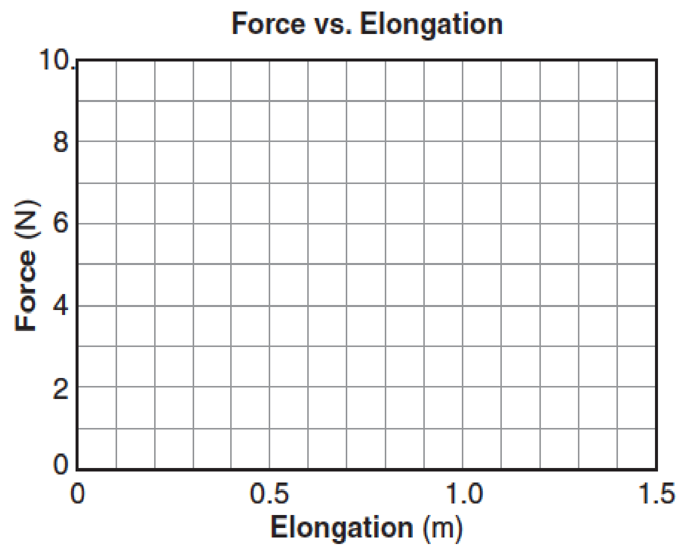
Name: ______________________________ Period: __________

WEP-Springs

Base your answers to questions 1 through 3 on the information and data table below.

In an experiment, a student applied various forces to a spring and measured the spring's corresponding elongation. The table below shows his data.

Force (newtons)	Elongation (meters)
0	0
1.0	0.30
3.0	0.67
4.0	1.00
5.0	1.30
6.0	1.50



1. On the grid at right, plot the data points for force versus elongation.
2. Draw the best-fit line
3. Using your graph, calculate the spring constant of the spring. [Show all work, including the equation and substitution with units.]

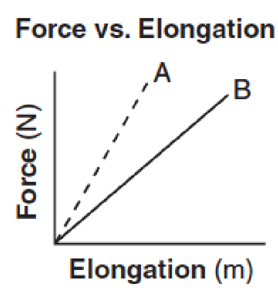
4. A 10-newton force is required to hold a stretched spring 0.20 meter from its rest position. What is the potential energy stored in the stretched spring?
   1. 1.0 J
   2. 2.0 J
   3. 5.0 J
   4. 50 J

5. A 5-newton force causes a spring to stretch 0.2 meter. What is the potential energy stored in the stretched spring?
   1. 1 J
   2. 0.5 J
   3. 0.2 J
   4. 0.1 J

6. The spring of a toy car is wound by pushing the car backward with an average force of 15 newtons through a distance of 0.50 meter. How much elastic potential energy is stored in the car's spring during this process?
   1. 1.9 J
   2. 7.5 J
   3. 30 J
   4. 56 J

Base your answers to questions 7 and 8 on the information and graph below.

The graph represents the relationship between the force applied to each of two springs, A and B, and their elongations.



7. What physical quantity is represented by the slope of each line?

8. A 1.0-kilogram mass is suspended from each spring. If each mass is at rest, how does the potential energy stored in spring A compare to the potential energy stored in spring B?

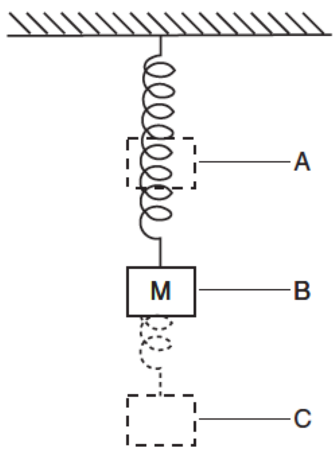
Name: ______________________________ Period: __________

WEP-Springs

9. A spring scale reads 20 newtons as it pulls a 5.0-kilogram mass across a table. What is the magnitude of the force exerted by the mass on the spring scale?
   1. 49 N
   2. 20 N
   3. 5.0 N
   4. 4.0 N

Base your answers to questions 10 through 12 on the information and diagram below.

A mass, M, is hung from a spring and reaches equilibrium at position B. The mass is then raised to position A and released. The mass oscillates between positions A and C. [Neglect friction.]



