Lagrangian

$$T = \frac{1}{2} m_1 (l_1 \dot{\theta}_1)^2 + \frac{1}{2}\left[\frac{1}{12} m_2 l_1^2 \dot{\theta}_1^2 + \frac{1}{12} m_2 l_2^2 \dot{\theta}_2^2 + \frac{1}{2} m_2 l_1 l_2 \dot{\theta}_1 \dot{\theta}_2 \cos(\theta_1 - \theta_2)\right]$$

$$V = -g m_1 \frac{l_1}{2} - g m_2 \left(l_1 \cos\theta_1 + \frac{l_2}{2} \cos\theta_2\right)$$

$$L = T - V$$

$$\left(\frac{1}{3} m_2 l_1^2\right) \ddot{\theta}_1 + \left(\frac{1}{2} m_2 l_1 l_2\right) \ddot{\theta}_2 \cos(\theta_1 - \theta_2) + \left(\frac{1}{2} m_2 l_1 l_2\right) \dot{\theta}_2^2 \sin(\theta_1 - \theta_2) = g l_1 \sin\theta_1$$

$$\left(\frac{1}{2} m_2 l_1 l_2\right) \ddot{\theta}_1 \cos(\theta_1 - \theta_2) + \left(\frac{1}{3} m_2 l_2^2\right) \ddot{\theta}_2 - \left(\frac{1}{2} m_2 l_1 l_2\right) \dot{\theta}_1^2 \sin(\theta_1 - \theta_2) = g l_2 \sin\theta_2$$

$$\ddot{\theta}_1 = -\frac{3(g l_1 m_1 \sin\theta_1 + 2 g l_1 m_2 \sin\theta_1 - g l_2 m_2 \sin\theta_2)}{2 l_1^2 m_1 - 3 l_1 l_2 m_2 + 6 l_2^2 m_2}$$

$$\ddot{\theta}_2 = -\frac{3(-3 g l_2 m_1 \sin\theta_1 - 6 g l_2 m_2 \sin\theta_1 + 2 g l_1 m_1 \sin\theta_2 + 6 g l_1 m_2 \sin\theta_2)}{2 l_2 (2 l_1^2 m_1 - 3 l_1 l_2 m_2 + 6 l_2^2 m_2)}$$