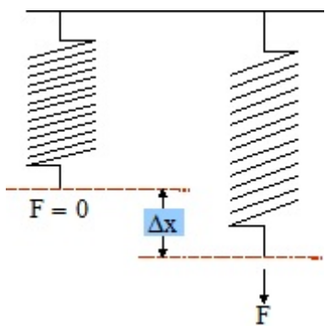
Physics 2204
Unit 3: Work, Power and Energy
Worksheet 3: Hooke's Law

Student Name:_____

Hooke's Law : states that stretch is proportional to the applied force on a spring. The force needed to distort a spring is related to the displacement from the rest position according to:

$$\vec{F}_{spring} = -k\Delta x$$



F is a "spring force" or "restoring force" (as the spring tries to return to its original or unloaded form) (Units: N)

x is the elongation or the deformation of the spring. Basically the difference in length of the spring when stretched from its unstretched length. (Units: m)

k is the "constant of elasticity" or basically a number that describes how elastic or stretchy a material is. (units: N/m)

Slope of a restoring force versus mass give the constant of elasticity . The steeper the slope, the greater the k value and stiffer the spring.

Part A: Hooke's Law Simulation Activity

a. Open a browser and go to:
https://phet.colorado.edu/sims/mass-spring-lab/mass-spring-lab_en.html

This link is also found on my website: www.mrfifieldcorner.weebly.com

b. Click on the "play" button triangle and start the sim. Then choose "intro".

c. Check all five boxes on the right hand side (applied force, spring force, displacement, equilibrium, values). Play around with the red slider control for the applied force.

Pre lab Questions:

1) What does a spring do when you pull on it? Be specific and use scientific terms.

_____

_____

2) What happens when you push a spring? How is this different than pulling it?

_____

_____

3) Are all springs/rubber bands the same? What makes them different?

_____

_____

A. When you are ready to begin the lab,
-turn the “friction” to none,
-Put the zero mark of the ruler on the equilibrium position. This will enable you to measure the displacement of the spring
-Make sure Earth is checked for the acceleration

B. Use this and your weight formula to find the force pulling on the spring, and measure how many meters the spring is displaced.

