Problem 1

A wheel with radius $r$ spins freely and without friction about its center. One end of a spring is attached to the wheel at a distance of $s$ from the center of the wheel. The other end of the spring (restlength $\ell$, spring constant $k$) is fixed to a point $d$ below the wheel’s center. A mass $m$ is attached to the wheel opposing the spring’s attachment point. Find the equations of motion for the wheel, parameterized by the polar angle $\theta$ of the spring’s attachment point. Your answer should be an ODE of the general form $\ddot{\theta} = f(\theta, \dot{\theta}, t)$. Hint: formulating energy first is easier.