Problem 5

Write down everything we are given, any assumptions we can make, and what we want to find.

Given: θ = 20o k = 500 N/m m=2.50 kg distance from spring = 0.300m vi=0.750 m/s vf=0

Assumptions: gravity of 9.81 m/s2 frictionless surface

Find: compression distance of spring

Seeing as how we are not concerned with vectors the work-energy theorem will do well here.

First let’s make a picture of the initial conditions

k=500 N/m

Vi=0.750 m/s

0.300 m

20o

Before we make the picture of the final conditions we have to consider something very important. The problem states that the spring does compress an amount. So the block will actually travel a distance of 3.00 m plus the compression distance of the spring (x).

So knowing this we can make our second picture.

0.300 m

k=500 N/m

(x)

20o

Now we should make a table to organize our energies. For our gravitational potential energies we can set our final height to zero and our initial height to sin(20o)(0.300m + (x)) and we will treat the compression of the spring as a positive distance.

|  |  |  |  |
| --- | --- | --- | --- |
|  | | Condition | |
| Initial | Final |
| Type of energy | KE = ½ (m)(v)2 | .703125 J | 0 |
| GPE =(m)(g)(h) | (24.525N)sin(20o)(0.300m + (x)) | 0 |
| MPE = ½ (k)(x)2 | 0 | 250 N/m (x)2 |
| Total energy (sum of all energy) | Constant | Constant |

Because our total energy is a constant, the sum of starting energy must be equal the sum of the final energy. By multiplying 25.525N by sin(20o) our initial GPE is now 2.5164J + 8.3880 N times (x). Our equation is .7013125 J + 2.5164 J + 8.3880 N (x) = 250 N/m (x)2.

By rearranging terms we have 250 N/m (x)2 -8.3880 N (x) – 3.2195 J = 0. If we use the quadratic equation and set a=250, b=-8.3880, and c = -3.2195 we’ll have our x equal to 0.131m and -0.098 m. Because we established that our compression distance would be positive our answer is .131m.