دانشکده مهندسی مکانیک

تمرین درس مکاترونیک

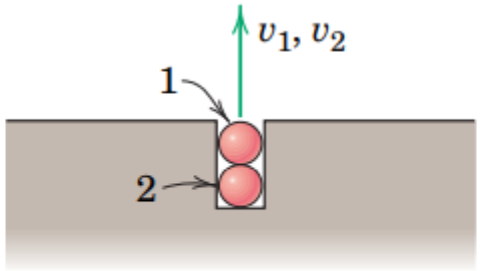
نام و شماره دانشجویی:

DYNAMICS REVIEW EXERCISES

Chapter 1 – 3

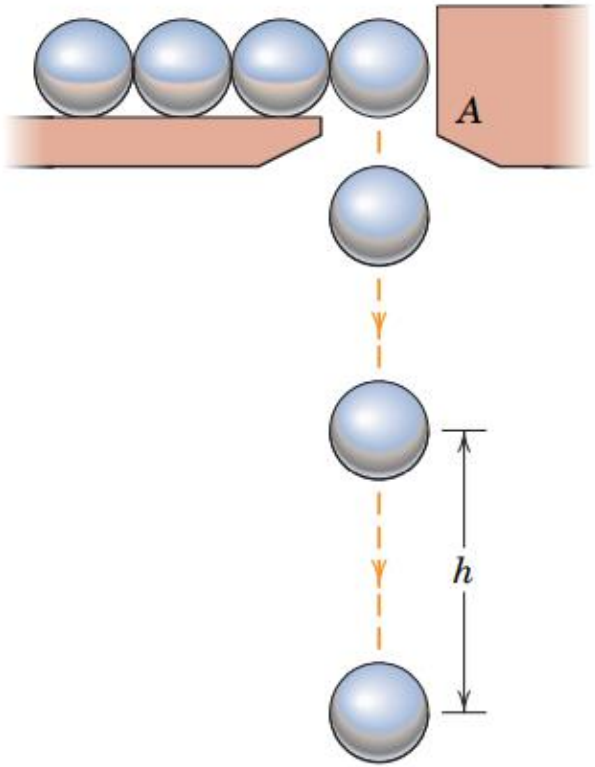
2/3 The velocity of a particle which moves along the s-axis is given by $v = 2 + 5t^{3/2}$, where t is in seconds and v is in meters per second. Evaluate the displacement s, velocity v, and acceleration a when $t = 4$ s. The particle is at the origin $s = 0$ when $t = 0$.

2/9 Ball 1 is launched with an initial vertical velocity $v_1 = 160$ ft/sec. Three seconds later, ball 2 is launched with an initial vertical velocity v_2. Determine v_2 if the balls are to collide at an altitude of 300 ft. At the instant of collision, is ball 1 ascending or descending?



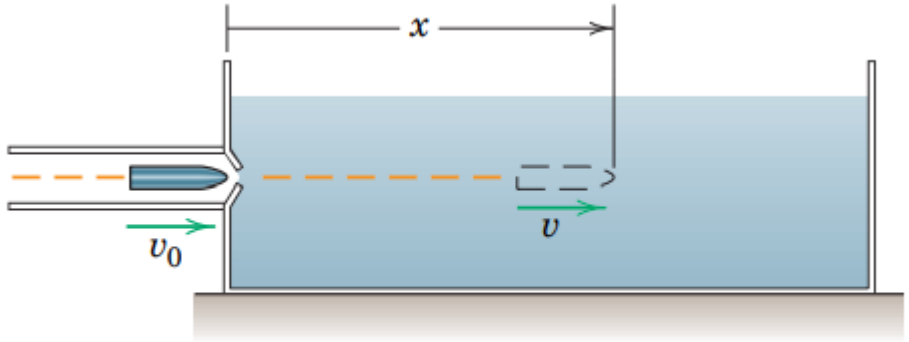
PROBLEM 2/9

2/21 Small steel balls fall from rest through the opening at A at the steady rate of two per second. Find the vertical separation h of two consecutive balls when the lower one has dropped 3 meters. Neglect air resistance.



PROBLEM 2/21

2/40 SS A test projectile is fired horizontally into a viscous liquid with a velocity v_0. The retarding force is proportional to the square of the velocity, so that the acceleration becomes $a = -kv^2$. Derive expressions for the distance D traveled in the liquid and the corresponding time t required to reduce the velocity to $v_0/2$. Neglect any vertical motion.

