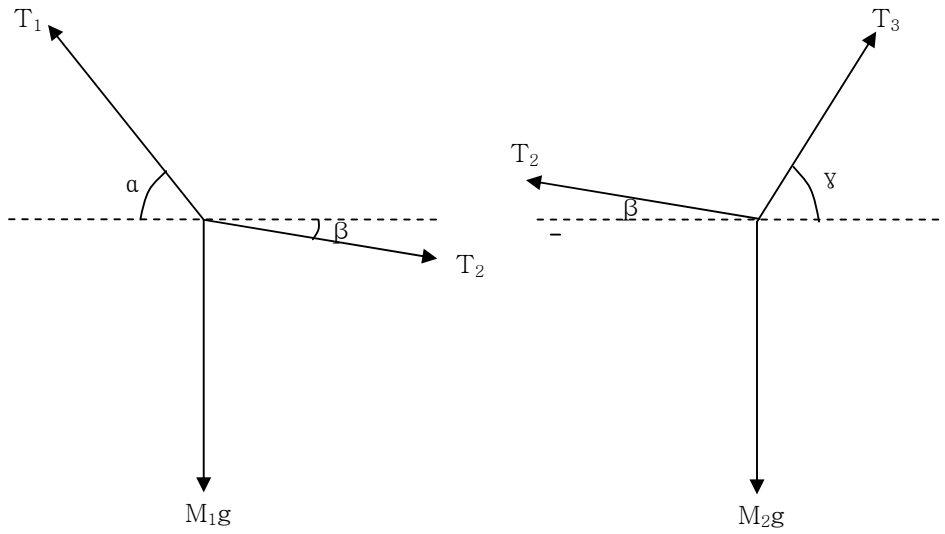
Physics 1A Quiz2 Solution

Problem 1.

Part (a) Free body diagram:

For the point A: For the point B:



Part (b) and (c)

Equation of motion for point A:

$$T_1 \sin\alpha - T_2 \sin\beta - M_1 g = 0$$

$$T_1 \cos\alpha - T_2 \cos\beta = 0$$

Equation of motion for point B:

$$T_2 \sin\beta + T_3 \sin\gamma - M_2 g = 0$$

$$T_2 \cos\beta - T_3 \cos\gamma = 0$$

From the above four equations, we can find tensions in terms of angles and mass 1 and mass2:

$$T_1 = \frac{M_1 g \cos\beta}{\sin(\alpha-\beta)}, \quad T_2 = \frac{M_1 g \cos\alpha}{\sin(\alpha-\beta)}, \quad T_2 = \frac{M_2 g \cos\gamma}{\sin(\beta+\gamma)}, \quad T_3 = \frac{M_2 g \cos\beta}{\sin(\beta+\gamma)},$$

Since mass 1 is unknown, we first obtain T3 and T2 from the last two expressions. Then mass 1 can be found from the second expression of tension 2, and finally we can get tension 1.

T_3=55.7(N), T_2=36.4(N), M_1=2.42 (kg), T_1 = 36.4 (N)

Problem 2

Part (a)

(1): $d_1 = (v_0 \cos\theta)t_1$

(2): $0 = (v_0 \sin\theta)t_1 - \frac{1}{2} g {t_1}^2$

From Eq(2) we can find $t_1 = \frac{2v_0 \sin\theta}{g}$, $\therefore d_1 = \frac{2{v_0}^2 \sin\theta\cos\theta}{g}$

Part (b)

$$v_2(t_2) = 0 = v_0\cos\theta - at_2 = v_0\cos\theta - \frac{g\sqrt{3}}{4}t_2, \ \therefore t_2 = \frac{4v_0\cos\theta}{\sqrt{3}g}$$

$$d_2 = (v_0\cos\theta)t_2 - \frac{1}{2}a{t_2}^2 = (v_0\cos\theta)\frac{4v_0\cos\theta}{\sqrt{3}g} - \frac{1}{2}\frac{g\sqrt{3}}{4}\left(\frac{4v_0\cos\theta}{\sqrt{3}g}\right)^2 = \frac{2}{\sqrt{3}}\frac{(v_0\cos\theta)^2}{g}$$

Part (c)

Total distance will be:

$$d_1 + d_2 = \frac{{v_0}^2}{g}\left(2\sin\theta\cos\theta + \frac{2}{\sqrt{3}}\cos^2\theta\right) = \frac{(12m/s)^2}{(9.8m/s^2)}\left(2\sin\theta\cos\theta + \frac{2}{\sqrt{3}}\cos^2\theta\right)$$

$$= \frac{(12m/s)^2}{(9.8m/s^2)}\left(\sin 2\theta + \frac{2}{\sqrt{3}}\frac{\cos 2\theta + 1}{2}\right) = \frac{(12m/s)^2 2}{(9.8m/s^2)\sqrt{3}}\left(\frac{\sqrt{3}}{2}\sin 2\theta + \frac{1}{2}\cos 2\theta + \frac{1}{2}\right)$$

$$= \frac{(12m/s)^2 2}{(9.8m/s^2)\sqrt{3}}\left(\sin(2\theta + 30°) + \frac{1}{2}\right) = 20m$$

$$\therefore \sin(2\theta + 30°) = 20m\frac{(9.8m/s^2)\sqrt{3}}{(12m/s)^2 2} - \frac{1}{2}$$

$$\therefore 2\theta + 30° = \sin^{-1}\left(20m\frac{(9.8m/s^2)\sqrt{3}}{(12m/s)^2 2} - \frac{1}{2}\right)$$

or $2\theta + 30° = \pi - \sin^{-1}\left(20m\frac{(9.8m/s^2)\sqrt{3}}{(12m/s)^2 2} - \frac{1}{2}\right)$

$\therefore \theta = 6.37°$ or $53.6°$