2015 #3

$F = kv^2$

$P_0 \rightarrow v_0$

$2P_0 \rightarrow ?$

v^2

$P_0 \rightarrow 2P_0$

$v_0 \rightarrow \sqrt{2} v_0$

X

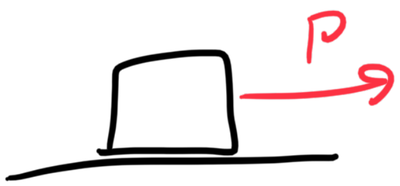
$P = Fv$

$= kv^3$

$\frac{v}{v_0} = \sqrt[3]{\frac{P}{P_0}} = \sqrt[3]{2} \Rightarrow 1.26$

(B)

#4



$\mu_k = c\mu_s$

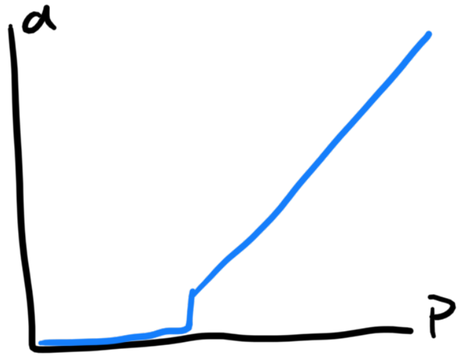
$P > \mu_s mg$

$\mu_k = 0.9\mu_s$

$ma = P - \mu_k mg = P - c\mu_s mg$

$a = \frac{P}{m} - c\mu_s g$

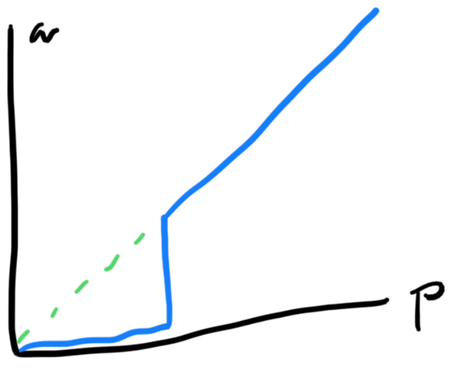
A



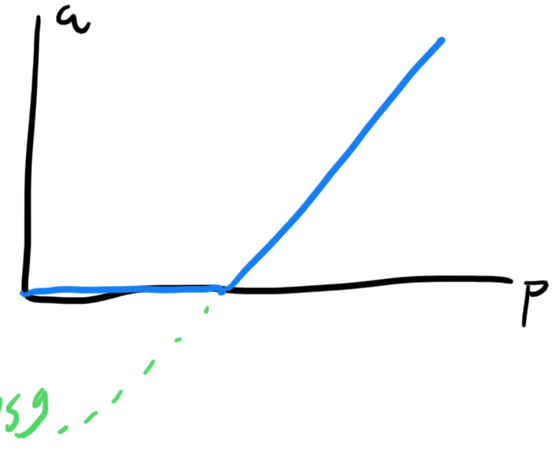
slope: $1/m$

int: $-c\mu_s g$

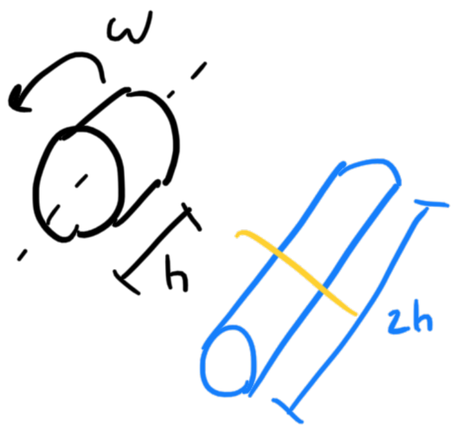
B



C



#17



ρ σ r ~~h~~

indep of h

ρ ↑

Pa

max $\frac{KE}{kg}$?