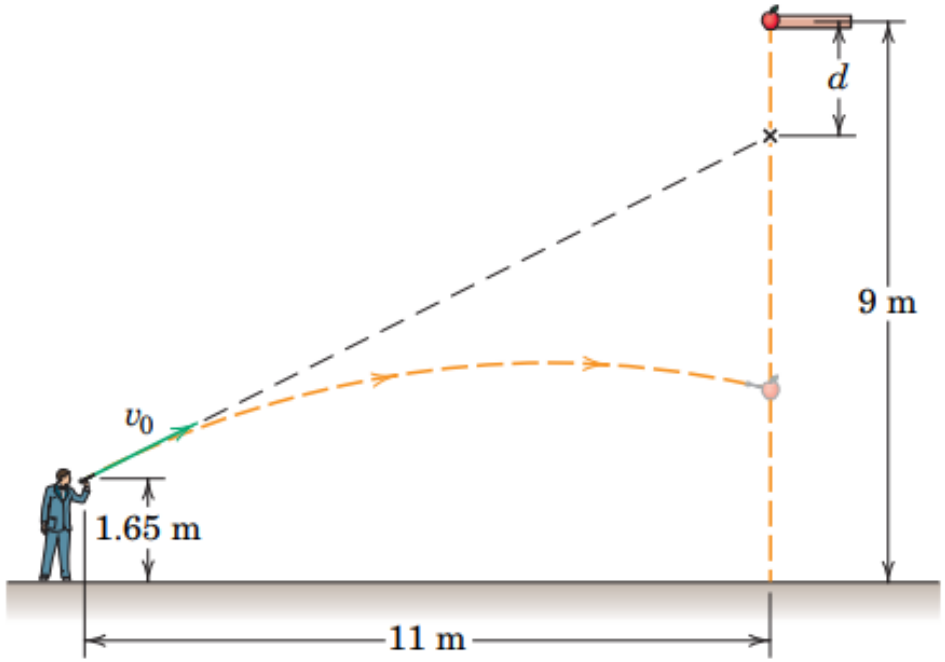


PROBLEM 2/40

2/47 At time $t = 0$, the position vector of a particle moving in the x-y plane is $\mathbf{r} = 5\mathbf{i}$ m. By time $t = 0.02$ s, its position vector has become $5.1\mathbf{i} + 0.4\mathbf{j}$ m. Determine the magnitude v_{av} of its average velocity during this interval and the angle θ made by the average velocity with the positive x-axis.

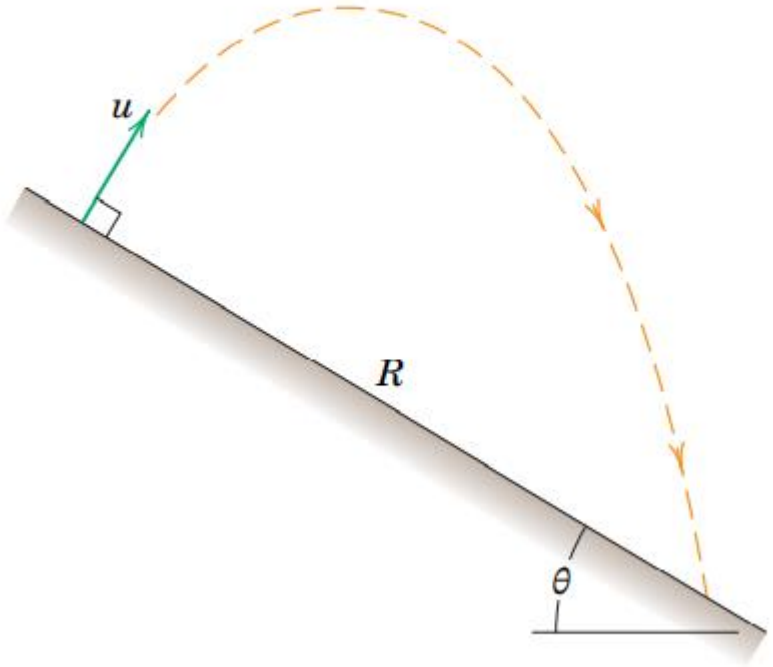
2/52 Prove the well-known result that, for a given launch speed v_0, the launch angle $\theta = 45°$ yields the maximum horizontal range R. Determine the maximum range. (Note that this result does not hold when aerodynamic drag is included in the analysis.)

2/59 As part of a circus performance, a man is attempting to throw a dart into an apple which is dropped from an overhead platform. Upon release of the apple, the man has a reflex delay of 215 milliseconds before throwing the dart. If the dart is released with a speed $v_0 = 14$ m/s, at what distance d below the platform should the man aim if the dart is to strike the apple before it hits the ground?



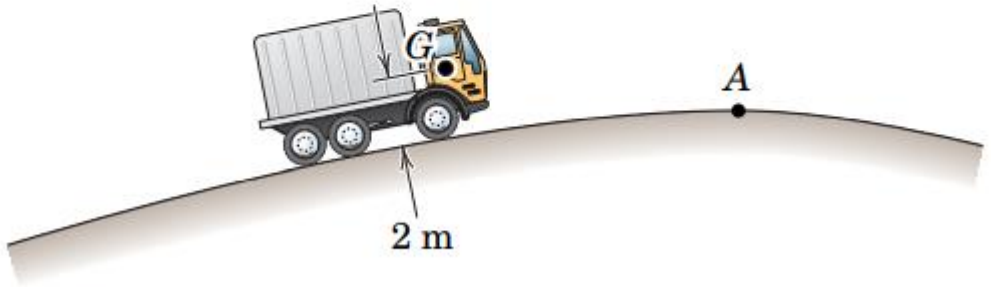
PROBLEM 2/59

2/72 A projectile is fired with a velocity u at right angles to the slope, which is inclined at an angle θ with the horizontal. Derive an expression for the distance R to the point of impact.



