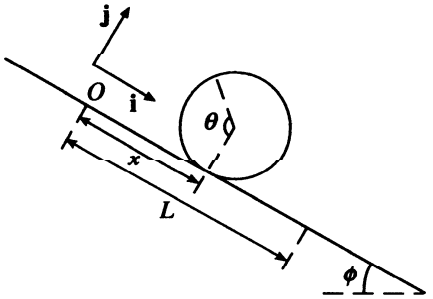
A sphere of radius R, mass M and moment of inertia I rolls down a slope that is inclined at an angle ϕ to the horizontal. The sphere starts from rest and rolls without slipping a distance L down the slope. Choose coordinates x and θ as shown in the diagram.



(a) Write down a relationship between x and θ.

(b) Write down an expression for the total kinetic energy of the sphere. Use your result from part (a) to find the kinetic energy in terms of $\dot{x}$ and constants.

(c) Apply the law of conservation of total mechanical energy to the system to find an equation of motion for the sphere.

I HAVE:

(a) $x = R\theta$

(b) $KE = \frac{1}{2}M\dot{x}^2 + \frac{1}{2}I\left(\frac{\dot{x}}{R}\right)^2$

I AM ONLY CONFUSED BY PART (C)...

I BELIEVE I SHOULD WRITE ALONG THE LINES OF:

In moving distance x, the centre of mass of sphere descends vertical distance $x \sin\phi$, so PE of sphere is reduced by Mgh

$= Mgx\sin\phi$.

If mechanical energy is conserved, we have:

$$\frac{1}{2}M\dot{x}^2 + \frac{1}{2}I\left(\frac{\dot{x}}{R}\right)^2 = Mgx\sin\phi$$

(Q) HOW DO I MAKE THIS INTO AN EQUATION OF MOTION AND IS WHAT I HAVE SAID SO FAR CORRECT?