$\rho\sigma/r = \frac{kg}{m^3}\ \frac{kg}{ms^2}\ \frac{1}{m}$

$= kg \cdots$

$\sigma/\rho = \frac{kg}{ms^2} \cdot \frac{m^3}{kg}$

$= m^2/s^2$ ✓

$= [m^2/s^2]$

(E)

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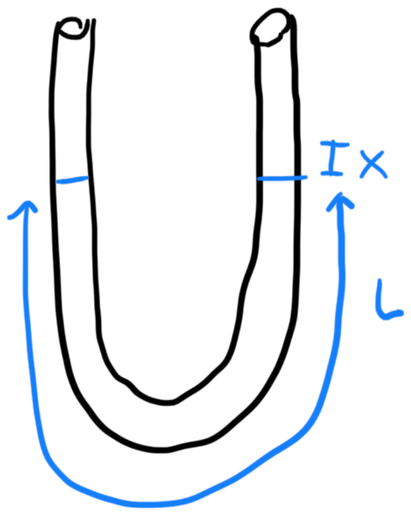

$q = ?$

Dimensional Analysis:

A or B

$T \sim 2\pi \Rightarrow \omega \sim 1/2\pi \Rightarrow$ (A)

As a spring:

$m = \rho_w L A$

$T = 2\pi\sqrt{\frac{m}{k}}$

$= 2\pi\sqrt{L/2g}$

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

$= 2\rho_w A g$

$q = \frac{1}{2\pi}\sqrt{\frac{2g}{L}}$ (A)

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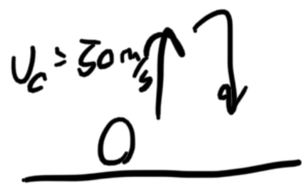

$C = 90\%$

$\Rightarrow v_{bounce} = 0.9\, v_{init}$

$T_n = \frac{2v_n}{g}$

$v_n = C^n v_0 \qquad v_0 = 50\ m/s$

$T = \sum_{n=0}^{\infty} T_n = \sum \frac{2v_n}{g} = \frac{2v_0}{g} \sum_{n=0}^{\infty} C^n$

$1 + a + a^2 + a^3 + \cdots = \frac{1}{1-a} \qquad |a| < 1,$

$T = \frac{2v_0}{g(1-C)} = \frac{2 \cdot 50\ m/s}{10 \cdot (1-0.9)} = 100\ s$

(B)

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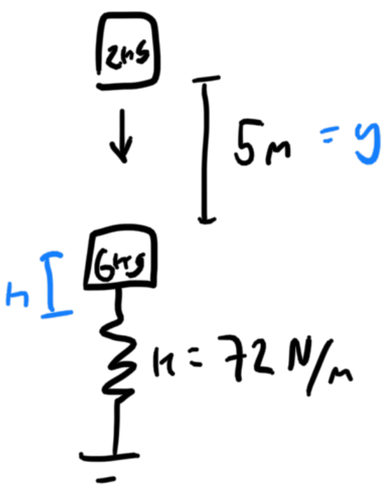

$\Delta x_{max} = ?$

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

$$F_s = m_2 g \Rightarrow kh = -m_2 g \qquad h = \frac{-m_2 g}{k}$$

$$m_1 g y = \frac{m_1 v^2}{2} \Rightarrow v_1 = \sqrt{2gy}$$

$$w = \frac{m_1 v}{m_1 + m_2} = \frac{m_1\sqrt{2gy}}{m_1 + m_2}$$ after collision

immediately:

$$E_{k_1} + E_{s_1} + E_{g_1} = \frac{(m_1+m_2)w^2}{2} + \frac{1}{2}kh^2 + 0$$

lowest point:

$$E_{k_2} + E_{s_2} + E_{g_2} = 0 + \frac{1}{2}k(h+x)^2 + (m_1+m_2)gx$$

$$\frac{(m_1+m_2)w^2}{2} = \frac{1}{2}kx^2 + m_1 g x \qquad x = -1.156\ m$$

(B)

24

$v = \sqrt{T/(m/L)}$

$r_1 \qquad r_2 = \eta r_1$

$q_1/q_2 = ?$

$T > \sigma A$

$T = \sigma A$

$v = \sqrt{\frac{TL}{M}} = \sqrt{\frac{\sigma A L}{M}} = \sqrt{\frac{\sigma}{\rho}}$

$v = qx$

$q = \frac{2v}{L} = \frac{2}{L}\sqrt{\frac{\sigma}{\rho}} \quad \not< r$

(A)

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middle spring not expanding or contracting.

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

$$x_A = x_B = x_0 \sin \omega_1 t$$

$$x_A = -x_B = x_0 \sin \omega_2 t$$

$$k' = k + 2k = 3k$$

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

$$\omega_2/\omega_1 = ?$$

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

(A)