68. (II) How fast must a cyclist climb a 6.0° hill to maintain a power output of 0.25 hp? Neglect work done by friction, and assume the mass of cyclist plus bicycle is 68 kg.

69. (II) A 1200-kg car has a maximum power output of 120 hp. How steep a hill can it climb at a constant speed of 75 km/h if the frictional forces add up to 650 N?

70. (II) What minimum horsepower must a motor have to be able to drag a 310-kg box along a level floor at a speed of 1.20 m/s if the coefficient of friction is 0.45?

71. (III) A bicyclist coasts down a 7.0° hill at a steady speed of 5.0 m/s. Assuming a total mass of 75 kg (bicycle plus rider), what must be the cyclist's power output to climb the same hill at the same speed?

General Problems

72. Designers of today's cars have built "5 mi/h (8 km/h) bumpers" that are designed to compress and rebound elastically without any physical damage at speeds below 8 km/h. If the material of the bumpers permanently deforms after a compression of 1.5 cm, but remains like an elastic spring up to that point, what must the effective spring stiffness constant of the bumper be, assuming the car has a mass of 1300 kg and is tested by ramming into a solid wall?

73. In a certain library the first shelf is 10.0 cm off the ground, and the remaining four shelves are each spaced 30.0 cm above the previous one. If the average book has a mass of 1.5 kg with a height of 21 cm, and an average shelf holds 25 books, how much work is required to fill all the shelves, assuming the books are all laying flat on the floor to start?

74. A film of Jesse Owens's famous long jump (Fig. 6–42) in the 1936 Olympics shows that his center of mass rose 1.1 m from launch point to the top of the arc. What minimum speed did he need at launch if he was traveling at 6.5 m/s at the top of the arc?

FIGURE 6–42 Problem 74.

75. The block of mass m sliding without friction along the looped track shown in Fig. 6–39 is to remain on the track at all times, even at the very top of the loop of radius r. (a) In terms of the given quantities, determine the minimum release height h (as in Problem 40). Next, if the actual release height is $2h$, calculate (b) the normal force exerted by the track at the bottom of the loop, (c) the normal force exerted by the track at the top of the loop, and (d) the normal force exerted by the track after the block exits the loop onto the flat section.

76. An airplane pilot fell 370 m after jumping from an aircraft without his parachute opening. He landed in a snowbank, creating a crater 1.1 m deep, but survived with only minor injuries. Assuming the pilot's mass was 78 kg and his terminal velocity was 35 m/s, estimate (a) the work done by the snow in bringing him to rest; (b) the average force exerted on him by the snow to stop him; and (c) the work done on him by air resistance as he fell.

77. A ball is attached to a horizontal cord of length L whose other end is fixed (Fig. 6–43). (a) If the ball is released, what will be its speed at the lowest point of its path? (b) A peg is located a distance h directly below the point of attachment of the cord. If $h = 0.80L$, what will be the speed of the ball when it reaches the top of its circular path about the peg?

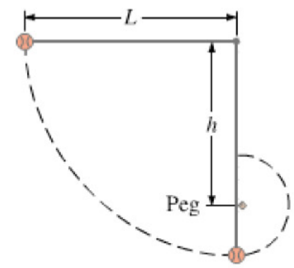

FIGURE 6–43 Problem 77.

78. A 65-kg hiker climbs to the top of a 3700-m-high mountain. The climb is made in 5.0 h starting at an elevation of 2300 m. Calculate (a) the work done by the hiker against gravity, (b) the average power output in watts and in horsepower, and (c) assuming the body is 15% efficient, what rate of energy input was required.

79. An elevator cable breaks when a 920-kg elevator is 28 m above a huge spring ($k = 2.2 \times 10^5$ N/m) at the bottom of the shaft. Calculate (a) the work done by gravity on the elevator before it hits the spring, (b) the speed of the elevator just before striking the spring, and (c) the amount the spring compresses (note that work is done by both the spring and gravity in this part).

80. Squaw Valley ski area in California claims that its lifts can move 47,000 people per hour. If the average lift carries people about 200 m (vertically) higher, estimate the power needed.

81. Water flows ($v \approx 0$) over a dam at the rate of 650 kg/s and falls vertically 81 m before striking the turbine blades. Calculate (a) the speed of the water just before striking the turbine blades (neglect air resistance), and (b) the rate at which mechanical energy is transferred to the turbine blades, assuming 58% efficiency.

82. Show that on a roller coaster with a circular vertical loop (Fig. 6–44), the difference in your apparent weight at the top of the circular loop and the bottom of the circular loop is 6 g's—that is, six times your weight. Ignore friction. Show also that as long as your speed is above the minimum needed, this answer doesn't depend on the size of the loop or how fast you go through it.

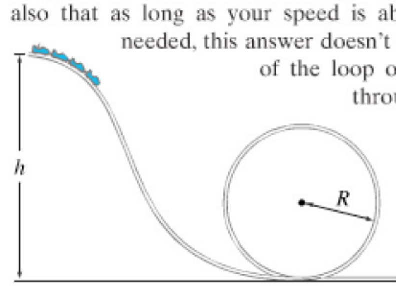

FIGURE 6–44 Problem 82.