Name: _____

Class: _____

Due Date: _____

Physics Topic 15B – Work and Energy with Springs

Answer the following questions. The solutions to this worksheet can be found on the YouTube channel Go Physics Go.

1. C: State the equation for the *elastic potential energy* of a compressed or stretched spring. Define each variable. What is the meaning and units for the *spring constant k*?

2. E: A force of 35.0 N is applied to a spring and as a result the spring stretches a distance of 12.0 cm.

   a. What is the spring constant k for this spring?

   b. How much energy will be stored in this spring?

3. E: A spring, which has a spring constant k, is hung from the ceiling. A mass of 3.00 kg is added to the end of the spring and is then slowly lowered until equilibrium is reached. At this point the bottom of the mass has been lowered a distance of 52.0 cm.

   a. What is the magnitude of the force being exerted by the spring when the system reaches equilibrium?

   b. What is the spring constant of this spring?

   c. How much energy is stored in the spring when equilibrium is reached?

4. E: A mass of 5.00 kg is dropped from a height of 2.20 m above a vertical spring sitting on a horizontal surface. Upon colliding with the spring the mass compresses the spring 30.0 cm before it momentarily comes to a halt. Assume $h = 0.00$ m at the lowest point.

   a. How much gravitational potential energy was contained in the 5.0 kg mass before it was dropped?

   b. How much energy will be stored in the spring when the mass comes briefly to a halt?

   c. What is the spring constant of this spring?

5. E: A horizontal spring with a spring constant $k = 3.00 \times 10^4 \ \frac{\text{N}}{\text{m}}$ is compressed 6.00 cm by an 800. gram block which is resting on a frictionless surface. The block is then released from rest.

a. Draw a figure.

b. What is the initial potential energy of the spring?

c. What is the kinetic energy of the block after it leaves the spring?

d. What is the final speed of the block after it leaves the spring?

e. After some distance the block moves through a rough surface with a coefficient of friction $\mu = 0.0500$. What is the total distance the block travels along the rough surface?

6. E: A mass of 2.20 kg is placed on a stiff vertical spring, which has a spring constant of 950. N/m. The object is then pressed against the spring until it has been compressed a distance of 77.0 cm. The mass is then released and is allowed to be thrown up into the air.

   a. What will be the elastic potential energy stored in the spring just before the mass is released?

   b. What will be the gravitational potential energy of this mass when it reaches the highest point?

   c. How high in the air will the mass be thrown?

   d. What will be the velocity of the mass just as it leaves the end of the spring?

7. E: A vertical spring is hung from one end. A mass of 5.00 kg is hung from the end of the spring. As a result of the addition of this mass the spring is stretched a distance of 125 cm.

   a. What is the spring constant for this spring?

   b. How much would this spring be stretched if the mass is 15.0 kg?

The 5.00 kg mass is then lifted up until the spring is unstretched. The mass is then released and is allowed to fall until at some lower point it stops. Assume that at this point $h = 0$ m.

   c. How far will the mass have fallen when it stops at the lowest point?

   d. What will be the gravitational potential energy stored in this system when the mass is at the lowest point?

   e. What will be the kinetic energy of this system when the mass reaches the lowest point?

f. What will be the elastic potential energy stored in the spring when the mass is at the lowest point?

g. What will be the elastic potential energy stored in the system when the mass is at the highest point?

h. What will be the kinetic energy of this system when the mass is at the highest point?

i. What will be the gravitational potential energy of this system when the mass is at the highest point?

j. What will be the total energy of this system at the highest point?

k. What will be the total energy of this system at the lowest point?

l. What will be the total energy of this system when the mass is 65.0 cm below the highest point?

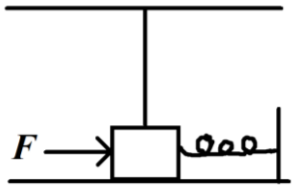
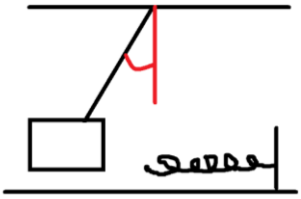
m. What will be the gravitational energy of this system when the mass is 65.0 cm below the highest point?

n. What will be the elastic potential energy of this system when the mass is 65.0 cm below the highest point?

o. What will be the kinetic energy of this system when the mass is 65.0 cm below the highest point?

p. What will be the velocity of the mass when it is 65.0 cm below the highest point?

8. E: A mass of 4.40 kg is attached at the end of a string, which is 2.60 m long, is pressed against a horizontal spring with $k = 5.60 \times 10^2 \ \frac{\text{N}}{\text{m}}$ as shown below. The other end of the string is attached to the ceiling. The spring is compressed by 12.0 cm by the applied force. The mass is then released and is allowed to swing outward until at some point it stops.

Before	After
	

a. What will be the total energy of this system just before the mass is released?

b. How much force is needed to press this mass against the spring?

c. What will be the velocity of the mass just as it leaves the spring?

d. What will be the total energy of the mass when it reaches the highest point?

e. How high, in cm, will the mass be when it stops at the highest point?

f. What will be the angle α between the string and the vertical line as shown in the diagram when the mass reaches the highest point?