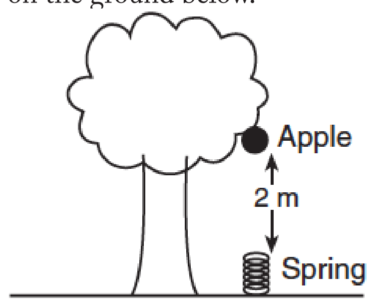
10. At which position, A, B, or C, is mass M located when the kinetic energy of the system is at a maximum? Explain your choice.

11. At which position, A, B, or C, is mass M located when the gravitational potential energy of the system is at a maximum? Explain your choice.

12. At which position, A, B, or C, is mass M located when the elastic potential energy of the system is at a maximum? Explain your choice.

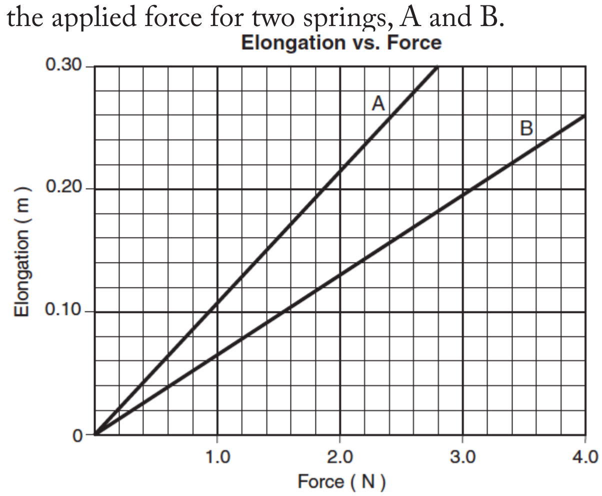
13. A spring with a spring constant of 80 newtons per meter is displaced 0.30 meter from its equilibrium position. The potential energy stored in the spring is
    1. 3.6 J
    2. 7.2 J
    3. 12 J
    4. 24 J

14. The diagram below shows a 0.1-kilogram apple attached to a branch of a tree 2 meters above a spring on the ground below.



The apple falls and hits the spring, compressing it 0.1 meter from its rest position. If all of the gravitational potential energy of the apple on the tree is transferred to the spring when it is compressed, what is the spring constant of this spring?
1. 10 N/m
2. 40 N/m
3. 100 N/m
4. 400 N/m

15. The graph below shows elongation as a function of the applied force for two springs, A and B.

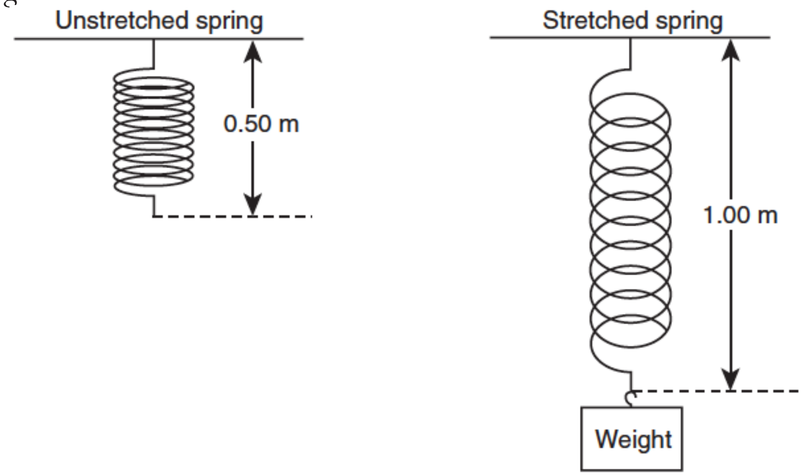


Compared to the spring constant for spring A, the spring constant for spring B is
1. smaller
2. larger
3. the same

Name: ______________________________ Period: __________

WEP-Springs

16. As shown in the diagram below, a 0.50-meter-long spring is stretched from its equilibrium position to a length of 1.00 meter by a weight.

