Tutorial Foundations Week 5

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Figure 1: *
The Ever Given has a mass of 220,000 tonnes, and a velocity of 13.5 knots when it ran aground in the suez canal.

1. If it comes to rest over a distance of 30m, what is the average force exerted on the ship by the sand?

2. If the angle of the shore is 5°, what is the coefficient of friction between the sand and the hull of the ship? (Assume the Ever Given is completed supported by the sand at the contact point, and that the water does nothing).

3. What is the change in momentum of the ship?

4. What is the impulse imparted by the ship on the sandbanks?

5. How long did it take the Ever Given to run aground?

••53 In Anchorage, collisions of a vehicle with a moose are so common that they are referred to with the abbreviation MVC. Suppose a 1000 kg car slides into a stationary 500 kg moose on a very slippery road, with the moose being thrown through the windshield (a common MVC result). (a) What percent of the original kinetic energy is lost in the collision to other forms of energy? A similar danger occurs in Saudi Arabia because of camel–vehicle collisions (CVC). (b) What percent of the original kinetic energy is lost if the car hits a 300 kg camel? (c) Generally, does the percent loss increase or decrease if the animal mass decreases?

1 Simple Harmonic Motion

- What is the potential energy and kinetic energy of a mass on a spring moving horizontally? (eg. sliding across a table)

- What about if the mass is now moving vertically? What are the different sources of energy?

•5 **SSM** In an electric shaver, the blade moves back and forth over a distance of 2.0 mm in simple harmonic motion, with frequency 120 Hz. Find (a) the amplitude, (b) the maximum blade speed, and (c) the magnitude of the maximum blade acceleration.

••33 **GO** A block of mass $M = 5.4$ kg, at rest on a horizontal frictionless table, is attached to a rigid support by a spring of constant $k = 6000$ N/m. A bullet of mass $m = 9.5$ g and velocity $\vec{v}$ of magnitude 630 m/s strikes and is embedded in the block (Fig. 15-38). Assuming the compression of the spring is negligible until the bullet is embedded, determine (a) the speed of the block immediately after the collision and (b) the amplitude of the resulting simple harmonic motion.
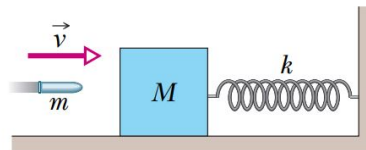
Additional Problems

•51   During a rockslide, a 520 kg rock slides from rest down a hill-side that is 500 m long and 300 m high. The coefficient of kinetic friction between the rock and the hill surface is 0.25. (a) If the gravitational potential energy U of the rock–Earth system is zero at the bottom of the hill, what is the value of U just before the slide? (b) How much energy is transferred to thermal energy during the slide? (c) What is the kinetic energy of the rock as it reaches the bottom of the hill? (d) What is its speed then?

••3   Figure 9-36 shows a slab with dimensions $d_1 = 11.0$ cm, $d_2 = 2.80$ cm, and $d_3 = 13.0$ cm. Half the slab consists of aluminum (density $= 2.70$ g/cm³) and half consists of iron (density $= 7.85$ g/cm³). What are (a) the x coordinate, (b) the y coordinate, and (c) the z coordinate of the slab's center of mass?
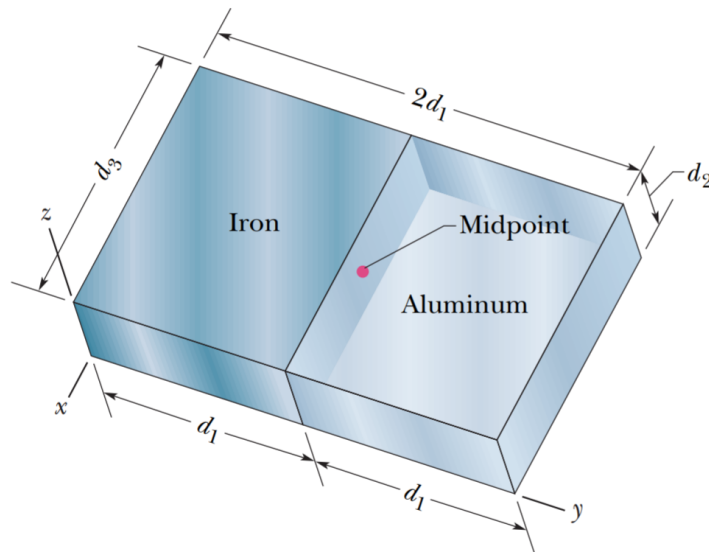

Fig. 9-36   Problem 3.

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•24 ✈ In February 1955, a paratrooper fell 370 m from an airplane without being able to open his chute but happened to land in snow, suffering only minor injuries. Assume that his speed at impact was 56 m/s (terminal speed), that his mass (including gear) was 85 kg, and that the magnitude of the force on him from the snow was at the survivable limit of 1.2×10^5 N. What are (a) the minimum depth of snow that would have stopped him safely and (b) the magnitude of the impulse on him from the snow?

••24 A block of mass $m = 2.0$ kg is dropped from height $h = 40$ cm onto a spring of spring constant $k = 1960$ N/m (Fig. 8-37). Find the maximum distance the spring is compressed.
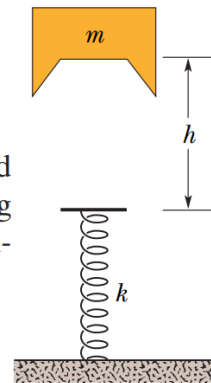

Fig. 8-37
Problem 24.

96 ✈ A spider can tell when its web has captured, say, a fly because the fly's thrashing causes the web threads to oscillate. A spider can even determine the size of the fly by the frequency of the oscillations. Assume that a fly oscillates on the *capture thread* on which it is caught like a block on a spring. What is the ratio of oscillation frequency for a fly with mass m to a fly with mass $2.5m$?