Problem 2:

First step: Write down everything given, all assumptions made, and what the problem is asking for.

Given: mass of block = 10.0 kg starting height = 3.00 m

surface is frictionless except for a length d= 6.00 m spring constant k = 2250 N/m

compression of spring = 0.300 m

vf=vi=0 (block starts from rest and we are concerned with the moment temporally comes to rest)

Assumptions: assume acceleration due to gravity closed system ( no change in energy)

Find: coefficient of kinetic friction μk

A picture might help

Length where friction will occur (d)

k =2250 N/m and no compression

Initial conditions

3.00m

6.00m

k =2250 N/m and compression of 0.300 m

Final conditions

3.00m

6.00m

This can best be solved with the work energy theorem as we are not concerned with vectors, just magnitudes. The most important thing to remember about an energy problem is that **in a closed system total energy is constant**. By using this fact we can say that **the sum of all energy at any time is constant**.

Let’s examine our energies.

In both the initial and final conditions the block is at rest. Kinetic energy (KE) is ½ mv2. Therefore KE in both conditions is 0.

The height at initial is 3 m off the ground. The height at final is ground level or zero. Gravitational Potential Energy (GPE) is mgh. Initial GPE is (10.0 kg)(9.81 m/s2)(3 m)= 294.3 Joules. Final GPE is 0.

The compression of the spring at initial is 0. The compression at final is 0.300m. Mechanical/spring/elastic potential energy (MPE) is ½ kx2. Initial MPE is 0. Final MPE is ½ (2250 N/m)(0.300m)2 = 101.25 Joules.

Last we have to consider internal energy (Eint). The Eint is heat do to friction. Work is defined as the dot product of force and displacement. In this instance our force is the frictional force and our displacement is the 6.00m length over which this force acts. Frictional force is defined as mgμk and acts in the direction opposite to motion. Even though the direction of force and direction of displacement are in opposite directions, we state that Eint=mgμk▪d = mgμkd. This makes sense if you think of friction as a system irreversibly change other energies into heat. Initial Eint = 0 as the block has not yet passed over the length where friction occurs. Final Eint = (10.0 kg)(9.81 m/s2)(μk)(6.00 m) = (μk)588.6 Joules.

Let’s put what we know into a table.

|  |  |  |  |
| --- | --- | --- | --- |
|  | | Condition | |
| Initial | Final |
| Type of energy | KE | 0 | 0 |
| GPE | 294.3 J | 0 |
| MPE | 0 | 101.25 J |
| Eint | 0 | (μk)588.6 J |
| Total energy (sum of all energy) | 294.3 J | 294.3 J |

Notice that we put the same value for total energy in both columns. As we have stated **the sum of all energy at any time is constant**. Now notice that we can find μk by stating 101.25 J + (μk)588.6 J = 294.3 J. By rearranging terms μk = (294.3 J – 101.25 J)/(588.6 J) = 0.328