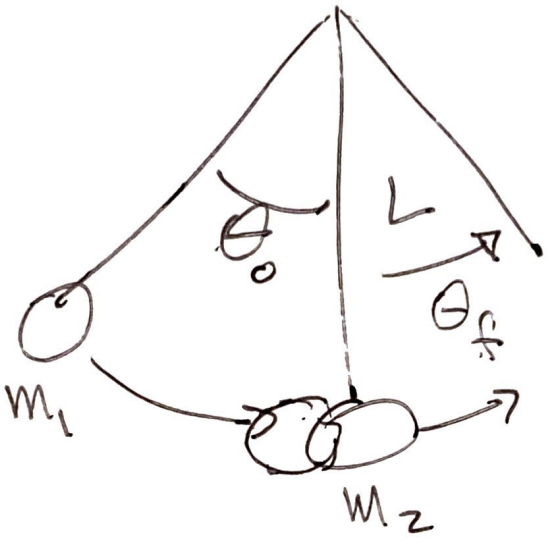
ENGR 212 Sample Prob Bruce

Given:



$m_1 = m_2 = m = .225$ kg

$\theta = 35^\circ$

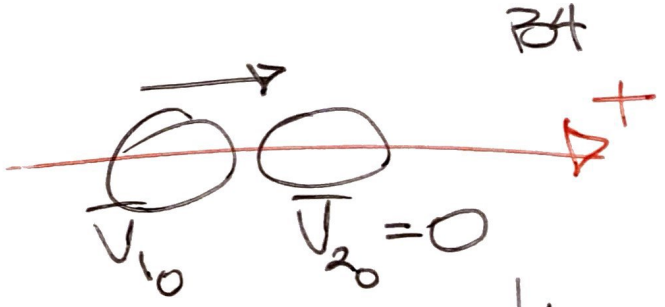
$e = .9$

$L = 15$ cm

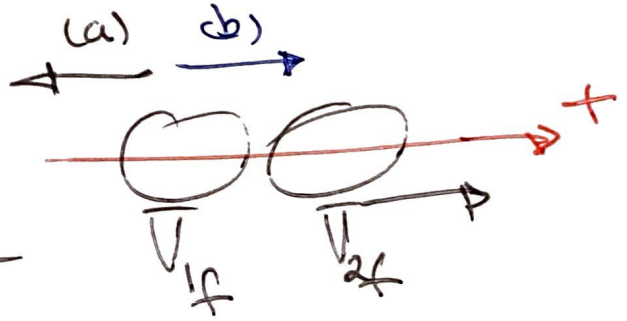
Req'd: final θ

Assump linear collision, g

Strategy Energy to find V_{1_0}
then bar charts + e



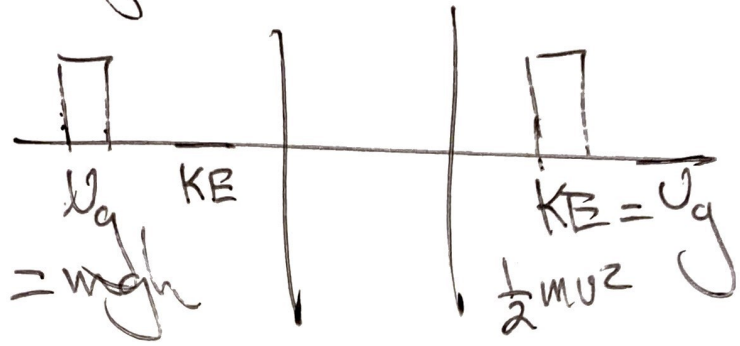
Estimate If collision were elastic
($e = 1$) then $\theta_f = \theta_0$ &
$V_{1_f} = 0$ (stops) from experience
expect θ_f just less than θ_0



V_{1_f} = small. (not sure which direction!)

