Virtual Learning

Physics

Elasticity,Stress and Strain

May 1, 2020

Physics

Elasticity, Stress and Strain: May 1,2020

Objective/Learning Target:

Students will examine the concepts of elasticity, stress and strain and use Hooke's law to solve some basic problems.

Quick Review

Watch the following video clip and answer the following questions.

[James Bond Skydive]

1. Describe the forces acting on the person the instant they began to fall from the plane.

2. At first why could James Bond not catch the first person? Describe in terms of forces

3. What did James bond do in order to catch the first person? Describe in terms of forces.

4. How did James Bond escape the last man off the plane “Jaws”. Explain in terms of forces, did Bond, James Bond actually get pulled upward?

Quick Review Answers

1. Once leaving the plane there two forces acting on the man, gravity and air drag. Gravity pulls him downward ever faster until finally the air drag equals his weight and he reaches terminal velocity.
2. Both Bond and the 1st man are at terminal velocity. Since both were about the same size their terminal velocities would be equal and therefore impossible to catch up.

Quick Review Answers

3. To speed up James Bond decreased his surface area b diving forward and therefore decreased the amount of drag. This meant forces were no longer balanced and he accelerated to a higher velocity.
4. To escape Bond increased the drag force by deploying his shoot causing a net upward force which slowed him down quickly. Jaws continued at the same rate and sped away from Bond. Bond still was moving downward the entire time, just at much slower terminal velocity, due to a larger surface area.

Problem Solving Using Newton's Laws

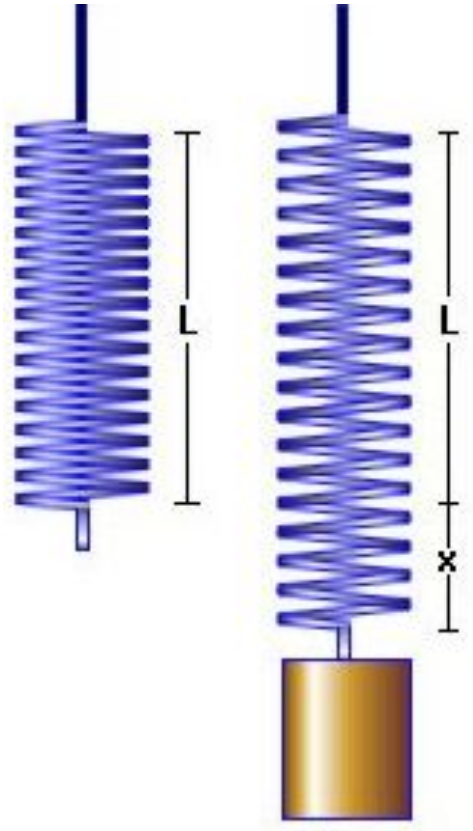
Link: Elasticity, stress and strain

Directions:

- Read through elasticity, stress, and strain..
- Work through any examples on a separate piece of paper before you scroll down to the solution.
- On a separate piece of paper complete the practice problems on the following slides.
- Check your answers.
- For additional practice check out the conceptual questions and the problems and exercises in the table of contents for the online text linked above.

Practice Problem #1

What is the magnitude of the force required to stretch a 20 cm-long spring, with a spring constant of 100 N/m, to a length of 21 cm?



