k_1} = \frac{F_2}{k_2} \qquad F = F_1 + F_2$$

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

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



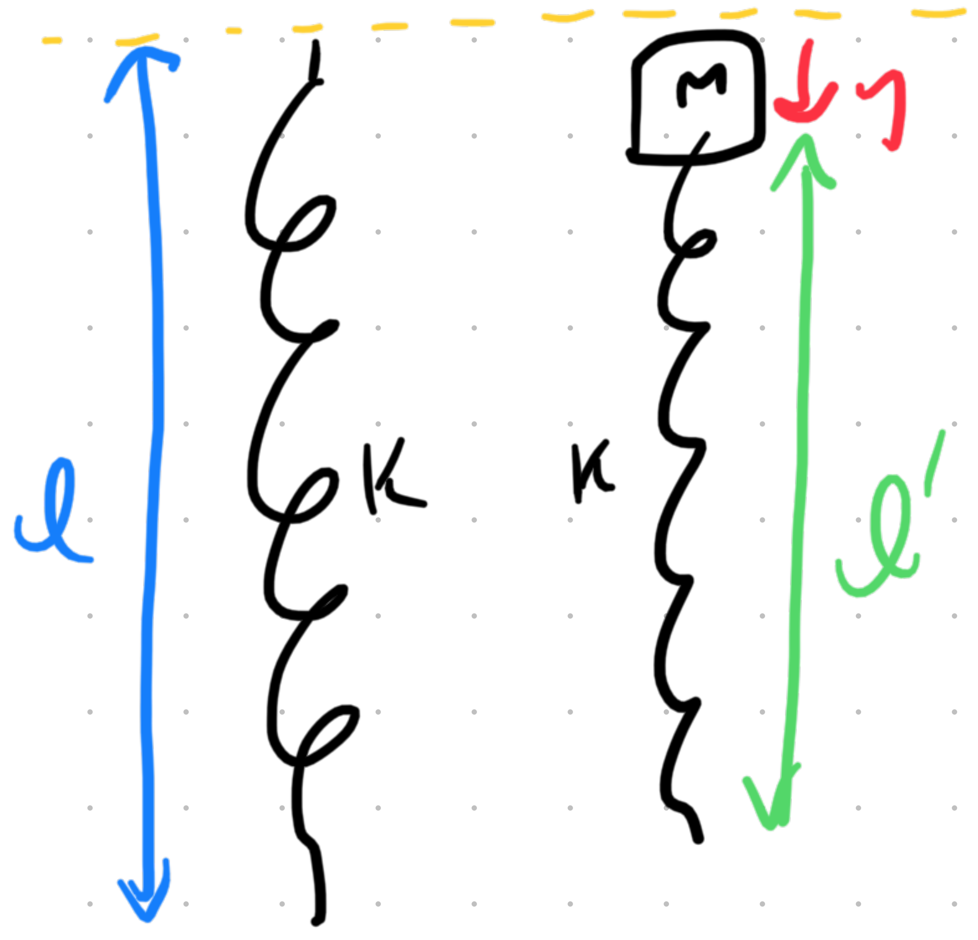

$K_{cut} = ?$

$K = F/X$

$X_{cut} = \frac{X}{N}$

(Topic 4.3)