C. Click pause to right to stop oscillating. Remember, divide by 100 to convert cm to m!

D. Add this to your data table below.

E. Create a Force Versus Elongation using the data from your table

F. Repeat for Spring 3 (Set Spring hardness to 7)

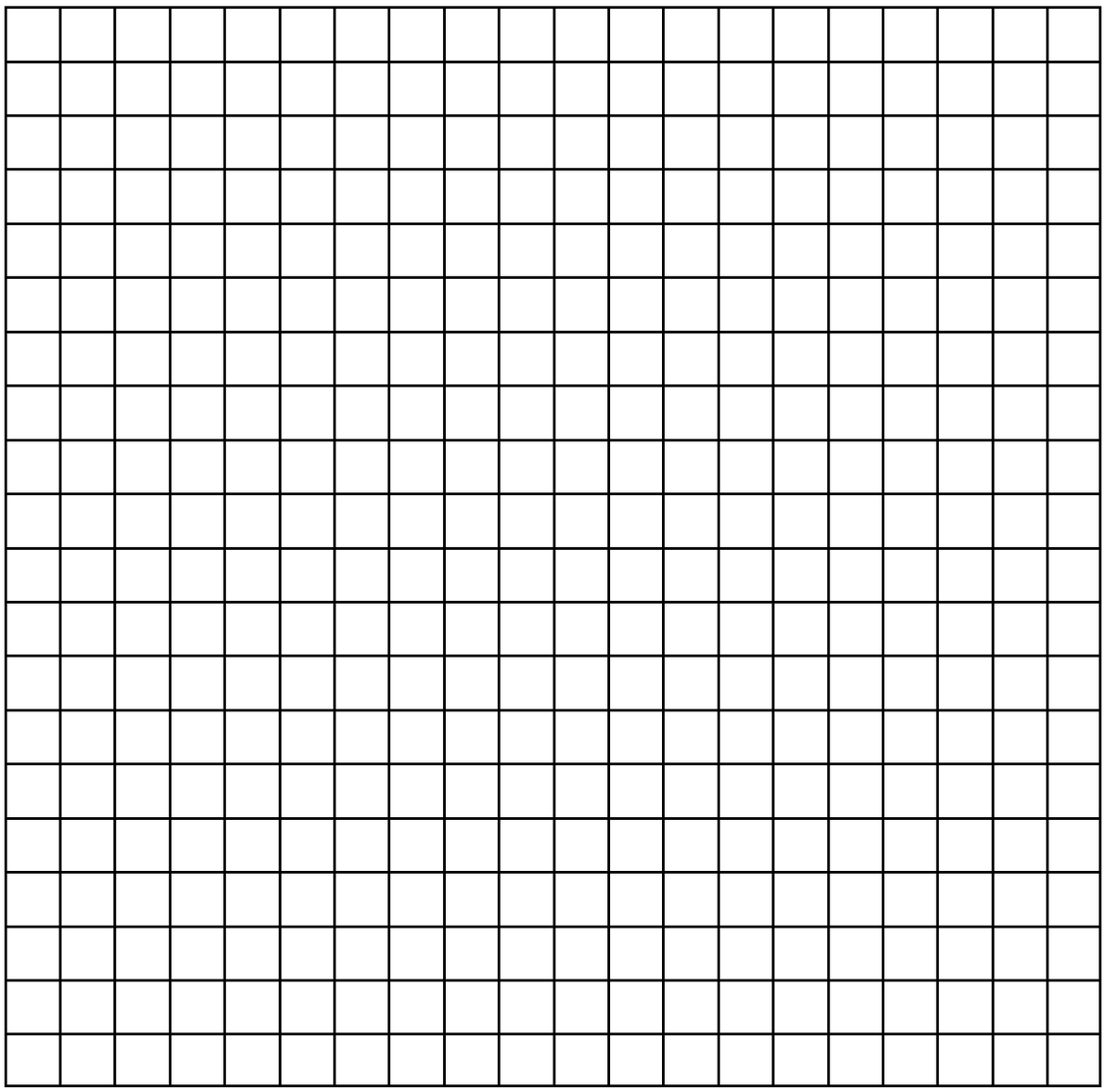
Spring 1:

Mass (kg)	Weight (N)	Displacement (m)
0.050		
0.100		
0.250		

Spring 3 : Set Spring to 7 for hardness

Mass (kg)	Weight (N)	Displacement (m)
0.050		
0.100		
0.250		

Force Versus Elongation



1. Calculate the slope of each line. (Ensure to include Units)

Spring 1	Spring 3

2. What does the slope of each line represent?

_____

_____

3. Use the simulation to calculate the unknown masses in the simulation

Mass Colour	Spring Constant (N/m)	Displacement (m)	Force (N)	Mass (kg)
Green				
Red				
Gold				

Complete the following statement:

The larger the Spring Constant, the (Stiffer/ Looser) the spring, and the (More/Less) force is required to get it to be displaced."

Part B: Hooke's Law Simulation Activity

A. Open a browser and go to:
https://phet.colorado.edu/sims/html/hookes-law/latest/hookes-law_en.html

This link is also found on my website: www.mrfifieldcorner.weebly.com

B. Check all five boxes on the right hand side (applied force, spring force, displacement, equilibrium, values). Play around with the red slider control for the applied force.

C. Set k value to 100 N/m and record data in the table.

D. Repeat for k value of 500 N/m and 1000 N/m

Table 1: k =100 N/m

Applied Force (N)	Restoring Force (N)	Elongation (m)
-100 N		
-50 N		
0		
50 N		
100 N		

Table 2: k =500 N/m

Applied Force (N)	Restoring Force (N)	Elongation (m)
-100 N		
-50 N		
0		
50 N		
100 N		

Table 3: k =1000 N/m

Applied Force (N)	Restoring Force (N)	Elongation (m)
-100 N		
-50 N		
0		
50 N		
100 N		

1. What do you notice about the applied force and restoring force at a particular elongation?

_____

_____

2. What do you notice about the elongation of spring as the spring constant (k) was increased?

_____

_____

3. For a particular spring, what did you observe if it was stretch (+x) or compressed (-x) the same amount from the equilibrium position.

