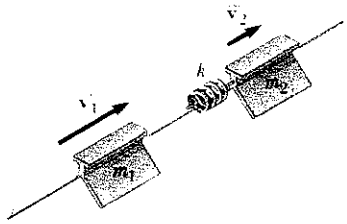
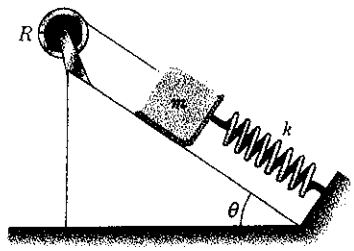
11
01

Two gliders are set in motion on an air track. A spring force constant k is attached to the near side of one glider. The first glider of mass m_1 has velocity $\vec{\mathbf{v}}_1$, and the second glider of mass m_2 moves more slowly, with velocity $\vec{\mathbf{v}}_2$, as shown in Figure P8.46. When m_1 collides with the spring attached to m_2 and compresses the spring to its maximum compression x_{max}, the velocity of the gliders is $\vec{\mathbf{v}}$. In terms of $\vec{\mathbf{v}}_1$, $\vec{\mathbf{v}}_2$, m_1, m_2, and k, find (a) the velocity $\vec{\mathbf{v}}$ at maximum compression, (b) the maximum compression x_{max}, and (c) the velocity of each glider after m_1 has lost contact with the spring.



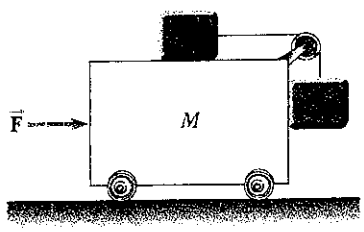
11
02

The reel shown in Figure [redacted] has radius R and moment of inertia I. One end of the block of mass m is connected to a spring of force constant k, and the other end is fastened to a cord wrapped around the reel. The reel axle and the incline are frictionless. The reel is wound counterclockwise so that the spring stretches a distance d from its unstretched position and is then released from rest. (a) Find the angular speed of the reel when the spring is again unstretched. (b) Evaluate the angular speed numerically at this point, taking $I = 1.00\ \text{kg}\cdot\text{m}^2$, $R = 0.300\ \text{m}$, $k = 50.0\ \text{N/m}$, $m = 0.500\ \text{kg}$, $d = 0.200\ \text{m}$, and $\theta = 37.0°$.



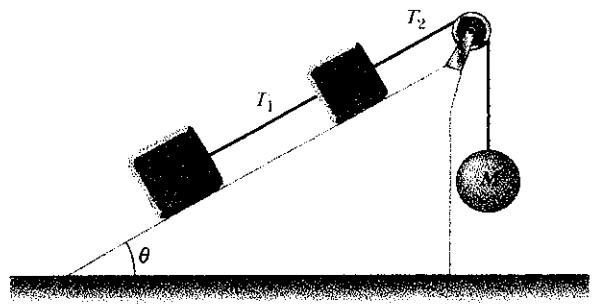
11
03

What horizontal force must be applied to the cart shown in Figure [redacted] so that the blocks remain stationary relative to the cart? Assume that all surfaces, wheels, and pulley are frictionless. ~~(Suggestion: Note that the force exerted by the string accelerates m_2.)~~



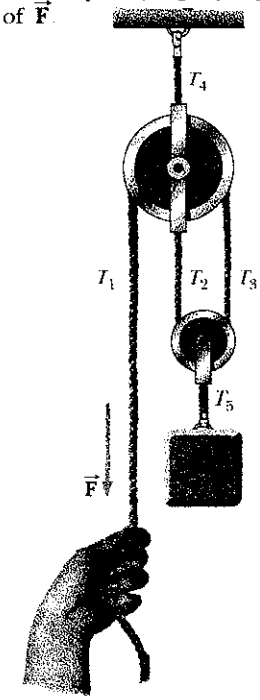
11
04

Consider the three connected objects shown in Figure [redacted]. Assume first that the inclined plane is frictionless and that the system is in equilibrium. In terms of m, g, and θ, find (a) the mass M and (b) the tensions T_1 and T_2. Now assume that the value of M is double the value found in part (a). Find (c) the acceleration of each object and (d) the tensions T_1 and T_2. Next, assume that the coefficient of static friction between m and $2m$ and the inclined plane is μ_s and that the system is in equilibrium. Find (e) the maximum value of M and (f) the minimum value of M. (g) Compare the values of T_2 when M has its minimum and maximum values.



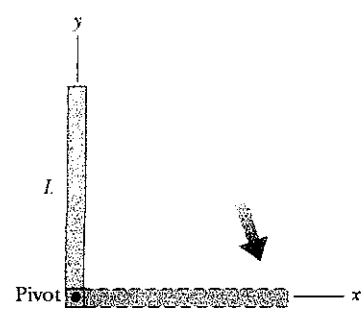
4
05

Physics Now An object of mass M is held in place by an applied force $\vec{\mathbf{F}}$ and a pulley system as shown in Figure P4.45. The pulleys are massless and frictionless. Find (a) the tension in each section of rope, T_1, T_2, T_3, T_4 and T_5 and (b) the magnitude of $\vec{\mathbf{F}}$.