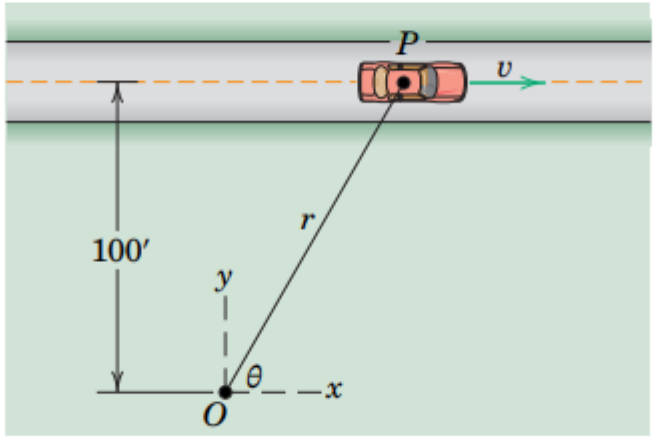
PROBLEM 2/72

2/82 The driver of the truck has an acceleration of $0.4g$ as the truck passes over the top A of the hump in the road at constant speed. The radius of curvature of the road at the top of the hump is 98 m, and the center of mass G of the driver (considered a particle) is 2 m above the road. Calculate the speed v of the truck.



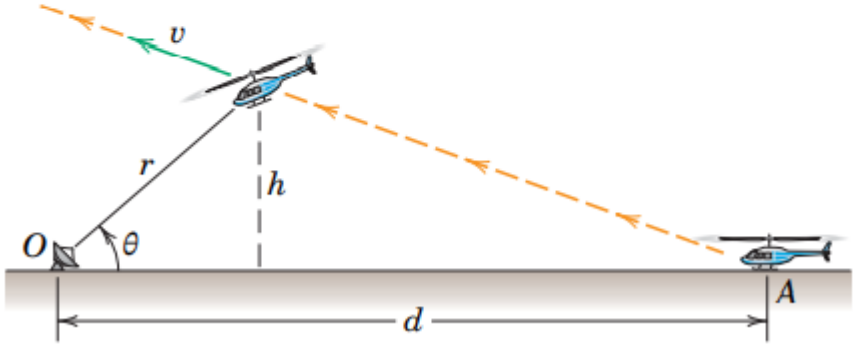
PROBLEM 2/82

2/105 A car P travels along a straight road with a constant speed $v = 65$ mi/hr. At the instant when the angle $\theta = 60°$, determine the values of $\dot{r}$ in ft/sec and $\dot{\theta}$ in deg/sec.



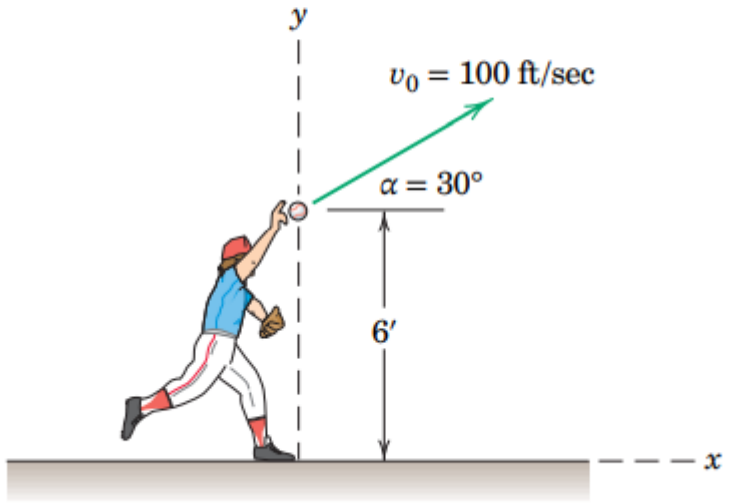
PROBLEM 2/105

2/116 A helicopter starts from rest at point A and travels along the straight-line path with a constant acceleration a. If the speed $v = 28$ m/s when the altitude of the helicopter is $h = 40$ m, determine the values of $\dot{r}$, $\ddot{r}$, $\dot{\theta}$, and $\ddot{\theta}$ as measured by the tracking device at O. At this instant, $\theta = 40°$, and the distance $d = 160$ m. Neglect the small height of the tracking device above the ground.



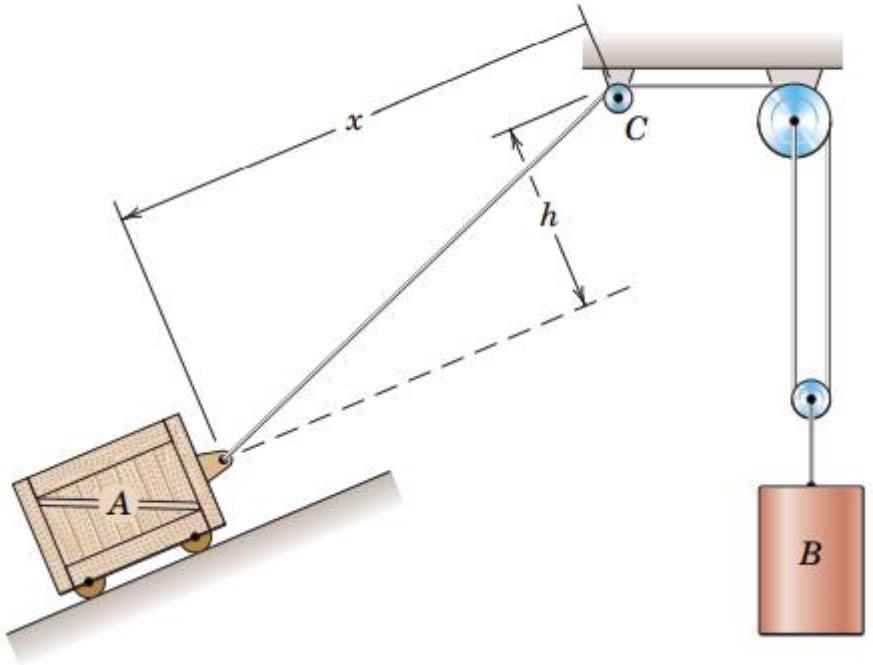
PROBLEM 2/116

▶**2/131** At time $t = 0$, the baseball player releases a ball with the initial conditions shown in the figure. Determine the quantities r, $\dot{r}$, $\ddot{r}$, θ, $\dot{\theta}$, and $\ddot{\theta}$, all relative to the x-y coordinate system shown, at time $t = 0.5$ sec.