$$K_c = \frac{F}{\left(\frac{X}{N}\right)} = \frac{NF}{X} = NK$$




$mg = ky$

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

$\ell' = \ell - \frac{mg}{k}$

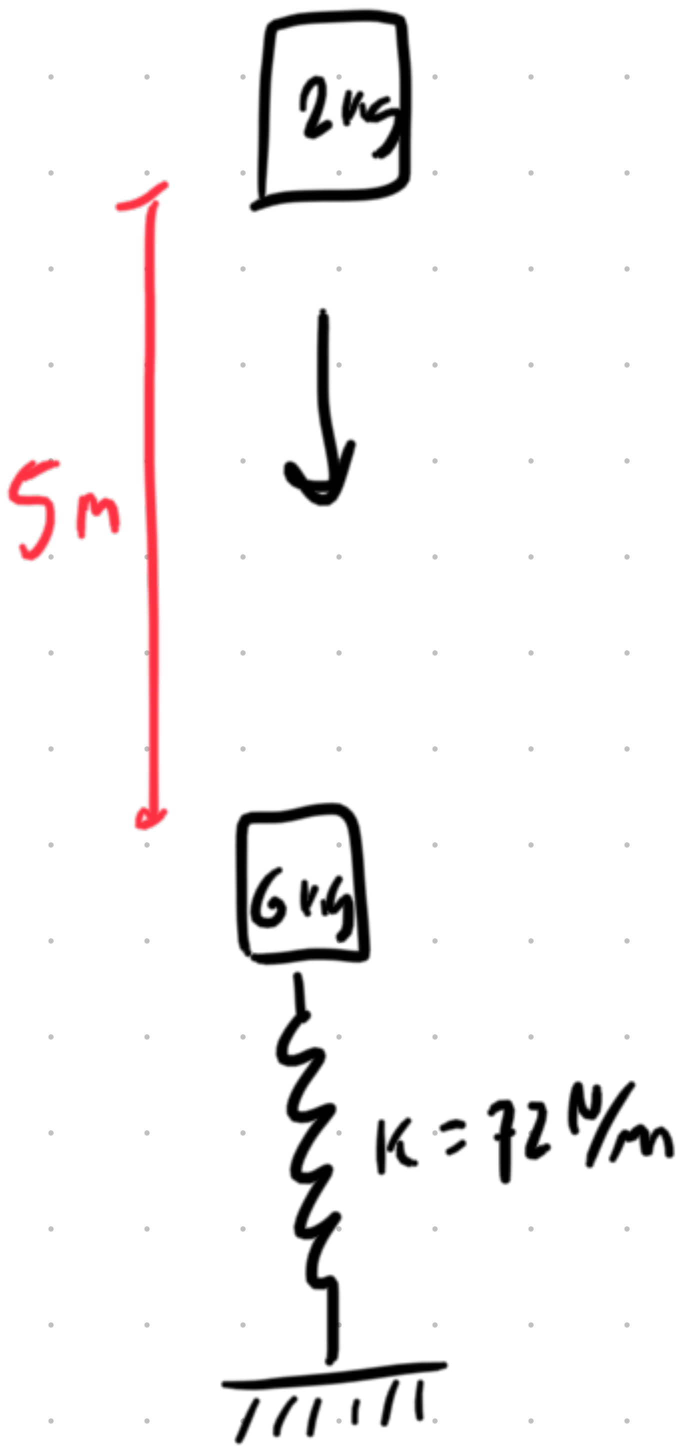
Restoring force

$F = -k\Delta y$

which is independent of true rest length.

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

# 2015 #23




$$\Delta E_s = \frac{1}{2}k(h+x)^2 - \frac{1}{2}kh^2 = \frac{1}{2}kx^2 + khx$$

$m_1 = 2\,kg \quad y = 5\,m \quad m_2 = 6\,kg \quad k = 72\,N/m$

original compression is

$$F_s - m_2 g = 0 \Rightarrow -kh = m_2 g \qquad h = -\frac{m_2 g}{k} = -0.833\,m$$