_____

_____

4. Make the following predictions:

   (A) What is the elongation of a 200 N/m spring if it experiences an applied force of 50 N? (Include sign)

   _____

   (B) What is the restoring force of the spring in Part A: (Include sign)

   _____

   (C) What is the elongation of a 200 N/m spring if it experiences an applied force of -50 N? (Include sign)

   _____

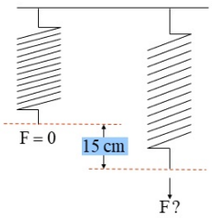
   (D) What is the restoring force of the spring in Part C: (Include sign)

   _____

Use the simulation to check your answers

Example 1:

A spring has a spring constant, k, of 5.0 N/m. What load will cause it to stretch by 15 cm?

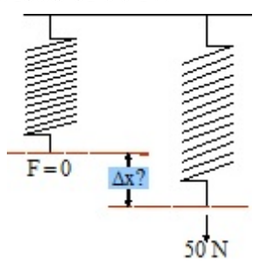


Example 2:

A spring is 0.38m long. When it is pulled by a force of 2.0 N, it stretches to 0.42 m. What is the spring constant? Assume the spring behaves elastically.

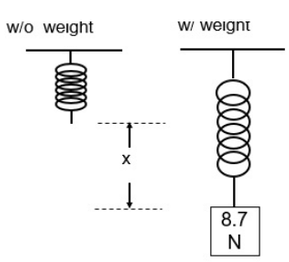
Example 3:

A spring has a spring constant, k, of 10 N/m.What will the extension be for a load of 50 N?



Example 4:

A weight of 8.7 N is attached to a spring that has a spring constant of 190 N/m. How much will the spring stretch?



PART A: MULTIPLE CHOICE

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

1. Robert Hooke (1635-1703) made a number of discoveries including the effect of force on elastic bodies now known as Hooke's law. Which one of the following statements is known as Hooke's Law?

   (A) Every action has an equal and opposite reaction.
   (B) The extension of a stretched spring is proportional to the force causing it.
   (C) Work = force x distance moved in the direction of the force.
   (D) When a body is in equilibrium, the sum of the clockwise moments is equal to the sum of the anticlockwise moments

2. Which expression represents Hooke's Law?

   (A) $F = \mu F_N$
   (B) $F = - kx$
   (C) $F = ma$
   (D) $F = mg$

3. A well known law states "The extension of a spring is proportional to the force causing the extension" is known as

(A) Fifield's Law
(B) Hooke's Law
(C) Ohm's Law
(D) Newton’s Law

4. A bungee cord has a spring constant of 112 N/m. How far will it stretch if a 50.0 kg mass is hung from it?

(A) 0.229 m
(B) 0.446 m
(C) 2.24 m
(D) 4.38 m

5. A 0.25g apple is gently hung from a spring that stretches 4.6 cm. 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

6. What is the spring constant of a spring that compresses 0.27 m when a force of 589 N is applied to it?

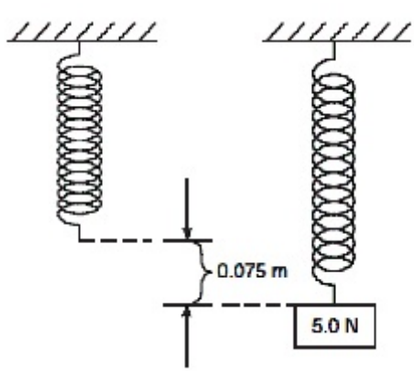
(A) 160 N/m
(B) 21 N/m
(C) 2200 N/m
(D) 0.00046 N/m

7. According to Hooke's law for an ideal spring, doubling the stretch distance will

(A) Double the velocity of the mass
(B) Double the force that the spring exerts on the mass
(C) Double the period
(D) Quadruple the force the spring exerts on the mass