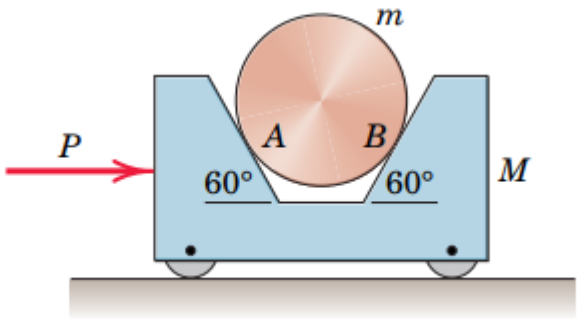


PROBLEM 2/131

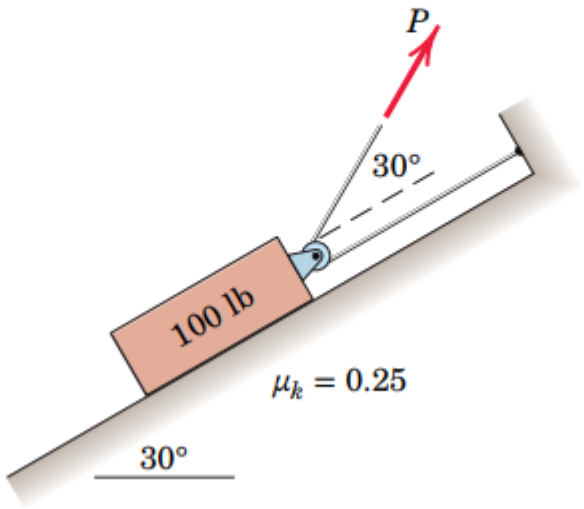
2/177 **SS** Determine an expression for the velocity v_A of the cart A down the incline in terms of the upward velocity v_B of cylinder B.



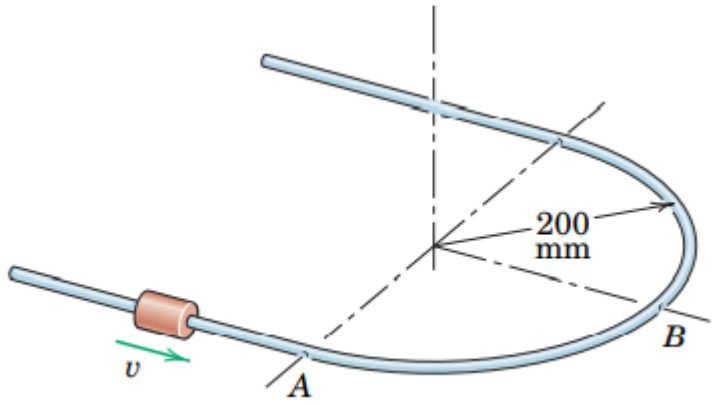
3/10 For a given horizontal force P, determine the normal reaction forces at A and B. The mass of the cylinder is m and that of the cart is M. Neglect all friction.



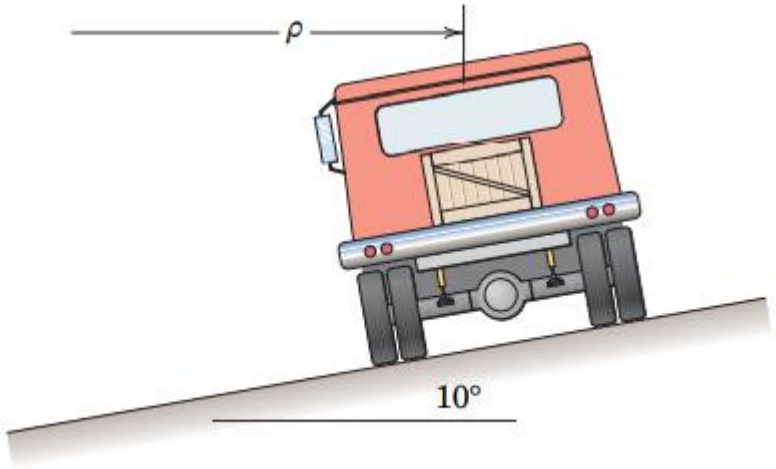
3/13 SS Determine the tension P in the cable which will give the 100-lb block a steady acceleration of 5 ft/sec^2 up the incline.