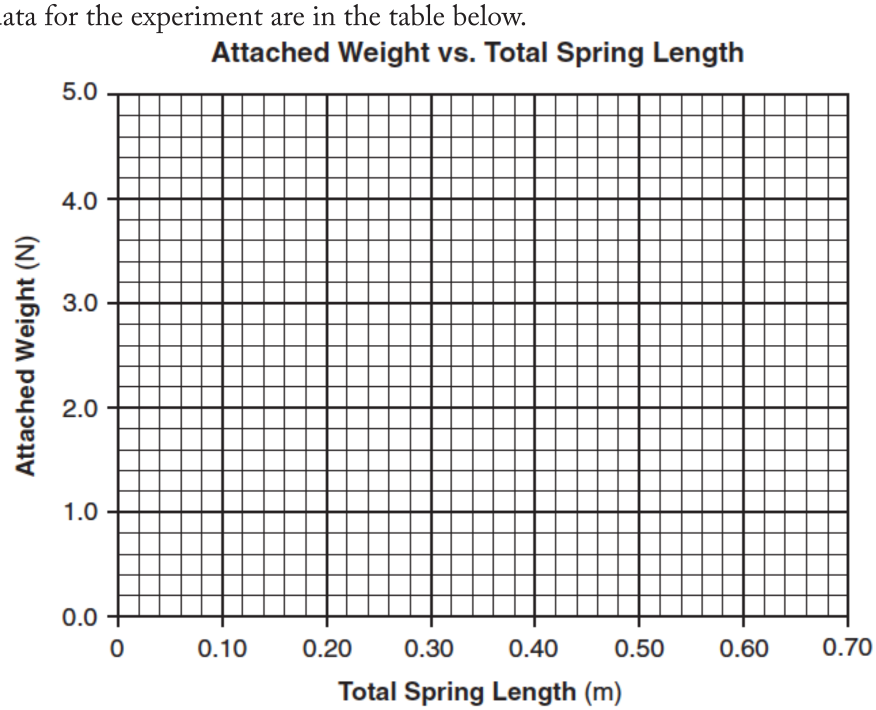


If 15 joules of energy are stored in the stretched spring, what is the value of the spring constant?
1. 30 N/m
2. 60 N/m
3. 120 N/m
4. 240 N/m

Base your answers to questions 17 through 19 on the information and data table below.

A student performed an experiment in which the weight attached to a suspended spring was varied and the resulting total length of the spring measured. The data for the experiment are in the table below.

Attached Weight (N)	Total Spring Length (m)
0.98	0.37
1.96	0.42
2.94	0.51
3.92	0.59
4.91	0.64



Using the information in the data table, construct a graph on the grid at right by following the directions below.

17. Plot the data points for the attached weight versus total spring length.

18. Draw the line or curve of best fit.

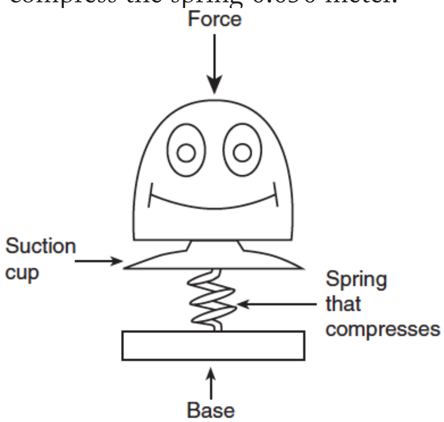
19. Using your graph, determine the length of the spring before any weight was attached.

Name: ____________________ Period: __________

WEP-Springs

Base your answers to questions 20 and 21 on the information and diagram below.

A pop-up toy has a mass of 0.020 kilogram and a spring constant of 150 newtons per meter. A force is applied to the toy to compress the spring 0.050 meter.

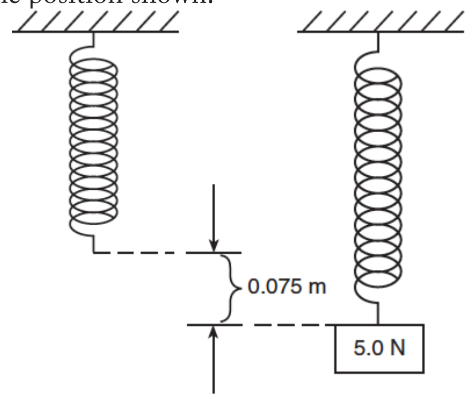


20. Calculate the potential energy stored in the compressed spring. [Show all work, including the equation and substitution with units.]

