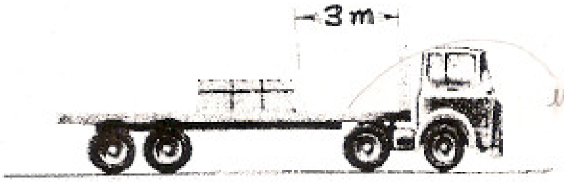
95/100 AH !! Great job!

92/100

Name Helen Chen

ME104 Section 1 Fall'07 Midterm Exam #1.
Closed book and notes, one formula sheet supplied, 80 minutes

1. The coefficient of static friction between the flat bed of the truck and the crate it carries is 0.30. Determine the minimum stopping distance s that the truck can have from a speed of 70 km/h with constant deceleration if the crate is not to slip forward.



$\mu = 0.30$

if crate is not to slip, it should carry same acceleration as truck. ✓

for the truck:

$v_f^2 = v_i^2 + 2ad$ ✓

$0 = (70\ \frac{km}{hr})^2 - 2a_T(s)$

$a_T = \frac{70^2}{2s}\ km/hr^2 = \frac{(70\frac{km}{hr}\cdot\frac{1000m}{1km}\cdot\frac{1hr}{3600s})^2\ m/s^2}{2s} = \frac{189.04}{s}\ m/s^2$

FBD of box.

$\mu N = F_f$ ✓

x direction:

$F_f = \mu mg = ma_T$ ✓

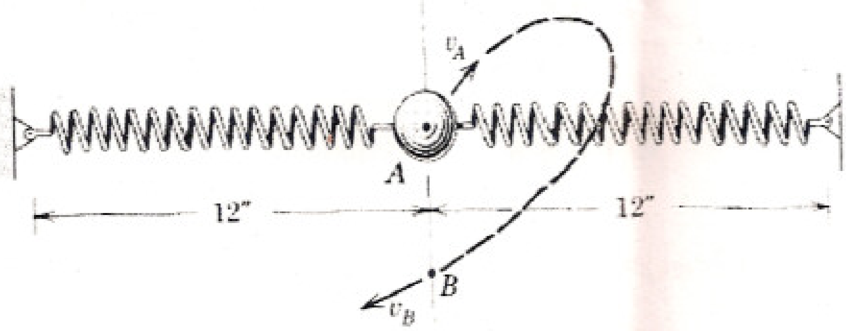
$\left(\frac{189.04}{s}\ m/s^2\right) = (0.30 \cdot 9.8\ m/s^2)$

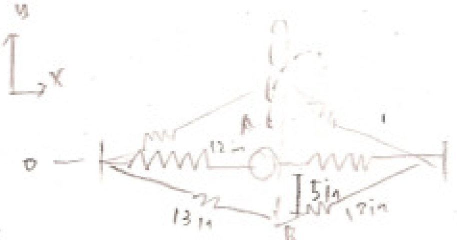
$\boxed{s = 64.30\ m}$ ✓

25

Name Helen Chow

2. The 3-lb ball is given an initial velocity $v_A = 8$ ft/sec in the vertical plane at position A, where the two horizontal attached springs are unstretched. The ball follows the dotted path shown and crosses point B which is 5 in. directly below A. Calculate the velocity v_B. Each spring has a stiffness of 10 lb/in.





Conservation of energy ✓

$KE_1 + PE_1 = KE_f + PE_f$ ✓ ✓

$\frac{1}{2}mv_i^2 + mgh_0 + \frac{1}{2}kx^2 = \frac{1}{2}mv_f^2 + mgh_0 + \left(\frac{1}{2}kx_f^2\right)2$

$\frac{1}{2}\left(\frac{3\text{ lb}}{32.2\text{ ft/s}^2}\right)(8\text{ ft/s})^2 = \frac{1}{2}\left(\frac{3\text{ lb}}{32.2\text{ ft/s}^2}\right)(v_f)^2 + \left(\frac{3\text{ lb}}{32.2\text{ ft/s}^2}\right)(32.2\text{ ft/s}^2)\left(\frac{-5}{12}\text{ ft}\right) + 2\cdot\frac{1}{2}\left(10\frac{\text{lb}}{\text{in}}\right)\left(\frac{1}{12}\text{ ft}\right)\ldots$ ✓

