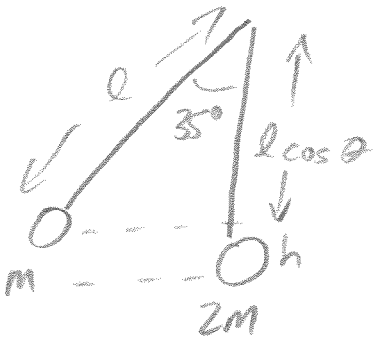
Physics 10154 - Exam #3c

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 mass M is initially at rest, connected to a 2.0 meter long string initially 35° angled from the vertical. The mass is released, and at the bottom of its motion, it collides and sticks to a mass 2M. After the collision, to what maximum height do the combined masses rise?



$h = 2 - 2\cos 35°$

$= 0.362\ m$

$W_f = 0$ $\quad K_0 = 0$

Part 1: $\Sigma W_f = W_{grav} = \frac{1}{2}mv^2 - 0$

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

$v = \sqrt{2gh} = 2.66\ m/s$

Part 2: $M(2.66) + 2M(0) = 3M v_f$

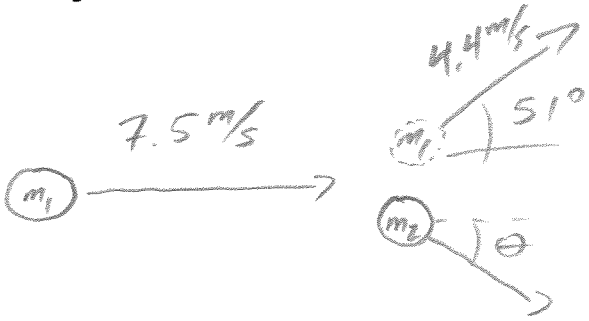
$2.66 = 3v_f$

$v_f = 0.888\ m/s$

Part 3 $\quad mgh = \frac{1}{2}mv_0^2$

$h = \frac{v_0^2}{2g} = \frac{(.888)^2}{2(9.8)} = \boxed{.040\ m}$

2. (30 pts) A 120 gram puck slides with a velocity of 7.5 m/s in the +x direction across a frictionless surface and strikes a 320 gram mass, initially at rest. After the collision, the puck deflects off the larger mass with a speed of 4.4 m/s at an angle 51° above +x. What is the magnitude and direction of the velocity of the larger mass after the collision?



$$x: \quad m_1 v_{1i,x} + m_2(0) = m_1 v_{1f,x} + m_2 v_{2f,x}$$

$$(.120)(7.5) = (.120)(4.4\cos 51°) + (.320) v_{2f,x}$$

$$0.900 = 0.332 + .320\, v_{2f,x}$$

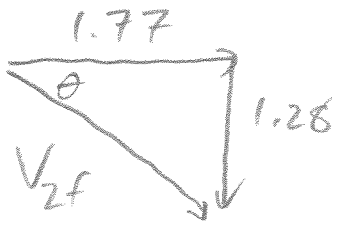
$$v_{2f,x} = 1.77 \text{ m/s}$$

$$y: \quad m_1(0) + m_2(0) = m_1 v_{1f,y} + m_2 v_{2f,y}$$

$$0 = (.120)(4.4\sin 510) + (.320) v_{2f,y}$$

$$0 = 0.410 + .320\, v_{2f,y}$$

$$v_{2f,y} = -1.28 \text{ m/s}$$

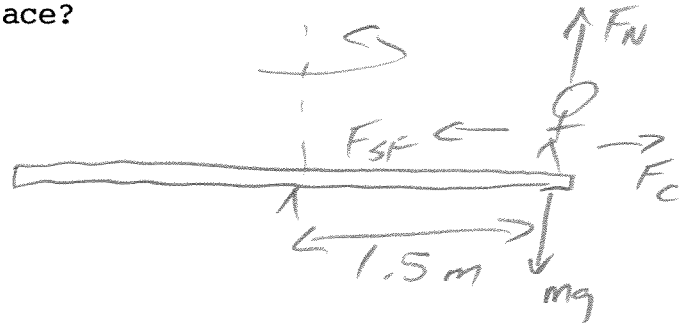


$$|v_{2f}| = \sqrt{1.77^2 + 1.28^2} = 2.19$$

$$\theta = \tan^{-1}\left(\frac{1.28}{1.77}\right) = 35.9°$$

$$\boxed{v_{2f} = 2.2 \text{ m/s}, \ 36° \text{ below } +x}$$

3. (40 pts) A 45 kg child is standing on a merry-go-round with a radius of 1.5 meters. The merry-go-round is completing a revolution every 5.0 seconds. If the girl is on the verge of slipping off, being pushed out radially by the motion, what must be the coefficient of static friction between her shoes and the surface?



$\omega = 0.2 \frac{rev}{sec}$

$= 1.26 \ rad/sec$

$v = r\omega$

$= 1.89 \ m/s$

$$\Sigma F_{rad} = \frac{mv^2}{r} - \mu_s F_N = 0$$

F_N on the verge of slipping

$$\frac{mv^2}{r} - \mu_s mg = 0$$

$$\mu_s = \frac{v^2}{rg} = \frac{(r\omega)^2}{rg} = \frac{r\omega^2}{g}$$

$$\mu_s = \frac{(1.5)(1.26)^2}{9.8} = \boxed{0.24}$$