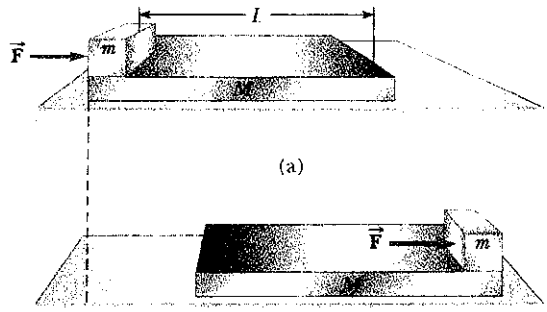
11
06

A long uniform rod of length L and mass M is pivoted about a horizontal, frictionless pin through one end. The rod is released from rest in a vertical position as shown in Figure [redacted]. At the instant the rod is horizontal, find (a) its angular speed, (b) the magnitude of its angular acceleration, (c) the x and y components of the acceleration of its center of mass, and (d) the components of the reaction force at the pivot.



4
07

A block of mass $m = 2.00$ kg rests on the left edge of a block of mass $M = 8.00$ kg. The coefficient of kinetic friction between the two blocks is 0.300, and the surface on which the 8.00-kg block rests is frictionless. A constant horizontal force of magnitude $F = 10.0$ N is applied to the 2.00-kg block, setting it in motion as shown in Figure [illegible]a. If the distance L that the leading edge of the smaller block travels on the larger block is 3.00 m, (a) in what time interval will the smaller block make it to the right side of the 8.00-kg block as shown in Figure [illegible]? (*Note:* Both blocks are set into motion when $\vec{F}$ is applied.) (b) How far does the 8.00-kg block move in the process?

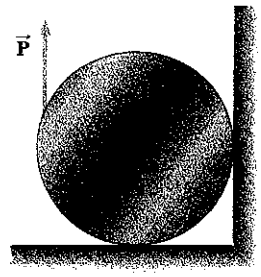


(a)

(b)

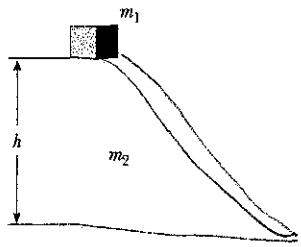
4
08

Figure [illegible] shows a vertical force applied tangentially to a uniform cylinder of weight F_g. The coefficient of static friction between the cylinder and all surfaces is 0.500. In terms of F_g, find the maximum force P that can be applied that does not cause the cylinder to rotate. (*Suggestion:* When the cylinder is on the verge of slipping, both friction forces are at their maximum values. Why?)

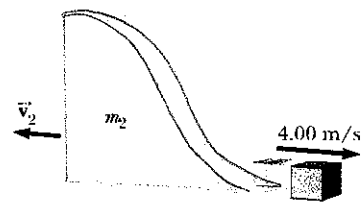


4
09

A small block of mass $m_1 = 0.500$ kg is released from rest at the top of a curve-shaped, frictionless wedge of mass $m_2 = 3.00$ kg, which sits on a frictionless, horizontal surface as shown in Figure [illegible]. When the block leaves the wedge, its velocity is measured to be 4.00 m/s to the right as shown in Figure P8.51b. (a) What is the velocity of the wedge after the block reaches the horizontal surface? (b) What is the height h of the wedge?



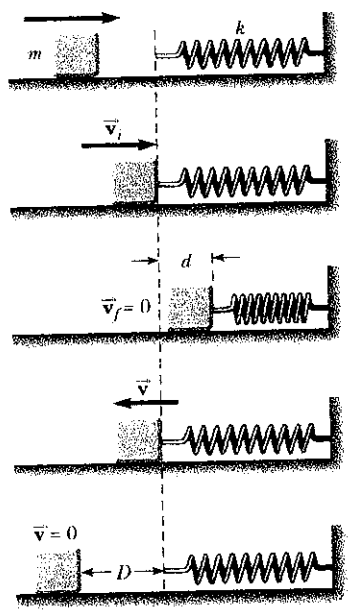
(a)



(b)

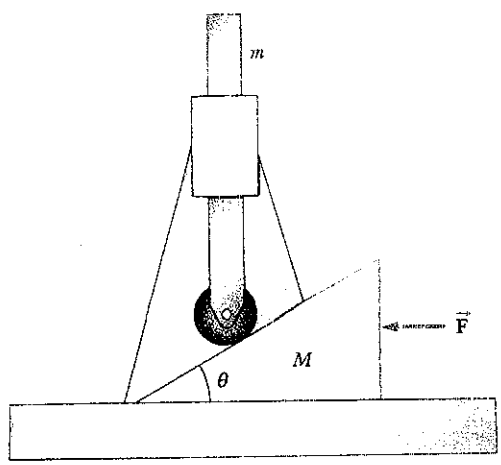
4
010

A 1 00-kg object slides to the right on a surface having a coefficient of kinetic friction 0 250 [redacted] The object has a speed of v_i = 3 00 m/s when it makes contact with a light spring that has a force constant of 50 0 N/m The object comes to rest after the spring has been compressed a distance d The object is then forced toward the left by the spring and continues to move in that direction beyond the spring s unstretched position The object finally comes to rest a distance D to the left of the unstretched spring Find (a) the distance of compression d (b) the speed v at the unstretched position when the object is moving to the left, and (c) the distance D where the object comes to rest



