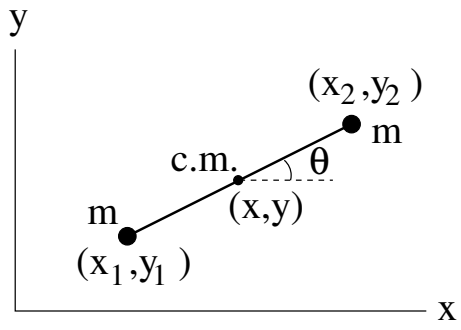
## [mex161] Massive dimer skating on incline

The massive dimer on skates described in [mex122] is now moving on an incline. The $y$-axis is tilted an angle $\alpha$ above the horizontal. (a) Write the Lagrangian $L(x, y, \theta, \dot{x}, \dot{y}, \dot{\theta})$, where $x, y$ are the center-of-mass coordinates and the $\theta$ is the angle between the rod and the $x$-axis. (b) Express the nonholonomic constraint as a relation between $\dot{x}, \dot{y}, \theta$. (c) Derive the equations of motion in the form of three Lagrange equations and one equation of (nonholonomic) constraint. (d) Solve these equations of motion for the initial conditions $x(0) = y(0) = 0$, $\dot{x}(0) = 0$, $\dot{y}(0) = v_0 > 0$, $\theta(0) = 0$, $\dot{\theta}(0) = \omega > 0$. (e) Determine the forces of nonholonomic constraint.




**Solution:**