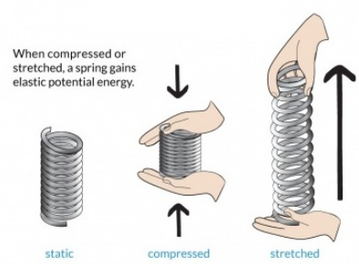
Physics 2204
Unit 3: Work, Power and Energy
Worksheet 5: Elastic Potential Energy

Student Name:_____

Elastic Potential Energy: is the energy stored in elastic materials as the result of their stretching or compressing**.**



The formula for calculating Elastic Potential Energy is:

$$PE_{Elastic} = Work$$

Since the force must be greater and greater to stretch the spring more and more, consider the work as the product of the average force and the displacement of the spring.

$$PE_{elastic} = \vec{F}_{ave} \bullet \vec{d}$$

Since the force is a linear function of the displacement then the average force is the force that occurs halfway through the displacement. This means that it occurs at one-half the displacement. In other words, while in general, F = kx,, for this special average force we write Fav = k½x. You can therefore write

$$PE_{Elastic} = \frac{1}{2}kx^2$$

k (N/m) is spring constant

x (m) is the amount of compression/stretch relative to equilibrium position

$PE_{elastic}$ (J) measure for energy is joules

Example 1:

What is the Elastic potential energy of a car spring that has been stretched 0.5 meters? The spring constant for the car spring is 90 N/m.

Example 2:

A ball is pushed into a spring-loaded launcher with a force of 20 N, which compresses the spring 0.08 m.

A) What is the spring constant of the spring

B) Find the elastic potential energy (PEs) stored in the spring (or the work done on the spring)

Example 3:

A spring with a force constant of 5.20 N/m has a relaxed length of 2.45 m. When a mass is attached to the end of the spring and allowed to come to rest, the vertical length of the spring is 3.57 m. Calculate the elastic potential energy stored in the spring.

PART A: MULTIPLE CHOICE

Instructions: Shade the letter of the correct answer on the computer scorable answer sheet provided

1. What type of potential energy results from the bending, stretching, or compressing of matter?

   (A) Chemical
   (B) Elastic
   (C) Gravitational
   (D) Nuclear

2. A spring having a spring constant of 180 N/m is stretched 0.51 m from its equilibrium position. How much elastic potential energy does the spring possess?

   (A) 0.043 J
   (B) 23 J
   (C) 46 J
   (D) 94 J

3. A horizontal spring with a spring constant of 140 N/m is extended 0.20 m from the equilibrium position. How much elastic potential energy is stored in the spring?

   (A) 2.8 J
   (B) 5.6 J
   (C) 11 J
   (D) 14 J

4. What is the elastic potential stored in a spring of spring constant 3.5 N/m when it is extended by 0.85 m?

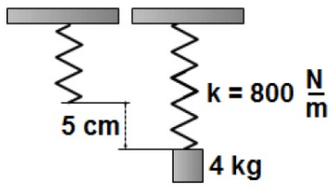
(A) 1.3 J
(B) 1.5 J
(C) 2.2 J
(D) 2.5 J

5. Which of the following is an example of an object with elastic potential energy?

(A) A wind-up toy that has been wound up
(B) A compressed basketball
(C) A stretched rubber band
(D) All of the above

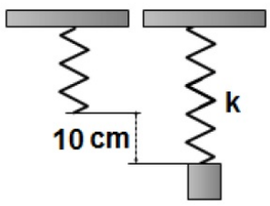
6. A 4.0 kg block is attached to a vertical spring with a spring constant 800 N/m. The spring stretches 5.0 cm down. How much elastic potential energy is stored in the system?

(A) 0.50 J
(B) 1.0 J
(C) 1.5 J
(D) 2.0 J



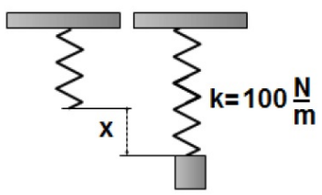
7. A heavy block is suspended from a vertical spring. The elastic potential energy is stored in the spring is 2.0 J. What is the spring constant if the elongation of the spring is 10 cm?

(A) 400 N/m
(B) 300 N/m
(C) 200 N/m
(D) 100 N/m



8. A heavy block is suspended from a vertical spring. The elastic potential energy is stored in the spring is 0.80 J. What is the elongation of the spring if the spring constant is 100 N/m?

(A) 4.0 cm
(B) 8.0 cm
(C) 11 cm
(D) 13 cm

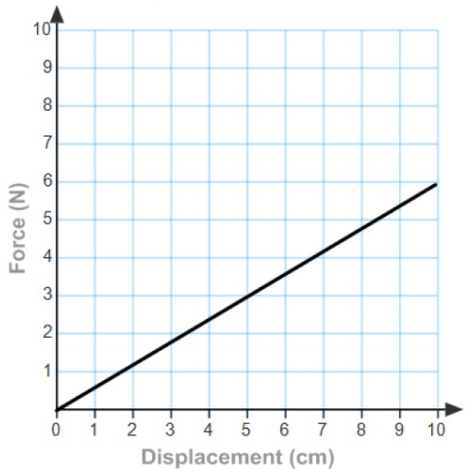


9. A apple is gently hung from a spring that stretches 4.6 cm and stores 0.056J of energy in the spring . What is the force constant of the spring?

(A) 0.054 N/m
(B) 6.1 N/m
(C) 18 N/m
(D) 53 N/m

10. The elastic force as a function of displacement presented by the graph. How much elastic potential energy is stored in the spring when it is stretched by 10 cm?

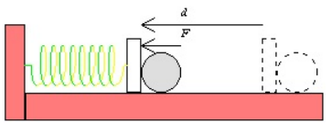
(A) 0.1 J
(B) 0.2 J
(C) 0.3 J
(D) 0.4 J



PART B: WRITTEN RESPONSE

1. Compare and contrast the type of potential energy that is in a bow and arrow (ready to shoot) with the type of potential energy that is in a rock perched at the top of a cliff. Note: compare and contrast are two different things!

2. An average force F was used to compress a spring some distance d. Explain how you know that the spring currently has potential energy.



3. Do the following:

   a. Suppose that the spring constant, k, for the spring shown above is 360 N/m. How much energy will be stored in the spring when it has been compressed 10.0 cm from the equilibrium position? **(ANSWER = 18 J)**

   b. If the spring from part (a) is compressed an ADDITIONAL 10 cm, how much energy will be stored? **(ANSWER = 7.2 J)**

4. Solve for each unknown.

   a. A spring with k = 450 N/m is compressed by 0.13 m. How much energy is stored? **(ANSWER = 3.8 J)**

   b. A spring with k = 520 N/m stores 7.04 J. How far is it extended from the equilibrium position? **(ANSWER = 0.16 m)**

   c. A spring, when compressed 0.20 m from the equilibrium position, stores 26 J. What is the value of the spring constant? **(ANSWER = 1300 N/m)**

5. An archer's bow has a spring constant of 800 N/m. Typically it is drawn back 40.0 cm to launch an arrow. How much energy is stored in the bow at this point? Note: it's kind of neat, but this energy will be transformed into energy of motion when the arrow is released. You'll see more on that in the upcoming lessons. **(ANSWER =64 J)**

6. The coil springs on a car's suspension have a value of k = 6.4 x 10^4 N/m. When the car strikes a bump the springs briefly compress by 4.0 cm. How much energy is momentarily stored in each spring **(ANSWER = 51.2J)**

7. The force constant of a spring is 150. N/m. (a) how much force is required to stretch the spring 0.25 m? (b) how much work is done on the spring in that case?