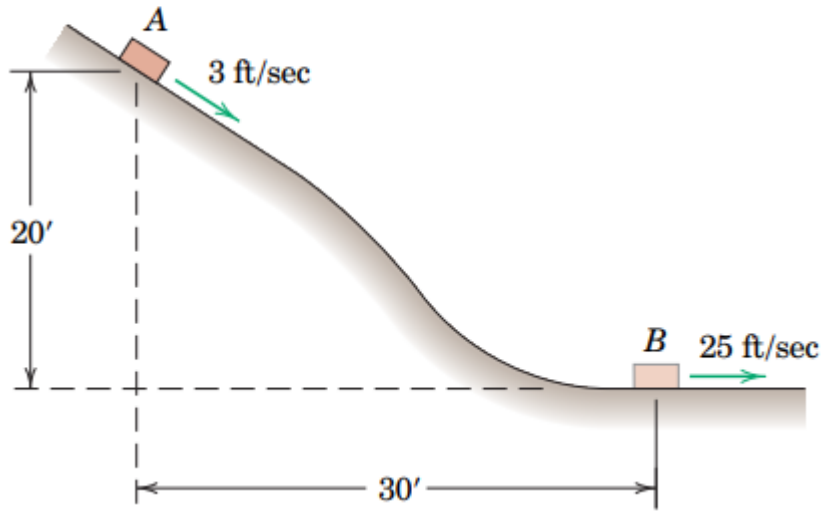
3/40 The 120-g slider has a speed $v = 1.4$ m/s as it passes point A of the smooth guide, which lies in a horizontal plane. Determine the magnitude R of the force which the guide exerts on the slider (a) just before it passes point A of the guide and (b) as it passes point B.



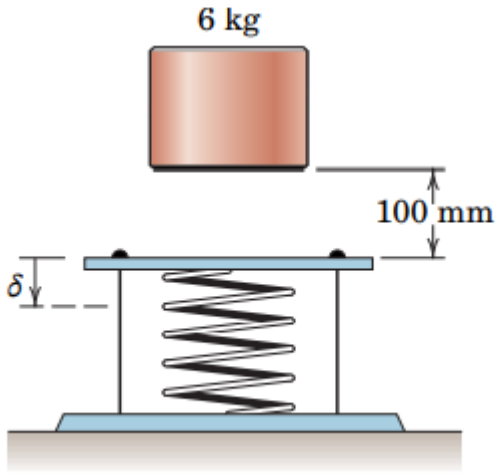
3/57 A flatbed truck going 100 km/h rounds a horizontal curve of 300-m radius inwardly banked at 10°. The coefficient of static friction between the truck bed and the 200-kg crate it carries is 0.70. Calculate the friction force F acting on the crate.



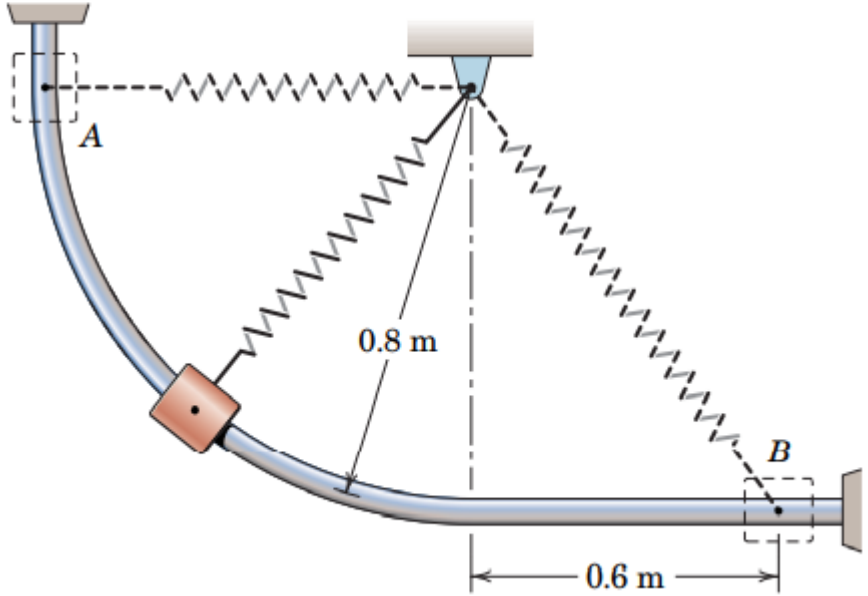
3/81 The 64.4-lb crate slides down the curved path in the vertical plane. If the crate has a velocity of 3 ft/sec down the incline at A and a velocity of 25 ft/sec at B, compute the work U_f done on the crate by friction during the motion from A to B.



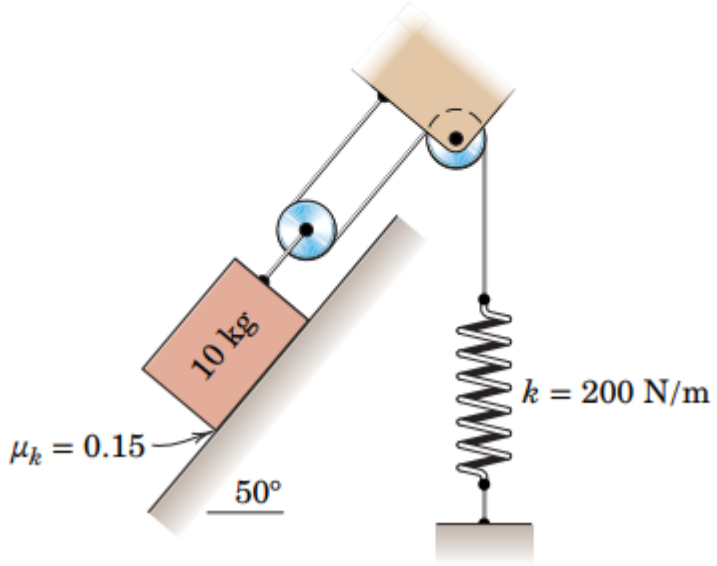
3/108 The 6-kg cylinder is released from rest in the position shown and falls on the spring, which has been initially precompressed 50 mm by the light strap and restraining wires. If the stiffness of the spring is 4 kN/m, compute the additional deflection δ of the spring produced by the falling cylinder before it rebounds.



