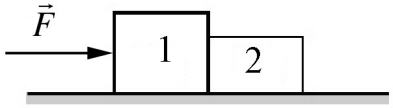
Concept of Force
Challenge Problems

Problem 1:

Force Applied to Two Blocks Two blocks sitting on a frictionless table are pushed from the left by a horizontal force $\vec{F}$, as shown below.

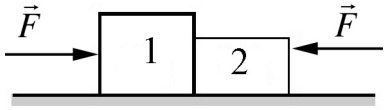


a) Draw a free-body diagram for each of the blocks.

b) What is the acceleration of the blocks?

c) Express, in terms of the quantities given in the figure, the magnitude of the contact force between the two blocks. Briefly explain why your make sense.

Suppose now a force of equal magnitude but opposite direction is applied to the block on the right.



d) What is the acceleration of the blocks?

e) What is the magnitude of the contact force between the two blocks in this case? Briefly explain why your make sense.

Problem 2: Forces Responsible for Acceleration of Car

When a car accelerates forward on a level roadway, which force is responsible for this acceleration? State clearly which body exerts this force, and on which body (or bodies) the force acts.

Problem 3: Spring Scale

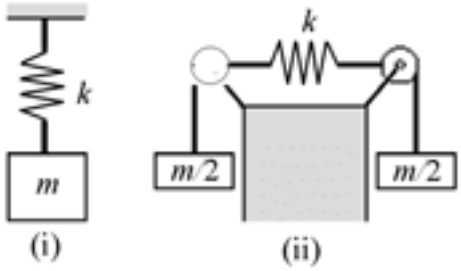
You are standing on a spring bathroom scale in an elevator and you look at the scale while the elevator is at rest with respect to the ground. Describe how the scale readings change as the elevator uniformly accelerates, moves at a constant velocity, and then uniformly decelerates. Explain your answer.

Problem 4: Hooke's Law

Consider a spring with negligible mass that has an unstretched length $l_0 = 8.8\times10^{-2}\,\text{m}$. A body with mass $m_1 = 1.5\times10^{-1}\,\text{kg}$ is suspended from one end of the spring. The other end (the upper end) of the spring is fixed. After a series of oscillations has died down, the new stretched length of the spring is $l = 9.8\times10^{-2}\,\text{m}$. Assume that the spring satisfies Hooke's Law when stretched. What is the spring constant?

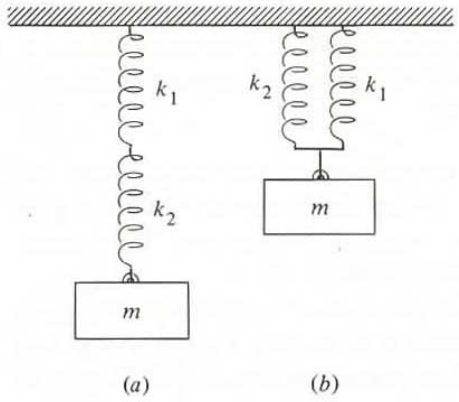
Problem 5: Force Hooke's Law

A body of mass m is suspended from a spring with spring constant k in configuration (a) and the spring is stretched 0.1m. If two identical bodies of mass $m/2$ are suspended from a spring with the same spring constant k in configuration (b), how much will the spring stretch? Explain your answer.



Problem 6: Equivalent Spring Constants

Find the effective spring constants for the two systems shown in figures (a) and (b). The block has mass m and the two springs having spring constants k_1 and k_2 respectively,



The spring with spring constant k_1 is attached to the ceiling and one end of the spring with spring constant k_2, and the other end of the second spring is attached to the block (the springs are attached in *series*).

a) Each spring is attached to the ceiling and the block (the springs are attached in *parallel*).

Problem 7: Pulling a Rope Attached to Two Trees

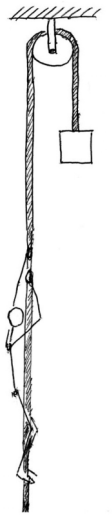
Suppose a rope is tied rather tightly between two trees that are $30\,\text{m}$ apart. You grab the middle of the rope and pull on it perpendicular to the line between the trees with as much force as you can. Assume this force is $1000\ \text{N}$ (about $225\ \text{lb}$), and the point where you are pulling on the rope is $h = 1\,\text{m}$ from the line joining the trees.

a) What is the magnitude of the force tending to pull the trees together?

b) Give an example of a situation where you think this may be of practical use.

Problem 8: Climbing a Rope

A person clings to a rope (assumed massless) that passes over a pulley. The person is balanced by a block of mass m hanging at the other end of the rope. Initially both the person and block are motionless. The person then starts climbing the rope by pulling on it with a constant force in order to reach the block. The person moves a distance L relative to the rope. Does the block move as a result of the person's climbing? If so, in which direction and by how much?



8.01SC Physics I: Classical Mechanics