$$v_1 = \sqrt{2gy} = 10\,m/s$$

$$v_2 = \frac{m_1 v_1}{m_1+m_2} = \frac{m_1\sqrt{2gy}}{m_1+m_2} = 2.5\,m/s$$

$$\frac{1}{2}(m_1+m_2)v_2^2 = \frac{1}{2}kx^2 + m_1 g x$$

$$E_1 = E_{k_1} + E_{s_1} + E_{g_1}$$

$$= \frac{1}{2}(m_1+m_2)v_2^2 + \frac{1}{2}kh^2 + 0$$

$$E_2 = E_{k_2} + E_{s_2} + E_{g_2}$$

$$= 0 + \frac{1}{2}k(h+x)^2 - (m_1+m_2)gx$$

$x = -1.16\,m$

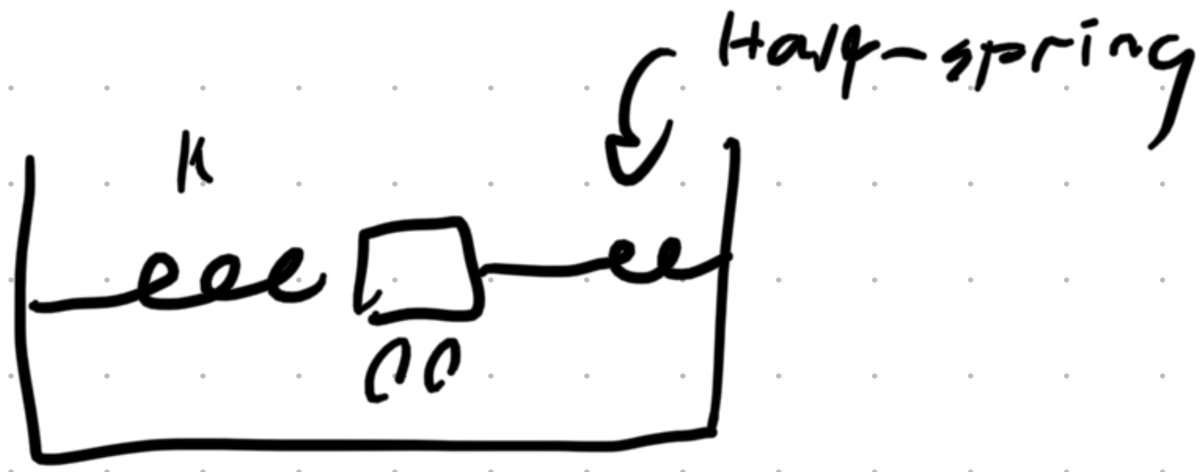
B

# 2015 #25


(1) oscillate in phase → center spring is "rigid"

