Physics 195 Chapter 10 Problem 70 30 pts

The reel shown has radius R and moment of inertia I. One end of the block of mass m is connected to a spring of force constant k and the other end is fastened to a cord wrapped around the reel. The reel axle and the incline are frictionless. The reel is wound counterclockwise so that the spring stretches a distance d from its unstretched position and is then released from rest. (a) Find the angular speed of the reel when the spring is again unstretched. (Answer using theta for θ, g for the acceleration due to gravity, and R, I, m, k, and d, as necessary.) (b) Evaluate the angular speed numerically at this point if

I = 1.10 kg·m², R = 0.300 m, k = 50.0 N/m, m = 0.500 kg, d = 0.200 m, and θ = 37.0°.

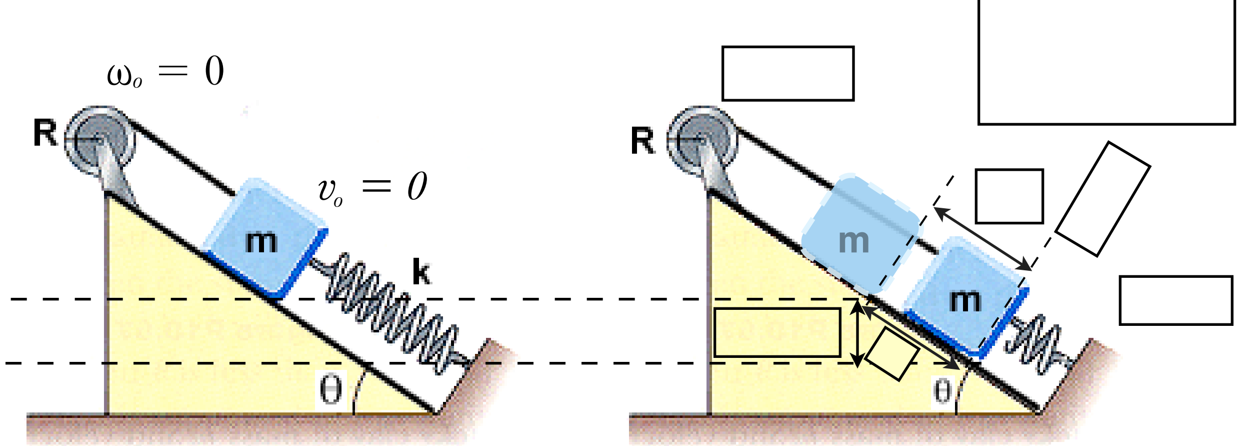
$PE_G = mgh_o$

$PE_S = \frac{1}{2}kx_o^2$

$KE_T = \frac{1}{2}mv_o^2$

$KE_R = \frac{1}{2}I\omega_o^2$

Finish the Diagram. (10 pts)



Before

Using the Conservation of Energy

After

Energy Before = *Energy After*

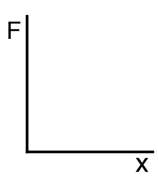
$$PE_G + PE_S + KE_T + KE_R = PE_G + PE_S + KE_T + KE_R$$

= 4 pts

What is k of a spring?

3 pts

Graph Hooke's Law for this k?



What is Hooke's Law?

$mgd\sin\theta + \frac{1}{2}kd^2 =$

$mgd\sin\theta + \frac{1}{2}kd^2 =$

$mgd\sin\theta + \frac{1}{2}kd^2 =$

6 pts

$v = rw$

solve for ω, *symbolically* $\omega_f =$ 2 pts

solve for ω, *numerically* $\omega_f =$ = 3 pts

2 pts

the original ***and*** ***is transformed into turning the reel and moving the box.***

