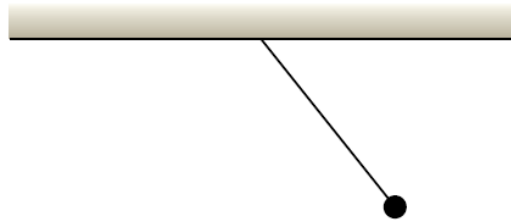


A ball of mass  $m$  hangs from a massless string of length  $l$  suspended from the ceiling. The mass is free to move in all three dimensions. The string remains taut as the ball swings.



- a. Write down the total energy ( $T + V$ ) of the ball in terms of Cartesian coordinates  $(x, y, z, \dot{x}, \dot{y}, \dot{z})$
- b. Find the coordinate transformations from Cartesian to spherical coordinates  $(r, \theta, \phi, \dot{r}, \dot{\theta}, \dot{\phi})$ , and plug these into your equation for  $T + V$  from part a. to obtain the total energy in terms of spherical coordinates. (Hint: you will need to use the Pythagorean trigonometric identity.)