21. The toy is activated and all the compressed spring's potential energy is converted to gravitational potential energy. Calculate the maximum vertical height to which the toy is propelled. [Show all work, including the equation and substitution with units.]

22. A 10-newton force compresses a spring 0.25 meter from its equilibrium position. Calculate the spring constant of this spring. [Show all work, including the equation and substitution with units.]

23. The diagram below represents a spring hanging vertically that stretches 0.075 meter when a 5.0-newton block is attached. The spring-block system is at rest in the position shown.



The value of the spring constant is
1. 38 N/m
2. 67 N/m
3. 130 N/m
4. 650 N/m

24. A spring with a spring constant of 4.0 newtons per meter is compressed by a force of 1.2 newtons. What is the total elastic potential energy stored in this compressed spring?
1. 0.18 J
2. 0.36 J
3. 0.60 J
4. 4.8 J

25. The spring in a scale in the produce department of a supermarket stretches 0.025 meter when a watermelon weighing 1.0×10^2 newtons is placed on the scale. The spring constant for this spring is
1. 3.2×10^5 N/m
2. 4.0×10^3 N/m
3. 2.5 N/m
4. 3.1×10^{-2} N/m

26. When a 1.53-kilogram mass is placed on a spring with a spring constant of 30.0 newtons per meter, the spring is compressed 0.500 meter. How much energy is stored in the spring?
1. 3.75 J
2. 7.50 J
3. 15.0 J
4. 30.0 J

Name: ______________________________ Period: __________

WEP-Springs

Base your answers to questions 27 through 30 on the information and data table below.

The spring in a dart launcher has a spring constant of 140 newtons per meter. The launcher has six power settings, 0 through 5, with each successive setting having a spring compression 0.020 meter beyond the previous setting. During testing, the launcher is aligned to the vertical, the spring is compressed, and a dart is fired upward. The maximum vertical displacement of the dart in each test trial is measured. The results of the testing are shown in the table below.

Data Table

Power Setting	Spring Compression (m)	Dart's Maximum Vertical Displacement (m)
0	0.000	0.00
1	0.020	0.29
2	0.040	1.14
3	0.060	2.57
4	0.080	4.57
5	0.100	7.10

Directions (27-28): Using the information in the data table, construct a graph on the grid below.

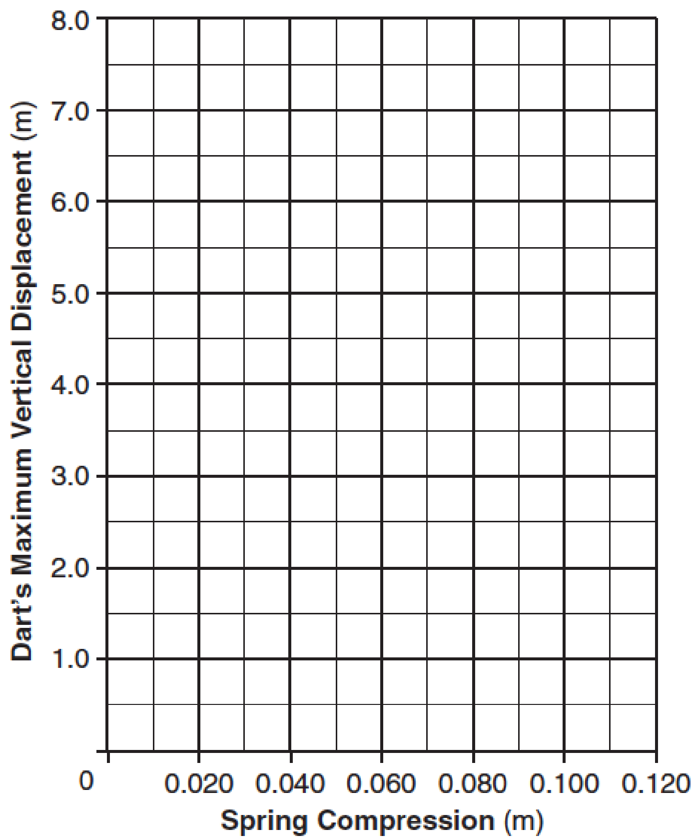
27. Plot the data points for the dart's maximum vertical displacement versus spring compression.