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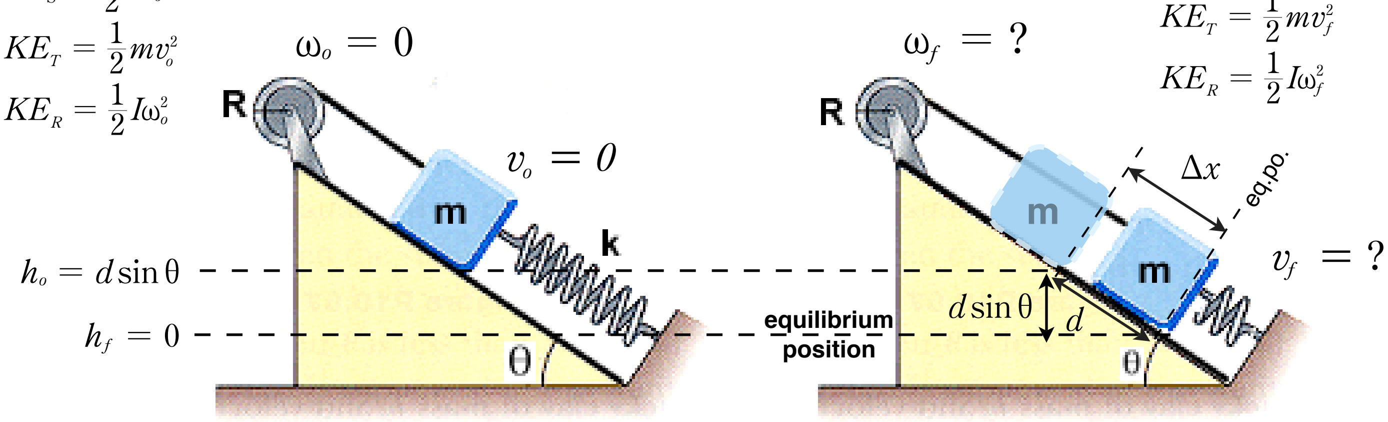
The reel shown has radius *R* and moment of inertia *I*. One end of the block of mass *m* is connected to a spring of force constant *k* and the other end is fastened to a cord wrapped around the reel. The reel axle and the incline are frictionless. The reel is wound counterclockwise so that the spring stretches a distance *d* from its unstretched position and is then released from rest. (a) Find the angular speed of the reel when the spring is again unstretched. (Answer using theta for *θ*, g for the acceleration due to gravity, and *R*, *I*, *m*, *k*, and *d*, as necessary.) (b) Evaluate the angular speed numerically at this point if

$I = 1.10\ \text{kg·m}^2$, $R = 0.300$ m, $k = 50.0$ N/m, $m = 0.500$ kg, $d = 0.200$ m, and $\theta = 37.0°$.

$$PE_G = mgh_o \qquad PE_S = \frac{1}{2}kx_o^2 \qquad KE_T = \frac{1}{2}mv_o^2 \qquad KE_R = \frac{1}{2}I\omega_o^2$$

$$PE_G = mgh_f \qquad PE_S = \frac{1}{2}kx_f^2 \qquad KE_T = \frac{1}{2}mv_f^2 \qquad KE_R = \frac{1}{2}I\omega_f^2$$



Before After

Using the Conservation of Energy

Energy Before = *Energy After*

The spring is stretched, the block is higher, and has zero linear and angular velocity.

The spring is not stretched, the block is lower, and has both linear and angular velocity.

$$PE_G + PE_S + \cancel{KE_T} + \cancel{KE_R} = \cancel{PE_G} + \cancel{PE_S} + KE_T + KE_R$$

$v_o = 0$ $\quad \omega_o = 0$ $\quad h_f = 0$ $\quad x_f = 0$

the box falls a distance $d\sin\theta$

the spring travels a distance d.

$$mgh_o + \frac{1}{2}kx_o^2 + 0 + 0 = 0 + 0 + \frac{1}{2}mv_f^2 + \frac{1}{2}I\omega_f^2$$

$v = rw$

$$mgd\sin\theta + \frac{1}{2}kd^2 = \frac{1}{2}m(r\omega_f)^2 + \frac{1}{2}I\omega_f^2$$

$$mgd\sin\theta + \frac{1}{2}kd^2 = \frac{1}{2}(mr^2)\omega_f^2 + \frac{1}{2}I\omega_f^2$$

$$mgd\sin\theta + \frac{1}{2}kd^2 = \frac{1}{2}\omega_f^2(mr^2 + I)$$

solve for ω

$$\omega_f = \sqrt{\frac{2mgd\sin\theta + kd^2}{(mr^2 + I)}}$$

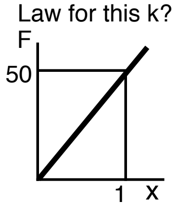
What is k of a spring?

Spring Constant

What is Hooke's Law?

F = kx

Graph Hooke's Law for this k?



$$\omega_f = \sqrt{\frac{2(0.5kg)9.8m/s^2(0.2m)\sin 37° + 50Nm(0.2m)^2}{0.5kg(0.3m)^2 + 1.00kg{\cdot}m^2}} = \boxed{1.75\frac{rads}{\sec}\ \text{cw}}$$

3 sig figs

the original PE_G and PE_S is transformed into turning the reel and moving the box.