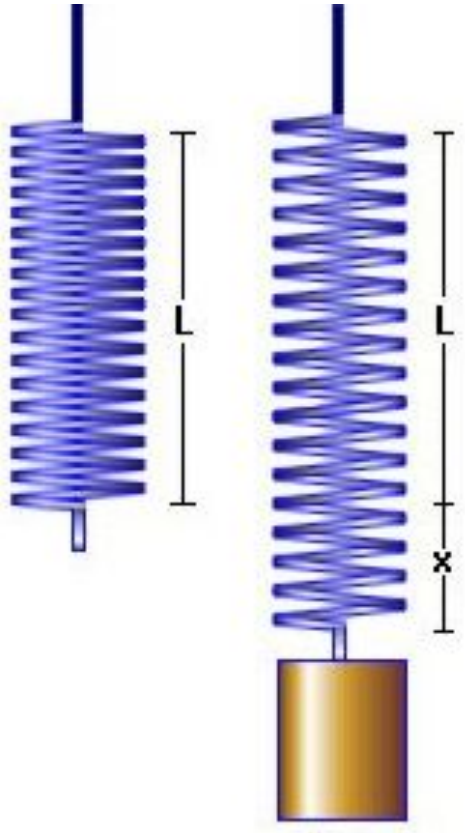
Practice Problem #1 Answer

The spring changes from a length of 20 cm to 21 cm, hence it stretches by 1 cm

or $|\Delta x| = 1 \text{ cm} = 0.01 \text{ m}.$

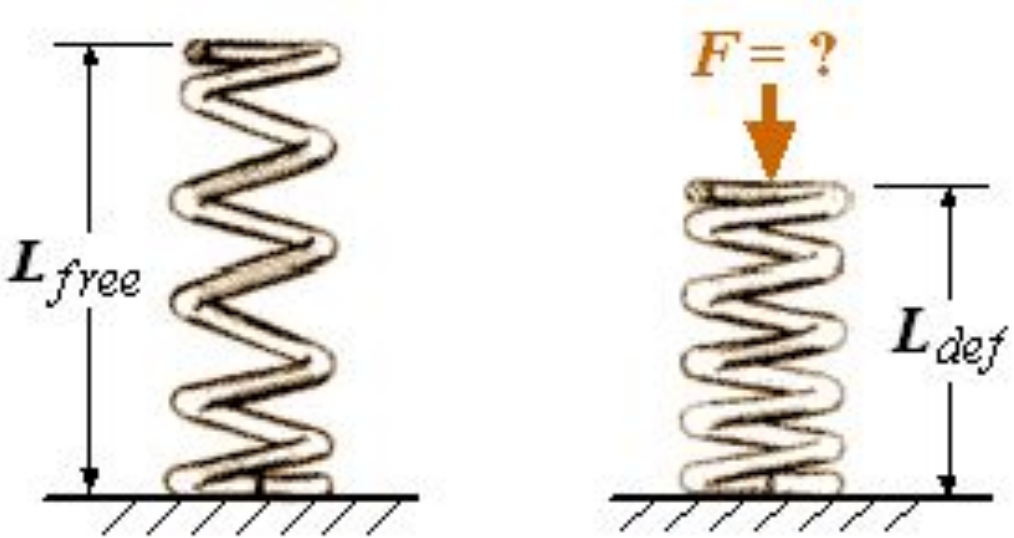
$F = k \Delta x$

$= 100 \text{ N / m} \times 0.01 \text{ m} = 1 \text{ N}$



Practice Problem #2

What is the spring constant of a spring that needs a force of 3 N to be compressed from 40 cm to 35 cm?



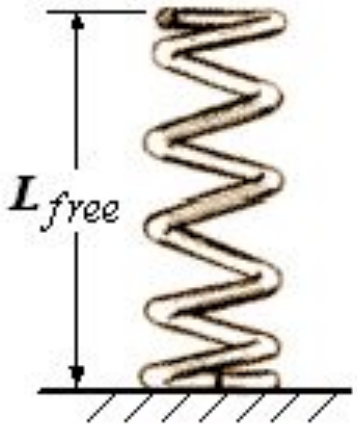
Practice Problem #2 Answer

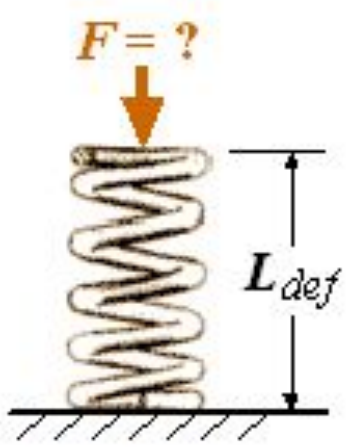
The spring changes from a length of 40 cm to 35 cm, hence it compresses 40 cm - 35 cm = 5 cm

$\Delta x = 5 \text{ cm} = 0.05 \text{ m}.$

$F = k\,x$

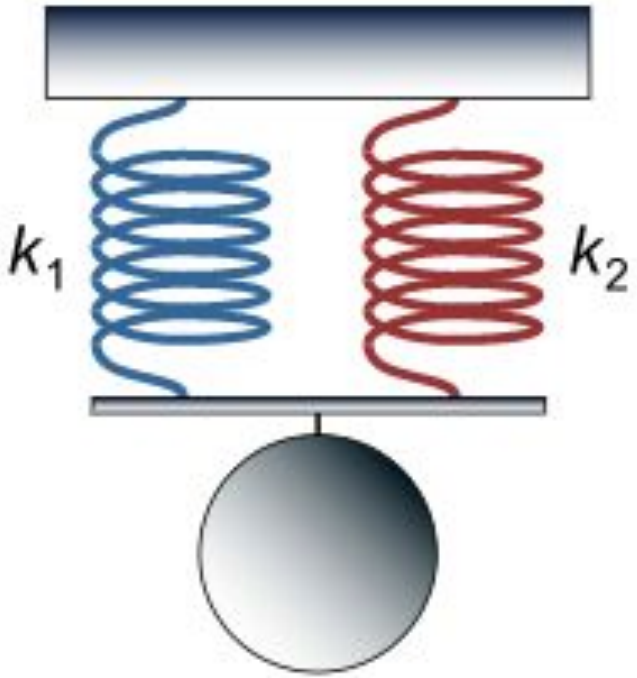
$k = \frac{F}{x} = \frac{3 \text{ N}}{0.05 \text{ m}} = 60 \text{ N/m}$





Practice Problem #3

What is the magnitude of the force required to stretch two springs of constants k_1 = 100 N/m and k_2 = 200 N/m by 6 cm if they are in parallel?