28. Draw the line or curve of best fit.

29. Using information from your graph, calculate the energy provided by the compressed spring that causes the dart to achieve a maximum vertical displacement of 3.50 meters. [Show all work, including the equation and substitution with units.]

30. Determine the magnitude of the force, in newtons, needed to compress the spring 0.040 meter.

Dart's Maximum Vertical Displacement vs. Spring Compression



Name: ______________________________ Period: __________

WEP-Springs

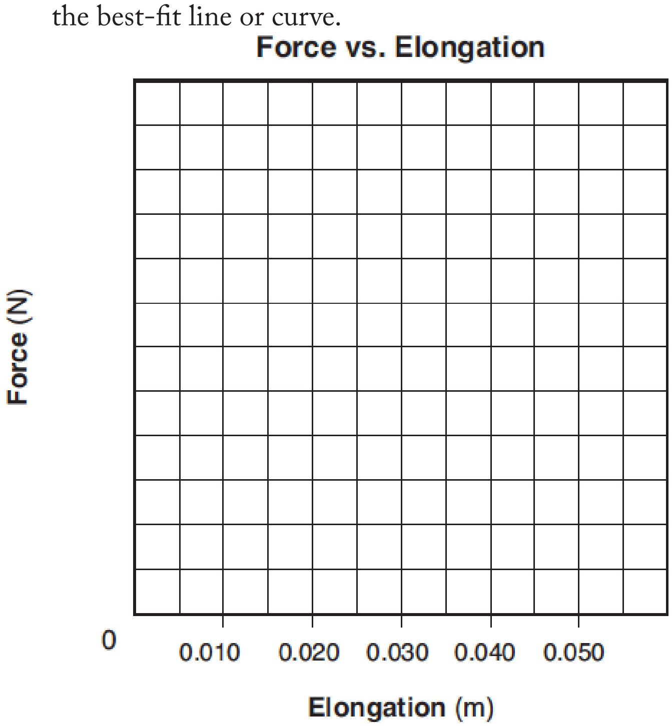
Base your answers to questions 31 and 32 on the information below.

In a laboratory investigation, a student applied various downward forces to a verticle spring. The applied forces and the corresponding elongations of the spring from its equilibrium position are recorded in the data table below.

Data Table

Force (N)	Elongation (m)
0	0
0.5	0.010
1.0	0.018
1.5	0.027
2.0	0.035
2.5	0.046

31. Construct a graph on the grid below. Mark an appropriate scale on the axis labeled “Force (N),” plot the data points for force versus elongation, and draw the best-fit line or curve.

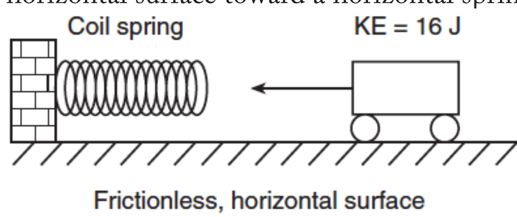


32. Using your graph, calculate the spring constant of this spring. [Show all work, including the equation and substitution with units.]

33. When a mass is placed on a spring with a spring constant of 15 newtons per meter, the spring is compressed 0.25 meter. How much elastic potential energy is stored in the spring?
    1. 0.47 J
    2. 0.94 J
    3. 1.9 J
    4. 3.8 J

34. The potential energy stored in a compressed spring is to the change in the spring’s length as the kinetic energy of a moving body is to the body’s
    1. speed
    2. mass
    3. radius
    4. acceleration

35. The diagram below shows a toy cart possessing 16 joules of kinetic energy traveling on a frictionless, horizontal surface toward a horizontal spring.



