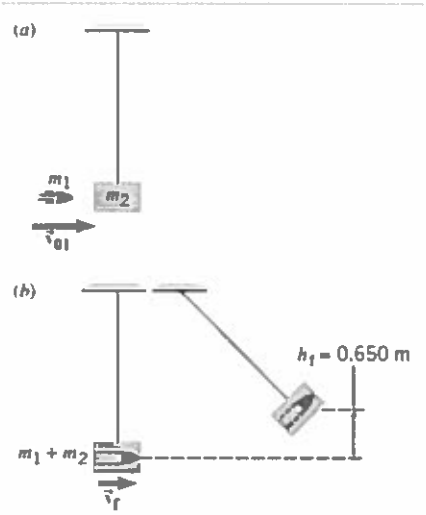
Physics 10154 - Exam #3C

Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct units and significant figures.

1. (30 pts) A 13.0 gram bullet is fired into a 2.43-kg block of wood initially at rest, connected to a string as a pendulum bob. After the collision, the bullet becomes embedded in the block, and the block rises to a maximum height of 0.650 m as shown. Assume that frictional forces do -3.50 J of work during the bullet-block rising motion. What is the initial speed of the bullet before the collision?



Pendulum

$\Sigma W_F = W_g + W_{Fric} = \Delta K$

$-mgh - 3.50 = 0 - \frac{1}{2}mv_0^2$

$-(2.443)(9.8)(.65) - 3.50 = -\frac{1}{2}(2.443)v_0^2$

$-15.56 - 3.50 = 1.2215 v_0^2$

$v_0^2 = 15.6$

use as v_f for collision $\rightarrow$ $v_0 = 3.95$ m/s

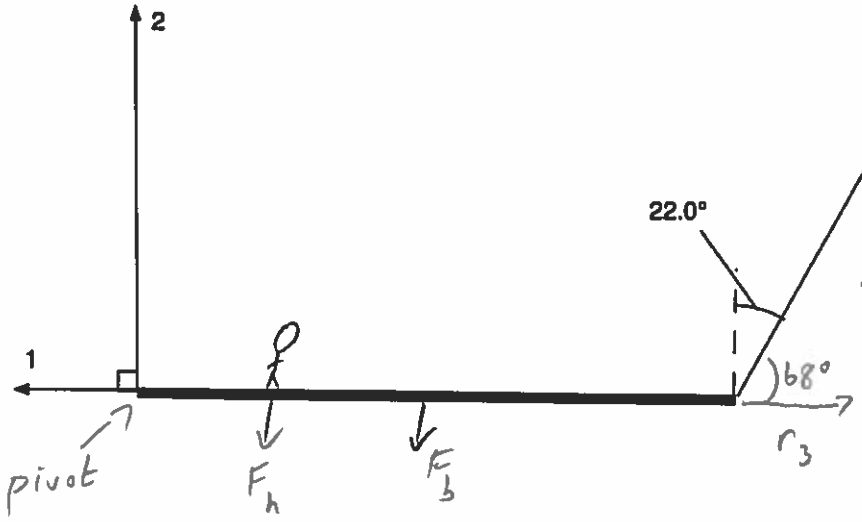
Collision:

$m_1 v_{1i} + 0 = (m_1 + m_2) v_f$

$.013 v_{1i} = 2.443(3.95)$

$\boxed{v_{1i} = 742 \text{ m/s}}$

2. (35 pts) A 925-N hiker is crossing a small horizontal bridge. The bridge is uniform and weighs 4210 N. The bridge has 3 numbered supporting ropes, as shown. The hiker stops 1/4 of the way from the left end of the bridge. What is the magnitude of the force that each rope exerts on the bridge? Answer with 3 SF.



$\tau_h = -(.25\ell)(925)\sin 90°$

$\tau_b = -(.50\ell)(4210)\sin 90°$

$\tau_3 = +(\ell)F_3 \sin 68°$

$\Sigma F_x = F_3 \cos 68° - F_1 = 0$

$\Sigma F_y = F_2 + F_3 \sin 68° - 925 - 4210 = 0$

$\Sigma \tau = \tau_h + \tau_b + \tau_3 = 0$

$= -(.25\ell)(925) - (.50\ell)(4210) + \ell F_3 \sin 68° = 0$

$= -231.25 - 2105 + .927 F_3 = 0$

$\boxed{F_3 = 2520\ N}$

$F_1 = F_3 \cos 68° = \boxed{944\ N}$

$F_2 = 5135 - F_3 \sin 68° = \boxed{2800\ N}$

3. (35 pts) A 1.45-kg mass is attached to one end of a spring (k = 1330 N/m) with the other end of the spring fixed in place. An applied force stretches the spring to a length of 22.0-cm from equilibrium, then releases the mass from rest to oscillate back and forth on a horizontal, frictionless surface.

a) How much time does it take for the system to complete 25.0 oscillations?
b) If x = 0 represents equilibrium, for what value of x is the mass moving with 75% of its maximum speed?
c) For what value of x is the kinetic energy equal to 20% of the total mechanical energy?

a) $\omega = \sqrt{\frac{k}{m}} \Rightarrow T = 2\pi\sqrt{\frac{m}{k}} = 0.20746\ s$

$t = 25T = \boxed{5.19\ s}$

b) If $V = 0.75 V_{max}$, then $K = 0.5625 K_{max}$ or $0.5625E$

so $U = .4375E$ since $K + U = E$

$\frac{1}{2}kx^2 = .4375\left(\frac{1}{2}kA^2\right)$

$x = \sqrt{.4375}\,A = \boxed{14.6\ cm}$

c) If $K = .2E$, then $U = 0.8E$

$\frac{1}{2}kx^2 = 0.8\left(\frac{1}{2}kA^2\right)$

$x = \sqrt{0.8}\,A = \boxed{19.7\ cm}$