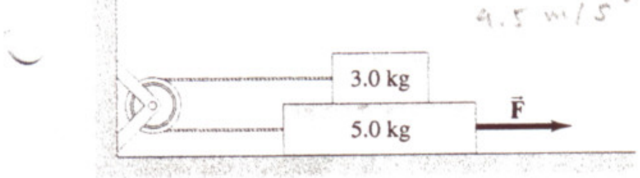
(II) A uniform disk turns at 3.7 rev/s around a frictionless spindle. A nonrotating rod, of the same mass as the disk and length equal to the disk's diameter, is dropped onto the freely spinning disk, Fig. 11-31. They then turn together around the spindle with their centers superposed. What is the angular frequency in rev/s of the combination?

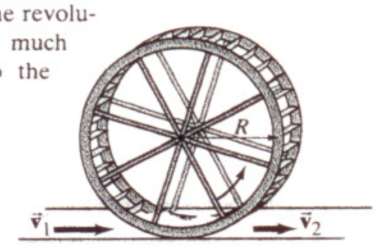
31. (III) A 3.0-kg block sits on top of a 5.0-kg block which is on a horizontal surface. The 5.0-kg block is pulled to the right with a force $\vec{F}$ as shown in Fig. 5–39. The coefficient of static friction between all surfaces is 0.60 and the kinetic coefficient is 0.40. (*a*) What is the minimum value of *F* needed to move the two blocks? (*b*) If the force is 10% greater than your answer for (*a*), what is the acceleration of each block?

82 N
4.5 m/s²

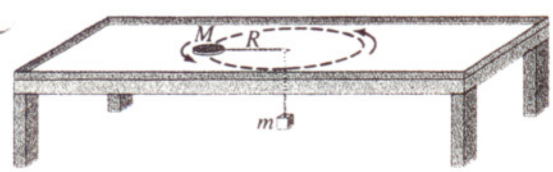


73. Water drives a waterwheel (or turbine) of radius $R = 3.0$ m as shown in Fig. 11–47. The water enters at a speed $v_1 = 7.0$ m/s and exits from the waterwheel at a speed $v_2 = 3.8$ m/s. (*a*) If 85 kg of water passes through per second, what is the rate at which the water delivers angular momentum to the waterwheel? (*b*) What is the torque the water applies to the waterwheel? (*c*) If the water causes the waterwheel to make one revolution every 5.5 s, how much power is delivered to the wheel?

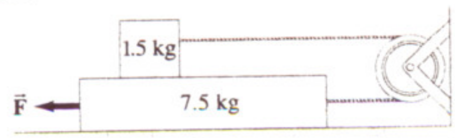
820 kg m²/s
820 Nm
930 W



80 flat puck (mass *M*) is revolved in a circle on a frictionless air hockey table top, and is held in this orbit by a light cord which is connected to a dangling mass (mass *m*) through a central hole as shown in Fig. 5–48. Show that the speed of the puck is given by $v = \sqrt{mgR/M}$.

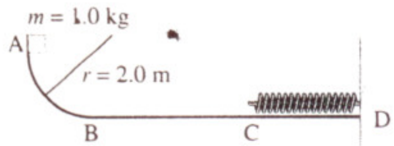


87. A 1.5-kg block rests on top of a 7.5-kg block
The cord and pulley have negligible mass, and there is no significant friction anywhere. (*a*) What force *F* must be applied to the bottom block so the top block accelerates to the right at 2.5 m/s²? (*b*) What is the tension in the connecting cord?

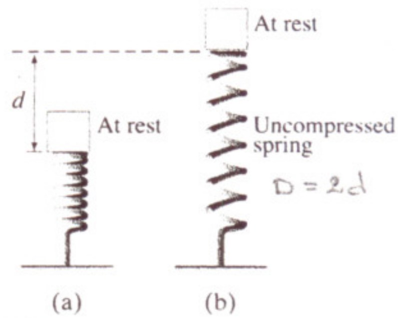


23 N
3.8 N

... The section AB is one quadrant of a circle of radius 2.0 m and is frictionless. B to C is a horizontal span 3.0 m long with a coefficient of kinetic friction $\mu_k = 0.25$. The section CD under the spring is frictionless. A block of mass 1.0 kg is released from rest at A. After sliding on the track, it compresses the spring by 0.20 m. Determine: (*a*) the velocity of the block at point B; (*b*) the thermal energy produced as the block slides from B to C; (*c*) the velocity of the block at point C; (*d*) the stiffness constant *k* for the spring.