4
011

Cam mechanisms are used in many machines For example cams open and close the valves in your car engine to admit gasoline vapor to each cylinder and to allow the escape of exhaust The principle is illustrated in Figure [redacted] showing a follower rod (also called a pushrod) of mass m resting on a wedge of mass M The sliding wedge duplicates the function of a rotating eccentric disk on a car's camshaft Assume that there is no friction between the wedge and the base, between the pushrod and the wedge, or between the rod and the guide through which it slides When the wedge is pushed to the left by the force $\vec{F}$ the rod moves upward and does something such as opening a valve By varying the shape of the wedge, the motion of the follower rod could be made quite complex, but assume that the wedge makes a constant angle of θ = 15 0° Suppose you want the wedge and the rod to start from rest and move with constant acceleration, with the rod moving upward 1 00 mm in 8 00 ms Take m = 0 250 kg and M = 0 500 kg What force F must be applied to the wedge?

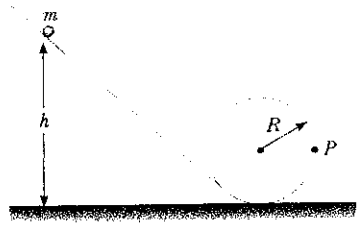


4
012

A uniform chain of length 8.00 m initially lies stretched out on a horizontal table. (a) Assuming that the coefficient of static friction between chain and table is 0.600, show that the chain will begin to slide off the table if at least 3.00 m of it hangs over the edge of the table. (b) Determine the speed of the chain as it all leaves the table, given that the coefficient of kinetic friction between the chain and the table is 0.400.

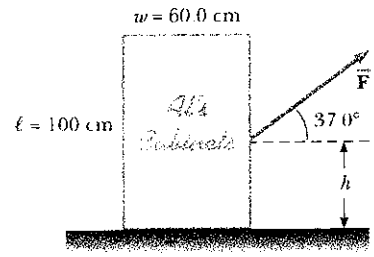
4
013

A solid sphere of mass m and radius r rolls without slipping along the track shown in Figure [illegible]. It starts from rest with the lowest point of the sphere at height h above the bottom of the loop of radius R much larger than r. (a) What is the minimum value of h (in terms of R) such that the sphere completes the loop? (b) What are the force components on the sphere at the point P if $h = 3R$?



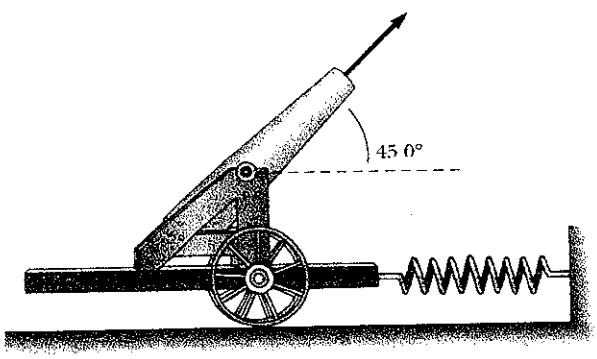
4
014

A force acts on a rectangular cabinet weighing 400 N as shown in Figure [illegible]. (a) Assuming that the cabinet slides with constant speed when $F = 200$ N and $h = 0.400$ m, find the coefficient of kinetic friction and the position of the resultant normal force. (b) Taking $F = 300$ N, find the value of h for which the cabinet just begins to tip.



015

A cannon is rigidly attached to a carriage, which can move along horizontal rails but is connected to a post by a large spring, initially unstretched and with force constant $k = 2.00 \times 10^4$ N/m, as shown in Figure [illegible]. The cannon fires a 200-kg projectile at a velocity of 125 m/s directed 45.0° above the horizontal. (a) Assuming that the mass of the cannon and its carriage is 5 000 kg, find the recoil speed of the cannon. (b) Determine the maximum extension of the spring. (c) Find the maximum force the spring exerts on the carriage. (d) Consider the system consisting of the cannon, carriage, and projectile. Is the momentum of this system conserved during the firing? Why or why not?



4
016

A toy cannon uses a spring to project a 5.30-g soft rubber ball. The spring is originally compressed by 5.00 cm and has a force constant of 8.00 N/m. When it is fired, the ball moves 15.0 cm through the horizontal barrel of the cannon, and the barrel exerts a constant friction force of 0.032 0 N on the ball. (a) With what speed does the projectile leave the barrel of the cannon? (b) At what point does the ball have maximum speed? (c) What is this maximum speed?