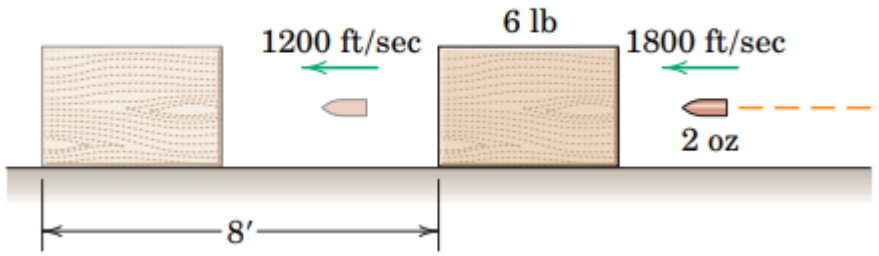
3/111 **SS** The spring has an unstretched length of 0.4 m and a stiffness of 200 N/m. The 3-kg slider and attached spring are released from rest at A and move in the vertical plane. Calculate the velocity v of the slider as it reaches B in the absence of friction.



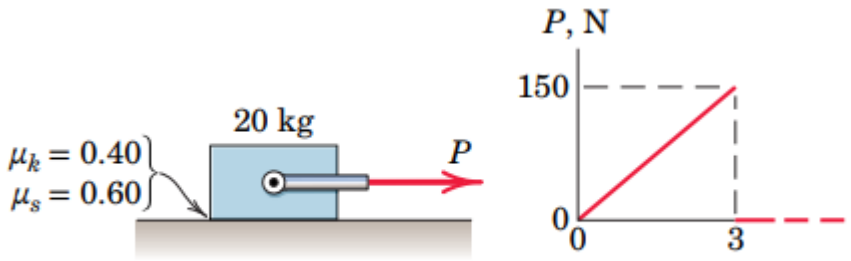
3/134 The system is initially moving with the cable taut, the 10-kg block moving down the rough incline with a speed of 0.3 m/s, and the spring stretched 25 mm. By the method of this article, (*a*) determine the velocity v of the block after it has traveled 100 mm, and (*b*) calculate the distance traveled by the block before it comes to rest.



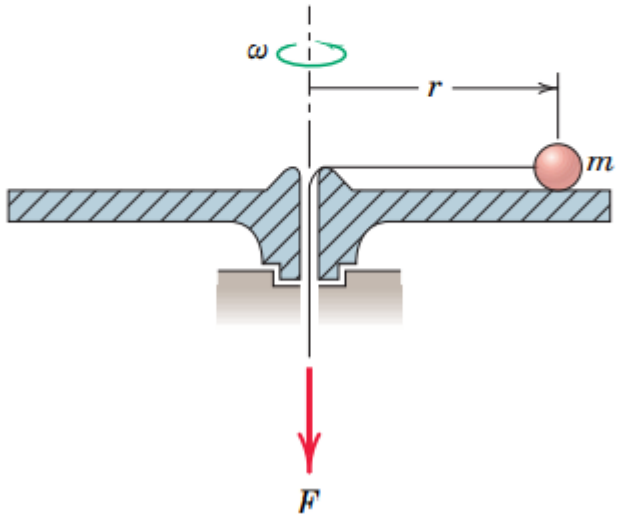
3/143 **SS** A 2-oz bullet is fired horizontally with a velocity $v_1 = 1800$ ft/sec into the 6-lb block of soft wood initially at rest on the horizontal surface. The bullet emerges from the block with the velocity $v_2 = 1200$ ft/sec, and the block is observed to slide a distance of 8 ft before coming to rest. Determine the coefficient of kinetic friction μ_k between the block and the supporting surface.



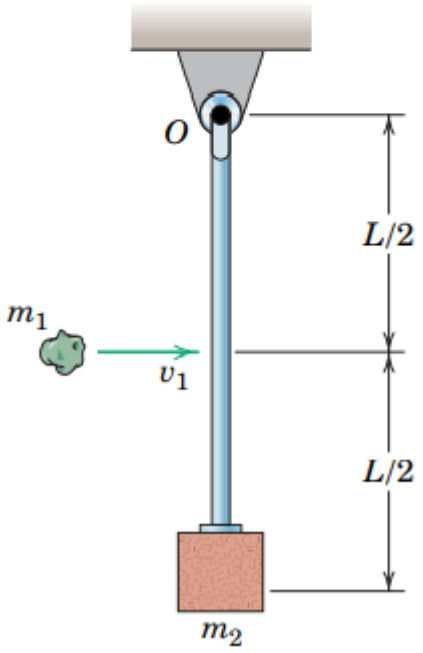
3/158 The initially stationary 20-kg block is subjected to the time-varying horizontal force whose magnitude P is shown in the plot. Note that the force is zero for all times greater than 3 s. Determine the time t_s at which the block comes to rest.



