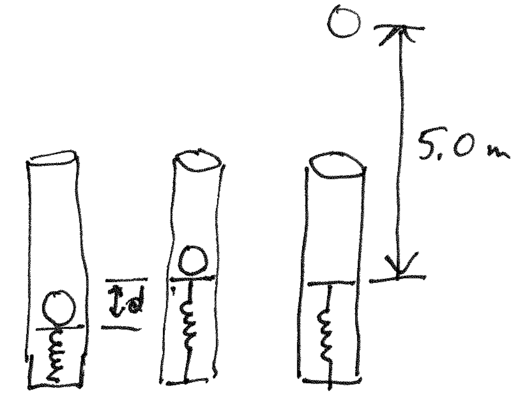
Chapter 8 Problem 43



$k = 12\,\frac{N}{cm} = 1200\,\frac{N}{m}$

$m = 0.015\,\cancel{g}\,kg$

$h = 5.0\,m$

How far is The spring initially compressed?

We will assume There are no losses due to air drag. ~~when The~~ we can Then use conservation of energy.

$$W_{non\text{-}cons} = \Delta K + \Delta U = 0 \longrightarrow K_0 + U_0 = K_f + U_f$$

The ball initially starts at rest and we will say The ~~zero~~ potential energy ~~due~~ ~~occurs~~ due to gravity is zero when ~~the~~ it rests on The compressed spring.

$\therefore$ Initially There is only potential energy due to The compressed spring

$$E_0 = K_0 + U_0 = 0 + \tfrac{1}{2}kd^2$$

After The ball reaches its max height, The potential ~~gra~~ energy due to gravity is

$$U_g = mg(h+d)$$

There is no potential energy due to The spring and at max height velocity equals zero.

Therefore, $E_f = K_f + U_f = 0 + mg(h+d)$

Setting The initial and final energy equal to each other

$$E_0 = E_f \longrightarrow \tfrac{1}{2}kd^2 = mg(h+d)$$

With a little algebra $d^2 = \frac{2mg(h+d)}{k}$ ~~= 2(0.015 kg)~~

$$d^2 = \frac{2(0.015\,kg)(9.8\,m/s^2)(5.0+d)}{1200\,N/m}$$

$$d^2 = 2.45\times10^{-4}(5.0+d)$$

Assume $d \ll 5.0$

$$d^2 \approx (2.45\times10^{-4})(5.0)$$

$$\approx 1.225\times10^{-3}\,m^2 \longrightarrow \boxed{d = 0.035\,m}$$

$d = 3.5\,cm$
This is small compared to $h = 5.0\,m$. $\therefore$ the approximation is very good.