inconsistent units

$v_f = 9.45$ ft/s in vertical direction ↑

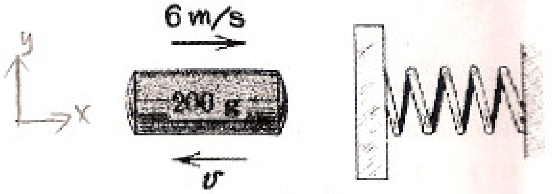
$v_B = 9.45$ ft/s $\hat{j}$ ↑ ✗

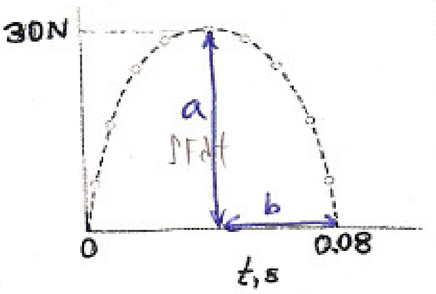
−2

23

Name Helen Chow

3. Careful measurements made during the impact of the 200-g metal cylinder with the spring-loaded plate reveal a semi-elliptical relation between the contact force F and the time t of impact as shown. Determine the rebound velocity v of the cylinder if it strikes the plate with a velocity of 6 m/s.





③ in the x-direction:

$mv_0 + \int F dt = m v_f$ ✓

$(0.2\,kg)(6\,m/s) - ~~1.6~~\ 1.885\ N{\cdot}s = (0.2\,kg)\,v_f$

$v_f = -2.0\ m/s$ ←

$\therefore\ V = 2.0\ m/s$ ←

$V = 3.425\ m/s$ to the left

① equation for Force:

$y = -kx^2$

$F = -k(t-0.04)^2 + 30$

$t=0,\ F=0$ $\quad 0 = -k(-0.04)^2 + 30$ not parabola, semi-ellipse

$k = 18750$

$F = -18750(t-0.04)^2 + 30$

$\int F dt = \frac{\pi a b}{2} = \frac{\pi(30)(0.04)}{2} = 1.885$

Area error (-3)

② then $\int F dt = \int -18750(t+0.04)^2 + 30\ dt$

$= \int -18750(t^2 + 0.08t + 0.0016) + 30\ dt$

$= -18750\left(\frac{t^3}{3} + \frac{0.08t^2}{2} + 0.0016t\right) + 30t \Big|_0^{0.08}$

$\int F dt = ~~1.6~~\ N{\cdot}s$ 1.885

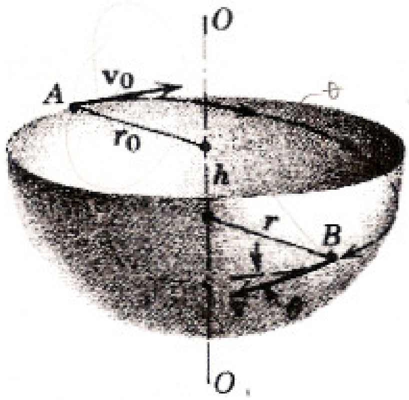
22/25

Name Helen Chow

4. A small mass particle is given an initial velocity v_o tangent to the horizontal rim of a smooth hemispherical bowl at a radius r_o from the vertical centerline, as shown at point A. As the particle slides past point B, a distance h below A and a distance r from the vertical centerline, its velocity v makes an angle θ with the horizontal tangent to the bowl through B.

a). Is the vector angular momentum conserved? Show why.

b) Determine θ.



+3

(A) ~~vector~~ scalar angular momentum about the O O' axis is conserved since the only forces acting on the particle is gravity and normal force, neither produces a moment about the OO' axis

Fn always pt. to the center and passes OO'

mg

vector angular momentum not cons.

Only scalar component cons.

about OO'

(B) $m v_o \times r_o = m v_f \times r$

$m v_o r_o = m v \cos\theta \, r$ +4

$\theta = \cos^{-1}\left(\frac{v_o r_o}{v r}\right)$ where $r = \sqrt{r_o^2 - h^2}$ ✓

$\theta = \cos^{-1}\left(\frac{v_o r_o}{v\sqrt{r_o^2 - h^2}}\right)$

conservation of energy ∴ normal force does not work

$KE_o + PE_o = KE_f + PE_f$

$\frac{1}{2} m v_o^2 + mgh = \frac{1}{2} m v^2 + 0$

$\sqrt{2\left(\frac{v_o^2}{2} + gh\right)}$

$v = \sqrt{v_o^2 + 2gh}$ ✓

$\theta = \cos^{-1}\left(\frac{v_o r_o}{\sqrt{(v_o^2 + 2gh)(r_o^2 - h^2)}}\right)$ ✓

AH

35/35

~~32/35~~