(2) oscillate out of phase → center point is fixed

$\omega_2/\omega_1 = ?$




$\omega_1 = \sqrt{2k/2m} = \sqrt{k/m}$

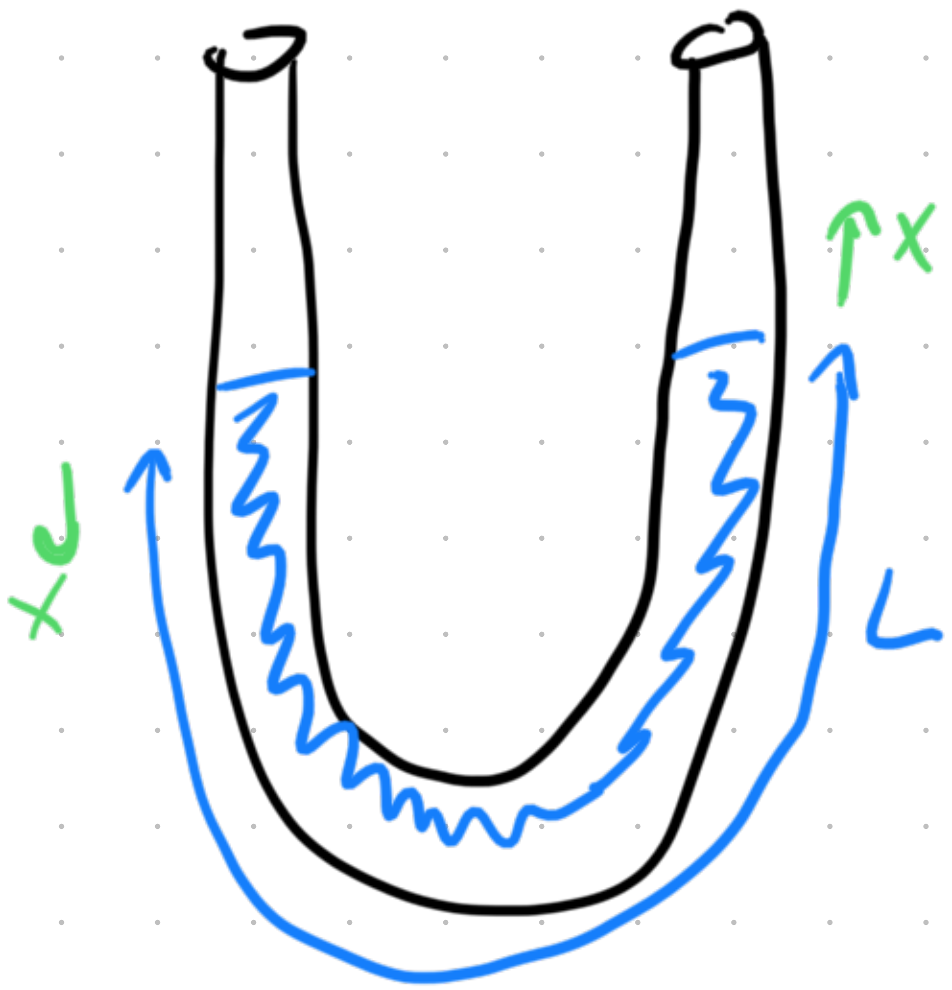
$K_A = k + 2k = 3k$

$\omega_2 = \sqrt{3k/m} = \sqrt{3}\,\omega_1$

$\omega_2/\omega_1 = \sqrt{3}$ A

2015 #19

Topic 3




$f = ?$

$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$

$m = \rho V = \rho L A$

$k = \frac{F}{x} = \frac{2\rho x A g}{x} = 2\rho A g$

$f = \frac{1}{2\pi}\sqrt{2g/L}$

A

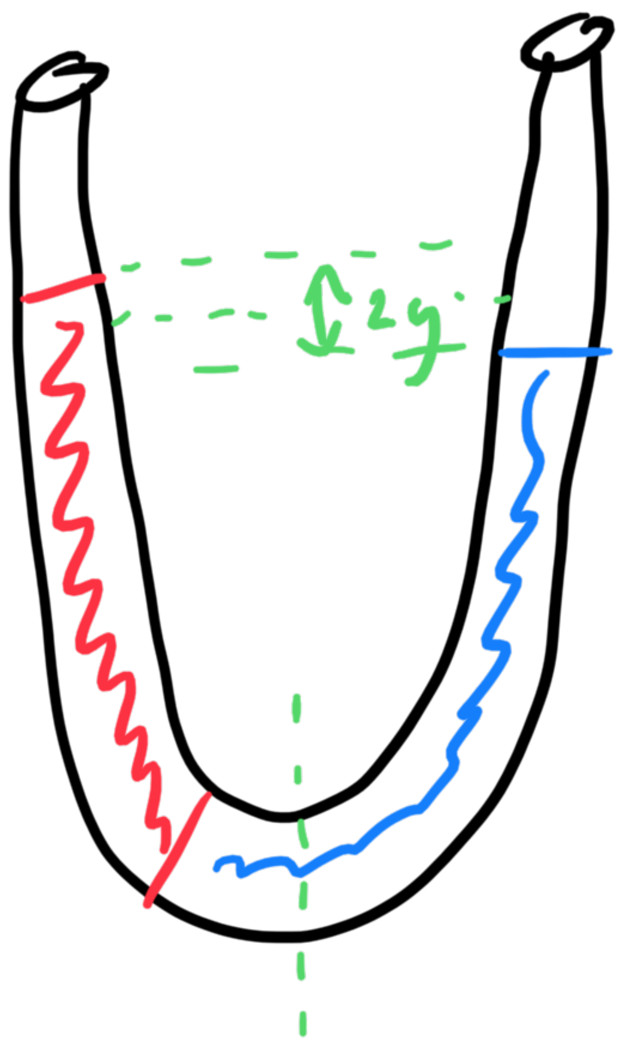
Dimensional analysis

A, B ok

C, D, E don't work

$f \sim \frac{1}{2\pi}$ A is a great guess

# 2015 #20




$h_w = L - y$

$h_o = L + y$

$h = 2y$

$\rho_o g L + \rho g y = \rho g (L - y)$

$\Rightarrow y = \frac{\rho - \rho_o}{2\rho} L = \frac{L}{4}$

$2y = \frac{L}{2}$