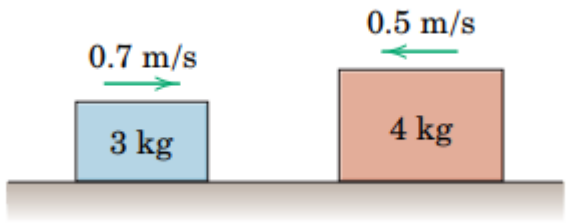
3/180 The small particle of mass m and its restraining cord are spinning with an angular velocity ω on the horizontal surface of a smooth disk, shown in section. As the force F is slightly relaxed, r increases and ω changes. Determine the rate of change of ω with respect to r and show that the work done by F during a movement dr equals the change in kinetic energy of the particle.



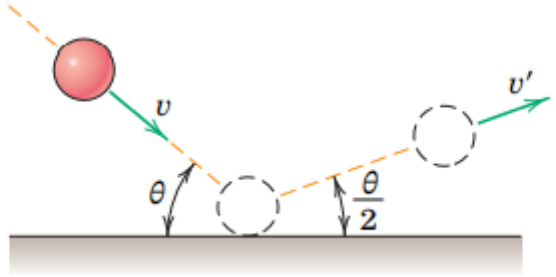
3/188 A wad of clay of mass m_1 with an initial horizontal velocity v_1 hits and adheres to the massless rigid bar which supports the body of mass m_2, which can be assumed to be a particle. The pendulum assembly is freely pivoted at O and is initially stationary. Determine the angular velocity $\dot{\theta}$ of the combined body just after impact. Why is linear momentum of the system not conserved?



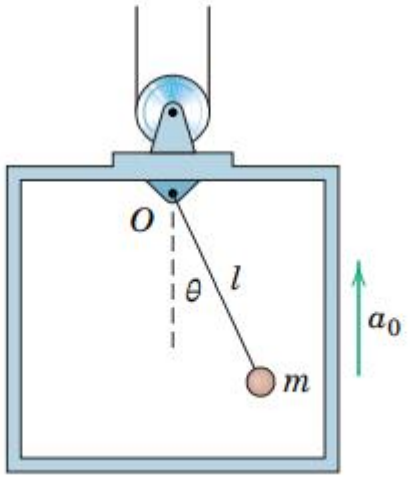
3/197 The two bodies have the masses and initial velocities shown in the figure. The coefficient of restitution for the collision is $e = 0.3$, and friction is negligible. If the time duration of the collision is 0.025 s, determine the average impact force which is exerted on the 3-kg body.



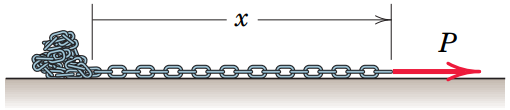
3/201 Determine the value of the coefficient of restitution e for which the outgoing angle is one-half of the incoming angle θ as shown. Evaluate your general expression for $\theta = 40°$.



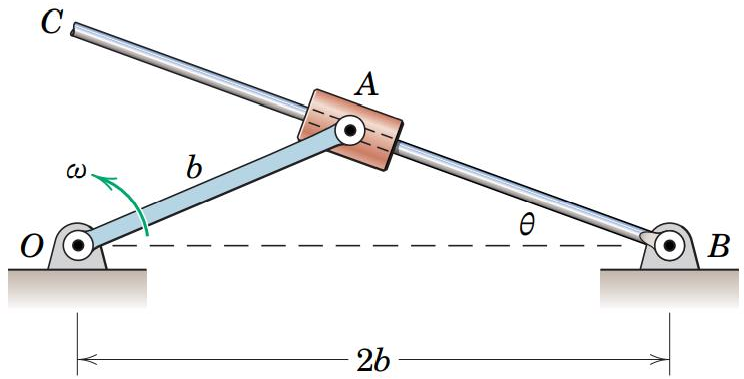
3/257 A simple pendulum is placed on an elevator, which accelerates upward as shown. If the pendulum is displaced an amount θ_0 and released from rest relative to the elevator, find the tension T_0 in the supporting light rod when $\theta = 0$. Evaluate your result for $\theta_0 = \pi/2$.



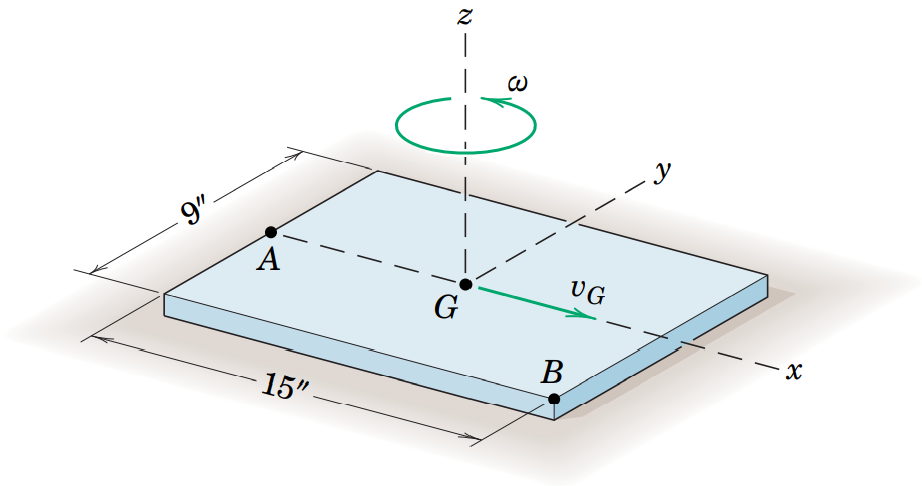
4/71 The end of a pile of loose-link chain of mass ρ per unit length is being pulled horizontally along the surface by a constant force P. If the coefficient of kinetic friction between the chain and the surface is μ_k, determine the acceleration a of the chain in terms of x and $\dot{x}$.