Practice Problem #3

The two springs behave like a spring with constant k given by

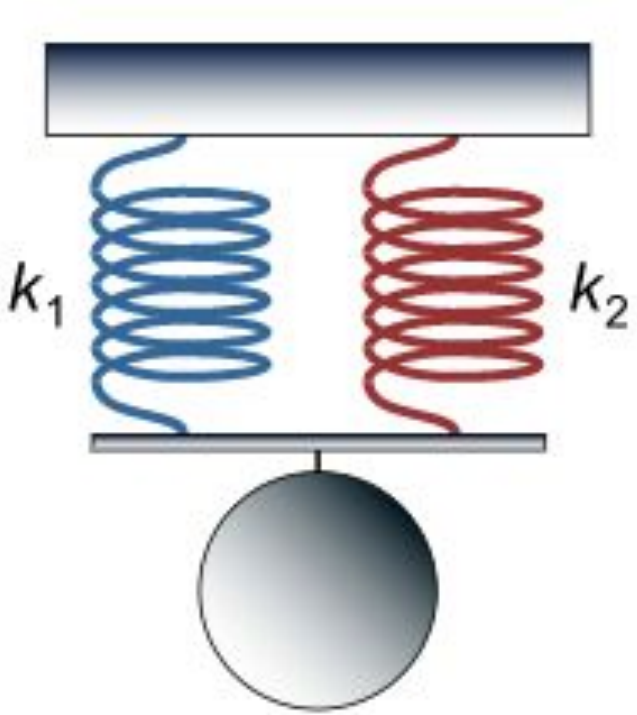
$k = k_1 + k_2$

$= 100\ \text{N/m} + 200\ \text{N/m}$

$F = kx$

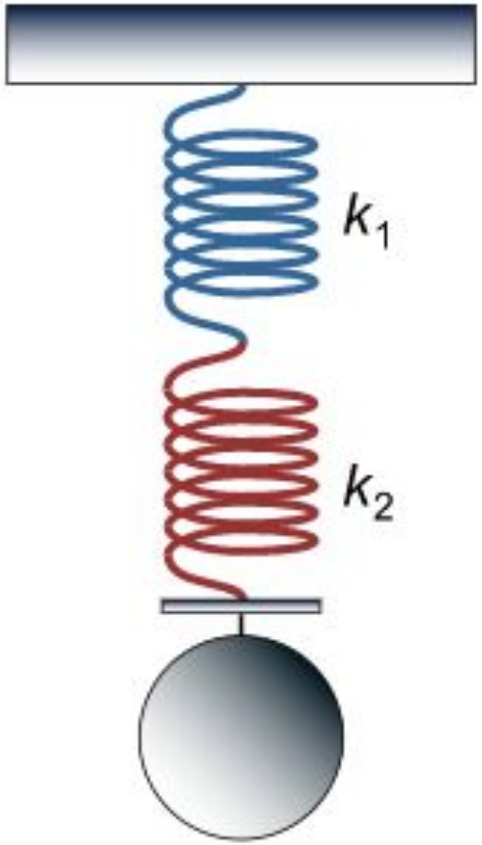
$= 300\ \text{N/m} \times 0.06\ \text{m}$

$= 18\ \text{N}$



Practice Problem #4

What is the magnitude of the force required to stretch two springs of constants 100 N/m and 200 N/m by 6 cm if they are in series?



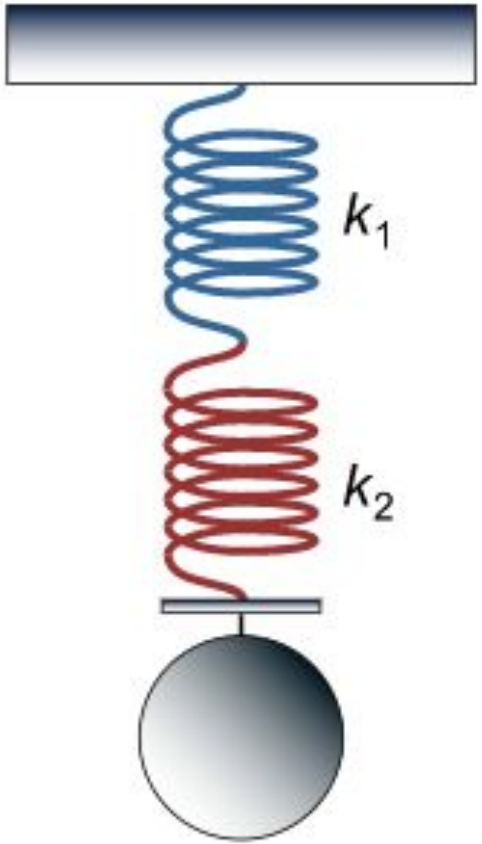
Practice Problem #4 Answer

The two springs behave like a spring with constant k obtained by solving for k the following

$$\frac{1}{k} = \frac{1}{k1} + \frac{1}{k2}.$$

$$\frac{1}{k} = \frac{1}{100} + \frac{1}{200} \rightarrow \quad k = 75 \text{ N/m}$$

$$F = kx = 75 \text{ N/m} \times 0.06 \text{ m} = 4.5 \text{ N}$$



Additional Practice

For additional practice check out the conceptual questions and the problems and exercises in the table of contents from the online text linked above.