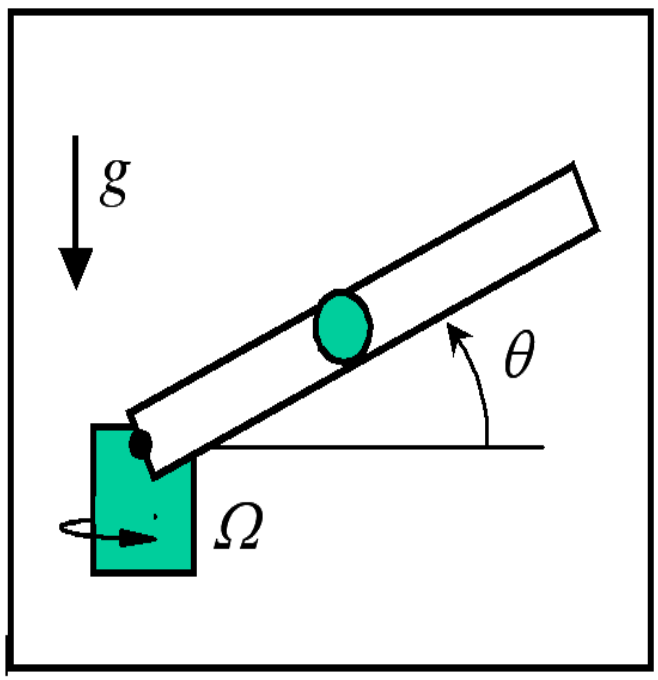
16.61 | Handout #5
Prof. J. P. How | March 13, 2003
Prof. J. Deyst | **Due:** March 20, 2003

16.61 Homework Assignment #5

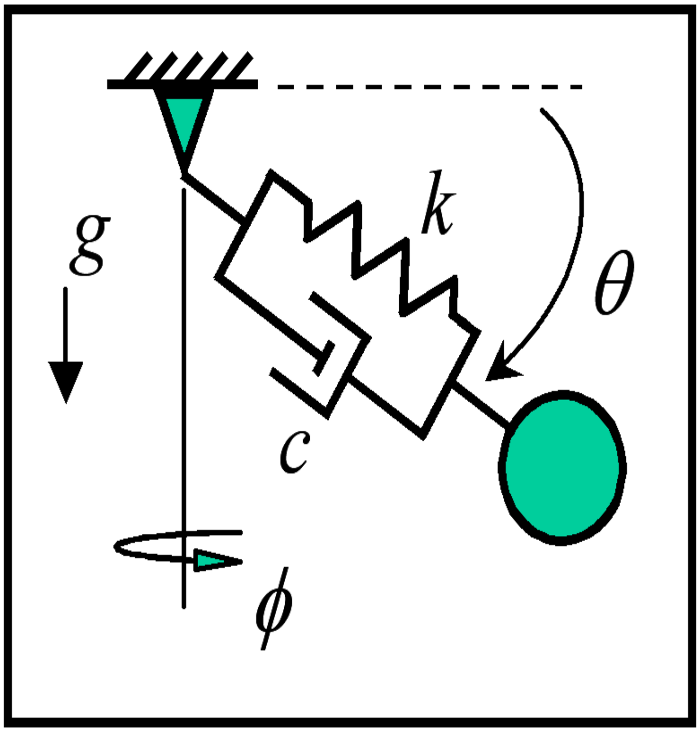
1. Consider the catapult problem covered in class, but this time include the effect of gravity and add a *twist*. The catapult shown has a constantly increasing elevation angle, θ , and a constant rotation rate, Ω about the vertical axis. Derive the equations of motion for the particle.



2. A particle moves in space subject to the constraint: $dz = (x + y)dy + (y + 3x)dx$. Is this constraint holonomic? How many degrees of freedom does the particle have? Find $z = f(x, y)$ or if you can not, explain why there is no solution.

3. Consider a spherical pendulum with a spring and damper connected in parallel. In the figure, $\dot{\phi}$ is positive *up* the page, $\dot{\theta}$ is positive going into the page. Using spherical coordinates r, θ, ϕ derive the equations of motion for the mass. For the initial conditions listed, describe the motion of the pendulum after a long time. (Neglect air resistance.)

$$r_0 = L,\ \dot{r}_0 = \dot{L},\ \theta_0 = \frac{3\pi}{4},\ \dot{\theta}_0 = 0,\ \phi_0 = 0,\ \dot{\phi}_0 = 0$$



4. Do problem 6.8 of Greenwood's *Principles of Dynamics*