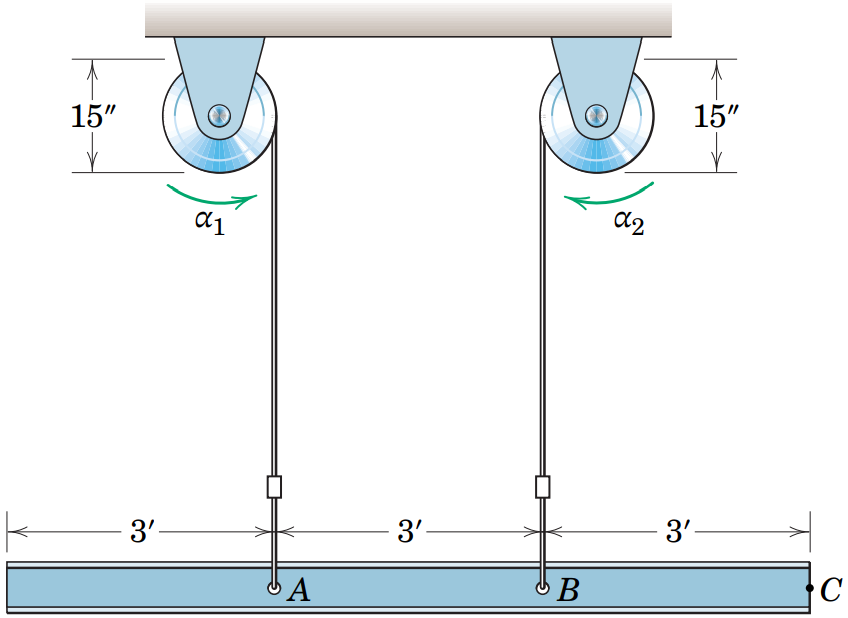
5/31 SS Link OA rotates with a counterclockwise angular velocity $\omega = 3$ rad/s. Determine the angular velocity of bar BC when $\theta = 20°$.



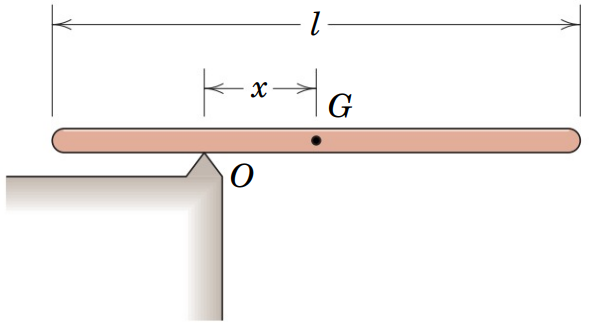
5/48 The uniform rectangular plate moves on the horizontal surface. Its mass center has a velocity $v_G = 10$ ft/sec directed parallel to the x-axis and the plate has a counterclockwise (as seen from above) angular velocity $\omega = 4$ rad/sec. Determine the velocities of points A and B.



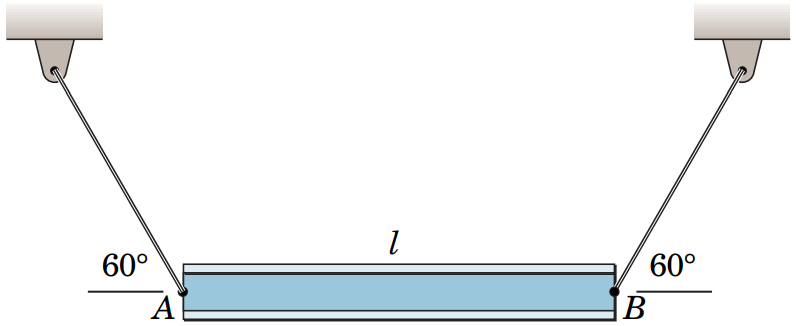
5/101 **SS** The 9-ft steel beam is being hoisted from its horizontal position by the two cables attached at A and B. If the initial angular accelerations are $\alpha_1 = 0.2$ rad/sec^2 and $\alpha_2 = 0.6$ rad/sec^2, determine the initial values of (a) the angular acceleration of the beam, (b) the acceleration of point C, and (c) the distance d from A to the point on the centerline of the beam which has zero acceleration.



6/48 The uniform slender bar is released from rest in the horizontal position shown. Determine the value of x for which the angular acceleration is a maximum, and determine the corresponding angular acceleration α.



6/67 The uniform steel beam of mass m and length l is suspended by the two cables at A and B. If the cable at B suddenly breaks, determine the tension T in the cable at A immediately after the break occurs. Treat the beam as a slender rod and show that the result is independent of the length of the beam.



6/109 The system is released from rest when the angle $\theta = 90°$. Determine the angular velocity of the uniform slender bar when θ equals 60°. Use the values $m_1 = 1$ kg, $m_2 = 1.25$ kg, and $b = 0.4$ m.