If the cart comes to rest after compressing the spring a distance of 1.0 meter, what is the spring constant of the spring?
    1. 32 N/m
    2. 16 N/m
    3. 8.0 N/m
    4. 4.0 N/m

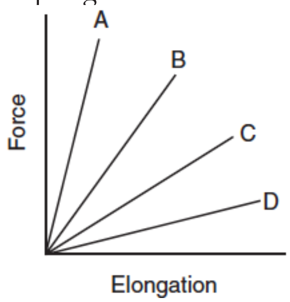
36. A spring in a toy car is compressed a distance, *x*. When released, the spring returns to its original length, transferring its energy to the car. Consequently, the car having mass *m* moves with speed *v*.

    Derive the spring constant, *k*, of the car’s spring in terms of *m*, *x*, and *v*. [Assume an ideal mechanical system with no loss of energy.]

Name: ______________________ Period: __________

WEP-Springs

37. The graph below represents the relationship between the force applied to a spring and spring elongation for four different springs.



Which spring has the greatest spring constant?
1. A
2. B
3. C
4. D

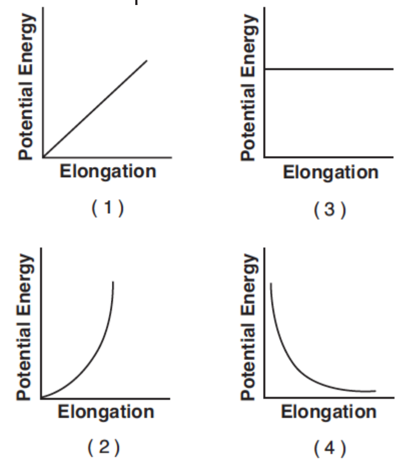
Base your answers to questions 38 and 39 on the information below.

A vertically hung spring has a spring constant of 150 newtons per meter. A 2.00-kilogram mass is suspended from the spring and allowed to come to rest.

38. Calculate the elongation of the spring produced by the suspended 2.00-kilogram mass. [Show all work, including the equation and substitution with units.]

39. Calculate the total elastic potential energy stored in the spring due to the suspended 2.00-kilogram mass. [Show all work, including the equation and substitution with units.]

40. Which graph best represents the relationship between the elastic potential energy stored in a spring and its elongation from equilibrium?



41. A child does 0.20 joule of work to compress the spring in a pop-up toy. If the mass of the toy is 0.010 kilogram, what is the maximum vertical height that the toy can reach after the spring is released?
1. 20 m
2. 2.0 m
3. 0.20 m
4. 0.020 m

42. A vertical spring 0.100 meter long is elongated to a length of 0.119 meter when a 1.00-kilogram mass is attached to the bottom of the spring. The spring constant of this spring is
1. 9.8 N/m
2. 82 N/m
3. 98 N/m
4. 520 N/m

43. An unstretched spring has a length of 10 centimeters. When the spring is stretched by a force of 16 newtons, its length is increased to 18 centimeters. What is the spring constant of this spring?
1. 0.89 N/cm
2. 2.0 N/cm
3. 1.6 N/cm
4. 1.8 N/cm

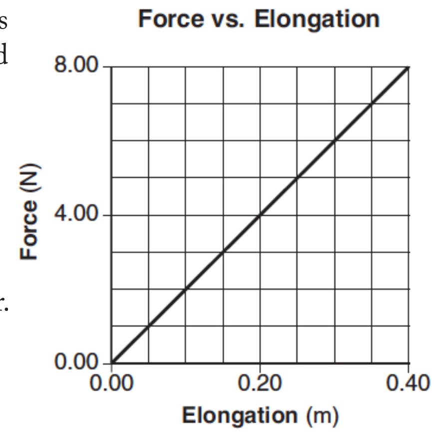
44. When a spring is compressed 2.50×10^{-2} meter from its equilibrium position, the total potential energy stored in the spring is 1.25×10^{-2} joule. Calculate the spring constant of the spring.

Name: ______________________ Period: __________

WEP-Springs

Base your answers to questions 45 and 46 on the information below.

A student produced various elongations of a spring by applying a series of forces to the spring. The graph at right represents the relationship between the applied force and the elongation of the spring.



45. Determine the spring constant of the spring.

46. Calculate the energy stored in the spring when the elongation is 0.30 meter. [Show all work, including the equation and substitution with units.]