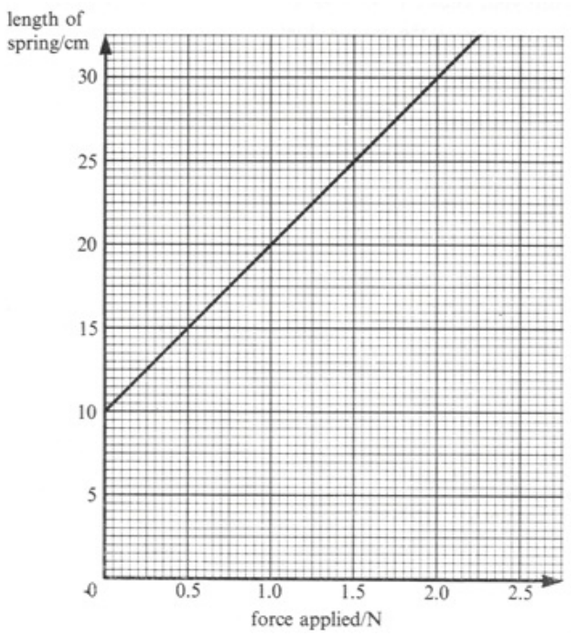
8. The diagram below represents a spring hanging vertically that stretches 0.075 m when a 5.0 N block is attached. The spring-block system is at rest in the position shown. What is the value of the spring constant?

(A) 38 N/m
(B) 67 N/m
(C) 130 N/m
(D) 650 N/m



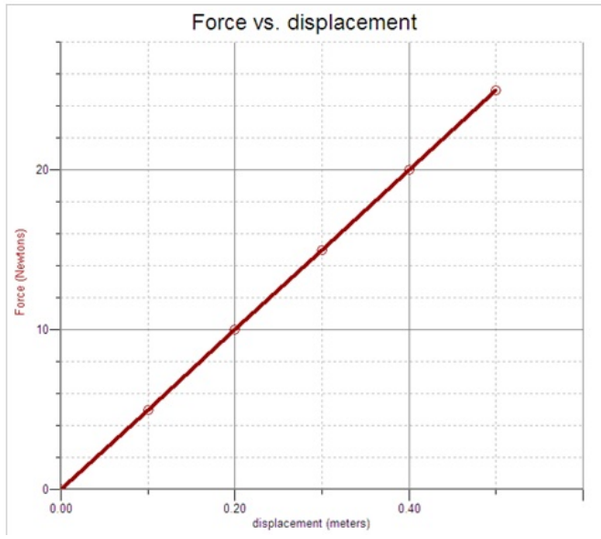
9. The graph shows how the length of a spring changes when a force is applied to it. What force is needed to stretch the spring by 10 cm?

(A) 0 N
(B) 0.5 N
(C) 1.0 N
(D) 2.0 N



10. Using the F-D graph, What is the spring constant (k)?

(A) 5 N/m
(B) 10 N/m
(C) 20 N/m
(D) 50 N/m



11. N/m is the unit for…

(A) Amplitude
(B) Elastic Potential Energy
(C) Spring Constant
(D) Torque

PART B: WRITTEN RESPONSE

1. If a spring has a spring constant of 2 N/m and it is stretched 5 cm, what is the force of the spring? (Answer = 0.1 N)

2. If a spring has a spring constant of 0.50 N/m and it is stretched 0.50 m, what is the force of the spring? (Answer = 0.25 N)

3. A spring is stretched 6 cm when a mass of 200 g is hung on it. Calculate the spring constant of this spring. (Answer = 32.67 N/m)

4. If you use the spring from problem #3 and hang a 500 g mass on it, how far will it stretch? Convert your answer to cm. (Answer = 15 cm)

5. A spring with a spring constant of 400 N/m has a mass hung on it so that it stretches 8.0 cm. Calculate how much mass the spring is supporting. (Answer = 3.3 kg)

6. What is the elastic force a spring will exert if it has k =175N/m and is stretched 30cm?

7. How far must a spring (spring constant = 35N/m) be pulled in order to exert a force of 63N?

8. How far will a spring with rest length 82cm and spring constant 0.50N/m be if it is stretched until it exerts 0.25N?

9. A spring has a rest length of 1.30m. When a 20kg mass is hung on it, it stretches to 3.60m. What is its spring constant?

10. A spring is compressed 10m when a force of 5N is applied. How far does it compress when 10N is applied? ((Answer = 20 m)