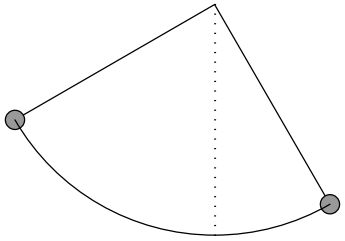
3. (40 pts.) Two clay balls are suspended from strings of length L as shown in the figure. The ball on the left has mass m_1 and is held at an initial angle of 60° from the vertical. The ball on the right has mass m_2 and is held at an initial angle of 30° from the vertical. The balls are released from rest (first m_1 and then m_2) such that they collide and stick together at the bottom and remain at rest.

a. (10 pts.) For each fundamental physics principle that you use, explain very briefly what principle you are using and why it is valid to use it.

b. (20 pts.) What is the ratio $\frac{m_1}{m_2}$?



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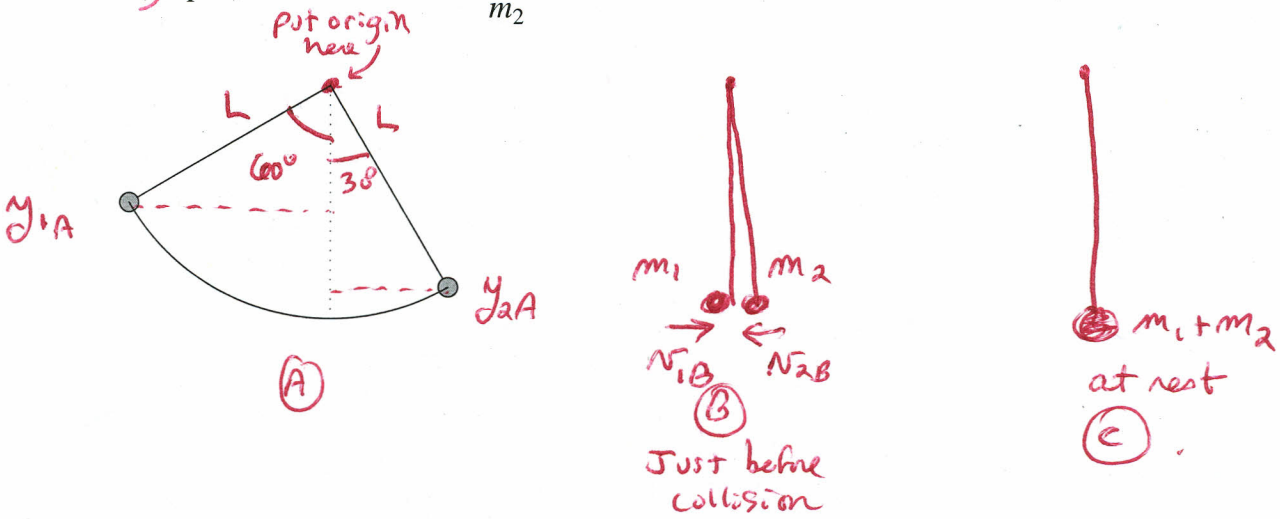
a. (10 pts.) For each fundamental physics principle that you use, explain very briefly what principle you are using and why it is valid to use it.

b. (30 pts.) What is the ratio $\frac{m_1}{m_2}$?



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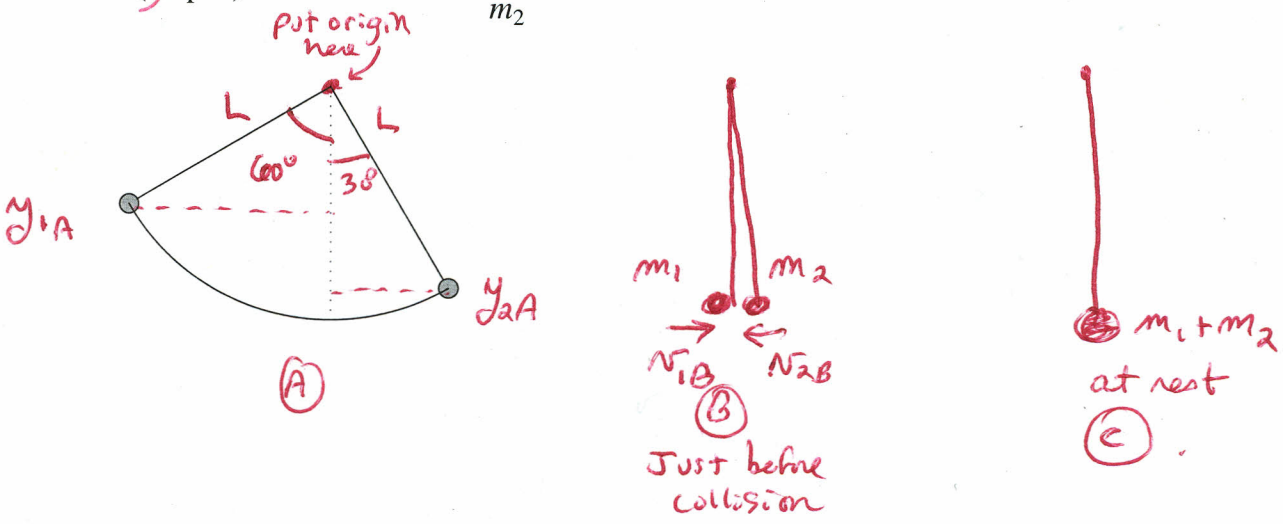

A → B Conserve energy. The only force that does work is gravity, which is conservative. First, look at m_1.

$$E_{1A} = E_{1B}$$

$$m_1 g y_{1A} + 0 = m_1 g y_{1B} + \tfrac{1}{2} m_1 v_{1B}^2$$

$$m_1 g(-L\cos 60^\circ) = m_1 g(-L) + \tfrac{1}{2} m_1 v_{1B}^2$$

$$\sqrt{2gL(1-\cos 60^\circ)} = v_{1B}$$

. Similarly, $v_{2B} = -\sqrt{2gL(1-\cos 30^\circ)}$.

B → C conserve momentum. The collision is sufficiently rapid that $\Sigma F_{ext} = 0$ during it.

$$m_1 v_{1B} + m_2 v_{2B} = 0$$

$$\frac{m_1}{m_2} = \frac{-v_{2B}}{v_{1B}} = \frac{\sqrt{2gL(1-\cos 30^\circ)}}{\sqrt{2gL(1-\cos 60^\circ)}} = \sqrt{\frac{1-\cos 30^\circ}{1-\cos 60^\circ}} = \boxed{0.518}$$