Soln:

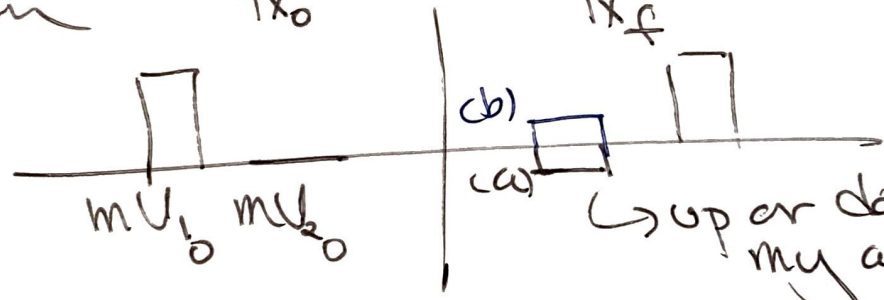
Energy



$mgh = \frac{1}{2}mv^2 \Rightarrow v = \sqrt{2gh}$

collision

$\overline{P}_{x_0}$ $\overline{P}_{x_f}$



↳ up or down depending on my assumed direction.

(a) $m_1v_{1_0} + 0 = m_1v_{1_f} + m_2v_{2_f} \Rightarrow v_{1_0} = v_{2_f} - v_{1_f}$

2 unk

(b) $m_1v_{1_0} + 0 = m_1v_{1_f} + m_2v_{2_f}$ $\quad v_{1_0} = v_{2_f} + v_{1_f}$

$$e = \frac{|v_{2/1,\,final}|}{|v_{2/1\,initial}|} = \frac{|v_{2_f} + v_{1_f}|}{v_{1_0}} \text{ or } |v_{2_f} - v_{1_f}| \leftarrow \text{depending on assumptions}$$

Scenario

(a)

$$\begin{cases} V_{1_0} = V_{2_f} - V_{1_f} \\ .9 = \dfrac{V_{2_f} + V_{1_f}}{V_{1_0}} \end{cases}$$

$$.9\left[V_{2_f} - V_{1_f}\right] = V_{2_f} + V_{1_f}$$

$$-1.9 V_{1_f} = .1 V_{2_f}$$

$$V_{1_f} = -\frac{.1}{1.9} V_{2_f}$$

(b)

$$\begin{cases} V_{1_0} = V_{2_f} + V_{1_f} \\ .9 = \dfrac{V_{2_f} - V_{1_f}}{V_{1_0}} \end{cases}$$

$$.9\left[V_{2_f} + V_{1_f}\right] = V_{2_f} - V_{1_f}$$

$$1.9 V_{1_f} = .1 V_{2_f}$$

$$V_{1_f} = \frac{.1}{1.9} V_{2_f}$$

same value

but (a) was assumed in "wrong" direction!!

$$\Rightarrow V_{1_0} = V_{2_f} + \frac{1}{19} V_{2_f} = 1.053\, V_{2_f}$$

$$\frac{\sqrt{2gh}}{1.053} = V_{2_f} = \frac{\sqrt{2 \cdot 9.81 \text{ m/s}^2 \cdot (.15\text{m} \cos 35^\circ)}}{1.053}$$

Soln: cont

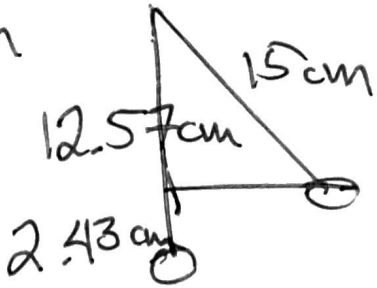
$$V_{2f} = \frac{\sqrt{2 \cdot 9.81 (.15 - .15\cos 30^\circ)\ m^2/s^2}}{1.053} \quad .027\ m$$

$$= \frac{.532}{1.053}\ m/s = .69\ m/s = V_{2f}$$

$V_{1_0} = .73\ m/s$ $\quad$ $V_{1f} = .036\ m/s$

to find how far ball swings just do same energy problem from beginning $\sqrt{2gh_f} = V_{2f}$

$$\Rightarrow h_f = \frac{V_{2f}^2}{2g} = \frac{(.69(m/s)^2)}{2 \cdot 9.81\ m/s^2} = .0243\ m$$



$$\theta = \cos^{-1}\frac{12.57\text{cm}}{15\text{cm}} = 33^\circ = \theta_f$$

Whew! Discussion: Many small errors to catch and lots of conceptual thinking. In the end it all feels consistent and reasonable for 15cm pendulum