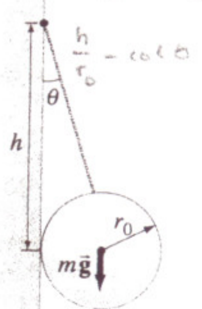
21. (II) When a mass *m* sits at rest on a spring, the spring is compressed by a distance *d* from its undeformed length (Fig. 8–33a). Suppose instead that the mass is released from rest when it barely touches the undeformed spring (Fig. 8–33b). Find the distance *D* that the spring is compressed before it is able to stop the mass. Does $D = d$? If not, why not?



D = 2d

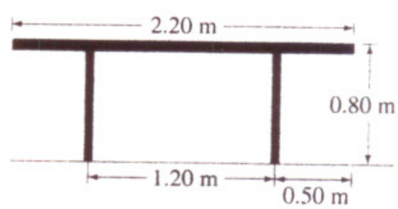
93. A uniform sphere of weight *mg* and radius r_0 is tethered to a wall by a rope of length ℓ. The rope is tied to the wall a distance *h* above the contact point of the sphere, as shown in Fig. 12–99. The rope makes an angle θ with respect to the wall and is not in line with the ball's center. The coefficient of static friction between the wall and sphere is μ. (*a*) Determine the value of the frictional force on the sphere due to the wall. [*Hint*: A wise choice of axis will make this calculation easy.] (*b*) Suppose the sphere is just on the verge of slipping. Derive an expression for μ in terms of *h* and θ.

mg(1 − r₀/h cot θ)
h/r₀ − cot θ



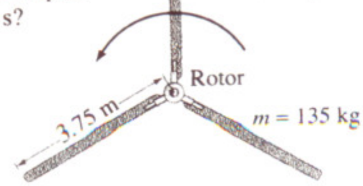
3. (II) How close to the edge of the 24.0-kg table shown in Fig. 12–53 can a 66.0-kg person sit without tipping it over?

0.28 m

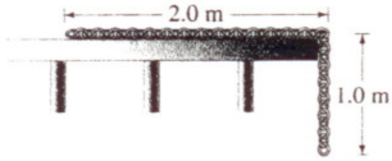


47. (II) A helicopter rotor blade can be considered a long thin rod, as shown in Fig. 10–55. (*a*) If each of the three rotor helicopter blades is 3.75 m long and has a mass of 135 kg, calculate the moment of inertia of the three rotor blades about the axis of rotation. (*b*) How much torque must the motor apply to bring the blades from rest up to a speed of 5.0 rev/s in 8.0 s?

1.90 · 10³ kg m²
7.5 · 10³ Nm

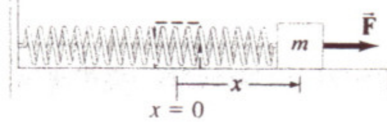


49. (III) A 3.0-m-long steel chain is stretched out along the top level of a horizontal scaffold at a construction site, in such a way that 2.0 m of the chain remains on the top level and 1.0 m hangs vertically, Fig. 7–26. At this point, the force on the hanging segment is sufficient to pull the entire chain over the edge. Once the chain is moving, the kinetic friction is so small that it can be neglected. How much work is performed on the chain by the force of gravity as the chain falls from the point where 2.0 m remains on the scaffold to the point where the entire chain has left the scaffold? (Assume that the chain has a linear weight density of 18 N/m.)



