$$\Sigma F = m_1 \vec{a}_1 = m_1 \begin{bmatrix} -\ddot{\theta}_1 \frac{w_1}{2} \sin(\theta_1) - \frac{w_1}{2} \dot{\theta}_1{}^2 \cos(\theta_1) \\ \ddot{\theta}_1 \frac{w_1}{2} \cos(\theta_1) - \frac{w_1}{2} \dot{\theta}_1{}^2 \sin(\theta_1) \end{bmatrix} = \vec{F}_a - \vec{F}_b$$

$$\Sigma \tau_1 = I_1 \ddot{\theta}_1 = 4 k_a \left(\frac{3\pi}{2} - \theta_1 \right) - 4 k_b \left(\pi - \theta_1 + \theta_2 \right) + \vec{r}_{a \to b} \times (-\vec{F}_b)$$