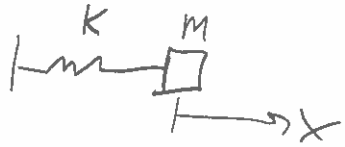
PHYS 1311 EOC problems

Chapter 4, Part II

Problems: P51, P53, P55, P57, P61 2-24-2016

Problem P51



$m = 2.2\ kg$

$k = 8\ N/m$

$x_i = +0.18\ m$, $V_i = 0$, $t_i = 0$

$t_f = 1.15\ s$

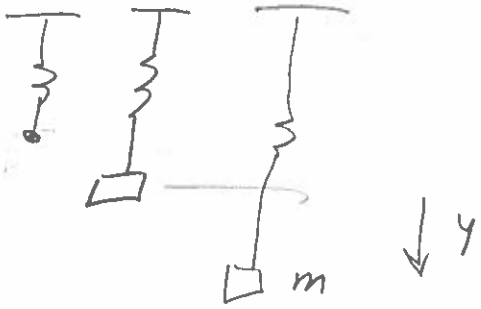
$x(t) = A\cos(\omega t + \phi)$ $\quad A = 0.18,\ \phi = 0$

$\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{8}{2.2}} = 1.9069\ rad/s$

$= (0.18\ m)\cos\left[\left(1.16064\ \frac{rad}{s}\right)(1.15\ s)\right]$

$= \boxed{-0.105\ m}$

Problem P53



$T_1 = 2.1\ s$, $A = y_1 = 1.7\ cm$

$y(t) = A\cos(\omega_1 t)$

$\omega_1 = \sqrt{\frac{k_1}{m_1}} = 2\pi f_1 = \frac{2\pi}{T_1}$

$m_2 = 6m_1$ $\quad k_2 = 10k_1$ $\quad g = 6.8\ N/kg$

$y_2 = 3.3\ cm$

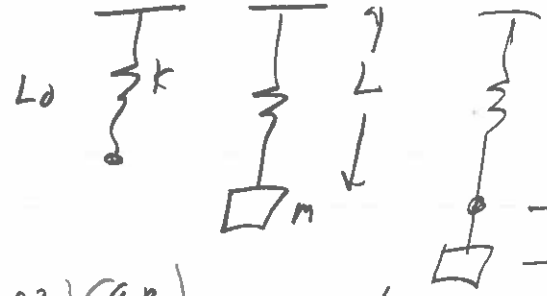
$\omega_2 = \sqrt{\frac{k_2}{m_2}} = \frac{2\pi}{T_2} = \sqrt{\frac{10k_1}{6m_1}} = \sqrt{\frac{5}{3}}\sqrt{\frac{k_1}{m_1}} = \sqrt{\frac{5}{3}}\frac{2\pi}{T_1}$

$\frac{T_2}{2\pi} = \sqrt{\frac{3}{5}}\frac{T_1}{2\pi} \Rightarrow T_2 = \sqrt{\frac{3}{5}}T_1 = \sqrt{\frac{3}{5}}(2.1) = \boxed{1.63\ s}$

chapter 4, part II

2-24-7 of 6

Problem P55



$m = 0.03\,kg$
$L_0 = 0.18\,m$
$L = 0.22\,cm$
$y = 0.01\,cm$

$L - L_0 = s$

$ks = mg$

$k = \frac{mg}{s} = \frac{(0.03)(9.8)}{0.22 - 0.18} = 7.35\,N/m$

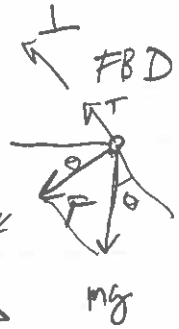
$T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{0.03\,kg}{7.35\,N/m}} = \boxed{0.40\,s}$

Problem P57 $A = 0.06\,m$, $T = 0.4\,s$

a) $v_{max} = A\omega = A\frac{2\pi}{T} = \frac{(0.06\,m)\,2\pi}{0.4\,s} = \boxed{0.943\,m/s}$

b) $a_{max} = A\omega^2 = A\frac{4\pi^2}{T^2} = \frac{(0.06\,m)\,4\pi^2}{(0.4)^2} = \boxed{1480\,m/s^2}$

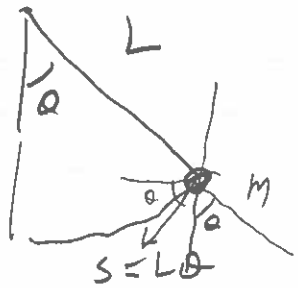
Problem P61



a) $\Sigma F_{\parallel} = -mg\sin\theta$

or since $\Delta\vec{p} = \vec{F}_{net}\Delta t$ ∥

or $\frac{\Delta\vec{p}}{\Delta t} = \vec{F}_{net} \rightarrow \frac{d\vec{p}}{dt}$



$\left.\frac{d\vec{p}}{dt}\right|_{\parallel} = -mg\sin\theta\,\hat{p} = \boxed{-mg\sin\left(\frac{s}{L}\right)\hat{p}}$

b) For small θ, $\sin\theta \approx \theta$

chapter 4, part II

Problem P61 (cont'd)

$$\frac{dp}{dt} \approx -mg\theta \approx -mg\frac{s}{L} \qquad \text{for small } \theta$$

or $m\frac{dv}{dt} + \frac{mg}{L}s = 0$ $\qquad v_{\parallel} = \frac{ds}{dt}$

$$\frac{dv}{dt} = \frac{d}{dt}\left(\frac{ds}{dt}\right) = \frac{d^2s}{dt^2}$$

or $\boxed{\frac{d^2s}{dt^2} + \left(\frac{g}{L}\right)s = 0}$

SHM equation $\rightarrow$ $\frac{d^2x}{dt^2} + \omega^2 x = 0$

c) then $\omega^2 = \frac{g}{L}$ or $\omega = \sqrt{\frac{g}{L}} = \frac{2\pi}{T}$

or $\boxed{T = 2\pi\sqrt{\frac{L}{g}}}$