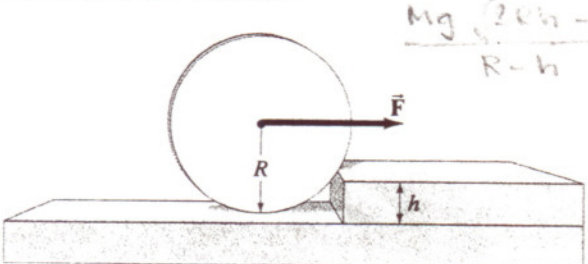
72 J

57. (II) A mass m is attached to a spring which is held stretched a distance x by a force F (Fig. 7–28), and then released. The spring compresses, pulling the mass. Assuming there is no friction, determine the speed of the mass m when the spring returns: (*a*) to its normal length ($x = 0$); (*b*) to half its original extension ($x/2$).

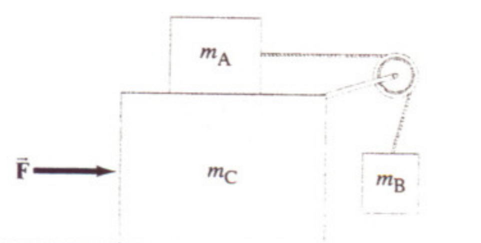


93. A wheel of mass M has radius R. It is standing vertically on the floor, and we want to exert a horizontal force F at its axle so that it will climb a step against which it rests (Fig. 10–66). The step has height h, where $h < R$. What minimum force F is needed?

$$\frac{Mg\sqrt{2Rh - h^2}}{R - h}$$

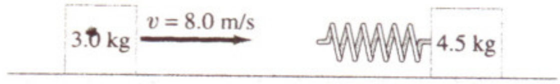


59. (III) Determine a formula for the magnitude of the force $\vec{F}$ exerted on the large block (m_C) in Fig. 4–51 so that the mass m_A does not move relative to m_C. Ignore all friction. Assume m_B does not make contact with m_C.

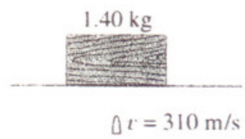


$$\frac{(m_A + m_B + m_C)\, m_B}{\sqrt{(m_A^2 + m_B^2)}}\, g$$

41. (III) A 3.0-kg block slides along a frictionless tabletop at 8.0 m/s toward a second block (at rest) of mass 4.5 kg. A coil spring, which obeys Hooke's law and has spring constant $k = 850$ N/m, is attached to the second block in such a way that it will be compressed when struck by the moving block, Fig. 9–40. (*a*) What will be the maximum compression of the spring? (*b*) What will be the final velocities of the blocks after the collision? (*c*) Is the collision elastic? Ignore the mass of the spring.

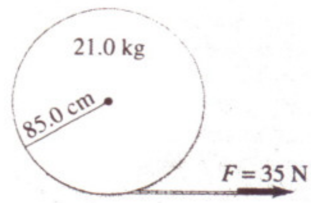


89. A gun fires a bullet vertically into a 1.40-kg block of wood at rest on a thin horizontal sheet, Fig. 9–50. If the bullet has a mass of 24.0 g and a speed of 310 m/s, how high will the block rise into the air after the bullet becomes embedded in it?



1.4 m

100. A solid uniform disk of mass 21.0 kg and radius 85.0 cm is at rest flat on a frictionless surface. Figure 10–71 shows a view from above. A string is wrapped around the rim of the disk and a constant force of 35.0 N is applied to the string. The string does not slip on the rim. (*a*) In what direction does the CM move? When the disk has moved a distance of 5.5 m, determine (*b*) how fast it is moving, (*c*) how fast it is spinning (in radians per second), and (*d*) how much string has unwrapped from around the rim.



99. The radius of the roll of paper shown in Fig. 10–70 is 7.6 cm and its moment of inertia is $I = 3.3 \times 10^{-3}\ \text{kg}\cdot\text{m}^2$. A force of 2.5 N is exerted on the end of the roll for 1.3 s, but the paper does not tear so it begins to unroll. A constant friction torque of 0.11 m·N is exerted on the roll which gradually brings it to a stop. Assuming that the paper's thickness is negligible, calculate (*a*) the length of paper that unrolls during the time that the force is applied (1.3 s) and (*b*) the length of paper that unrolls from the time the force ends to the time when the roll has stopped moving.

1.6 m
1.1 m