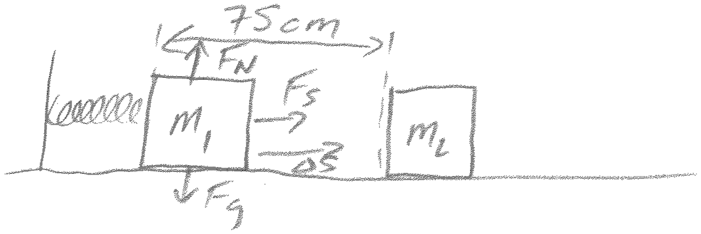
Physics 10154 - Exam #3c

Partial credit will be given provided you show all work and are solving parts of the problem correctly. 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 spring launcher has a spring constant k = 240 N/m and is compressed 75 cm from its equilibrium position by a 3.2 kg mass on a flat, frictionless surface. The system is released from rest, and after the mass leaves the spring, it has a collision with a 5.8 kg mass. After the collision, the 3.2 kg mass rebounds with a speed of [redacted] 1.8 m/s in the direction [redacted] opposite its original direction of motion. What is the velocity (magnitude and direction) of the [redacted] 5.8 kg mass after the collision?



starts at rest

Part 1: Spring

$W_N = 0$

$W_g = 0$

$W_s = \frac{1}{2}kx^2$

$$0+0+\frac{1}{2}kx^2 = \frac{1}{2}mv^2 - \cancelto{0}{\frac{1}{2}mv_0^2}$$

$$\frac{1}{2}kx^2 = mv^2$$

$$v = \sqrt{\frac{kx^2}{m}} = 6.495 \text{ m/s}$$ $= v_0$ for part 2

Part 2: Collision

$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$$

$$(3.2)(6.5) + (5.8)(0) = (3.2)(-1.8) + (5.8)v_{2f}$$

$$20.78 = -5.76 + (5.8)v_{2f}$$

$$v_{2f} = \frac{26.54}{5.8} = \boxed{4.6 \text{ m/s}}$$

2. (35 pts) A 350 gram ball is dropped from rest at a height of 2.1 meters, and it rebounds vertically up to a maximum height of 1.7 meters. If the ball is in contact with the floor for 0.025 seconds, what is the <u>magnitude and direction</u> of the average force exerted by the floor on the ball during that time interval?

Falling (Part 1)

$\Delta y = -2.1 m$

$V_0 = 0$

$V = ?$

$a = -9.8\ m/s^2$

$t = ?$

$v^2 = v_0^2 + 2a\Delta y$

$v^2 = 0 + 2(-9.8)(-2.1)$

$v = -6.416\ m/s$

Rising (Part 3)

$\Delta y = 1.7\ m$

$V_0 = ?$

$V = 0$

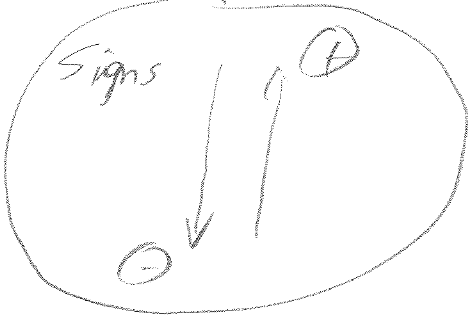
$a = -9.8\ m/s^2$

$t = ?$

$v^2 = V_0^2 + 2a\Delta y$

$0 = V_0^2 + 2(-9.8)(1.7)$

$V_0 = +5.772\ m/s$



Part 2: Collision with floor

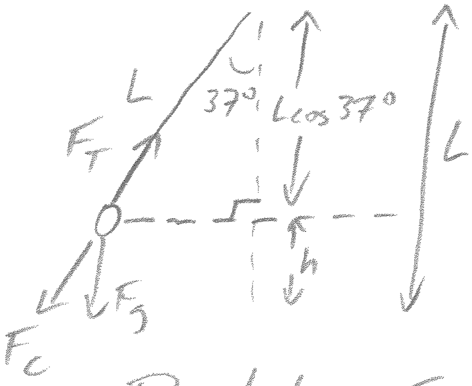
$$\Delta p = \underset{\substack{\nearrow \\ V_0 \text{ from pt } 3}}{mv} - \underset{\substack{\uparrow \\ v \text{ from part } 1}}{mV_0}$$

$\Delta p = (.350)(5.772) - (.350)(-6.416)$

$= +4.3\ kg \cdot m/s$

$F = \dfrac{\Delta p}{\Delta t} = \dfrac{4.266}{.025} = \boxed{170\ N,\ up}$

3\. (35 pts) A 45 kg pendulum bob is attached to a 3.1 meter long string and held at rest with the string making a 37° angle with respect to the vertical. The maximum tension that the string can withstand is 680 Newtons. When the pendulum passes through the lowest point of its motion, does the string break? Justify your answer.



$L = L\cos 37° + h$

$h = L - L\cos 37°$

$= 0.624\,m$

Pendulum Falling:

$W_T = 0$

$W_c = 0$

$W_g = mgh$

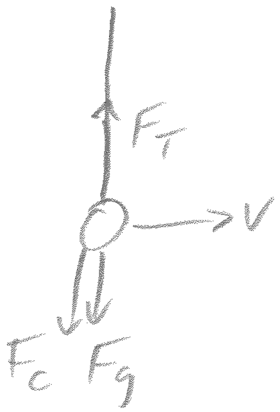
$0 + 0 + mgh = \frac{1}{2}mv^2 - \overset{0}{\cancel{\frac{1}{2}mv_0^2}}$

starts from rest

$v = \sqrt{2gh}$

$= 3.5\ m/s$

At bottom:



$\Sigma F_{rad} = F_c + F_g - F_T = 0$

$\frac{mv^2}{r} + mg = F_T$

$177.6 + 441 = \boxed{620\,N}$

$F_T = 620 < 680 \quad (F_{T,MAX})$

so string does not break.