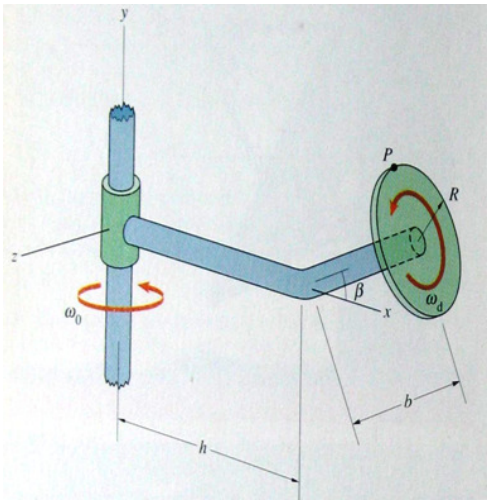
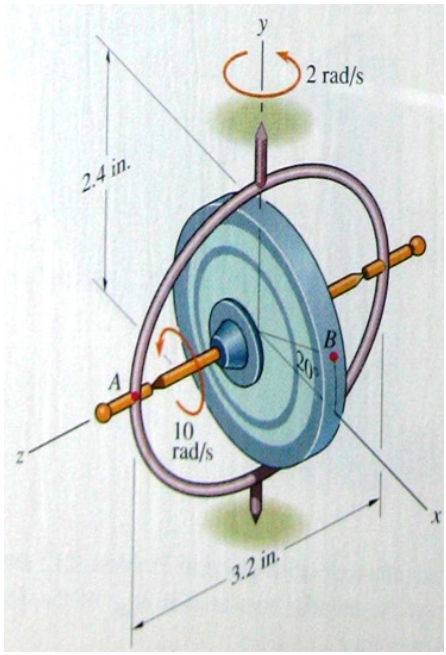
EGBE261: Biomechanics 2
Homework from Chapter 9: Three Dimensional Kinematics and Kinetics of Rigid Bodies

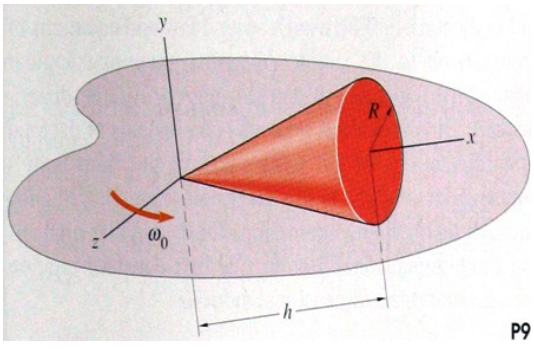
9.14. The bent bar is rigidly attached to the vertical shaft, which rotates with constant angular velocity ω0. The circular disk is pinned to the bent bar and rotates with constant angular velocity ωd relative to the bar. A) Determine the disk's angular velocity. B) Determine the velocity of point B, which is the uppermost point of the circular disk at the present instant.



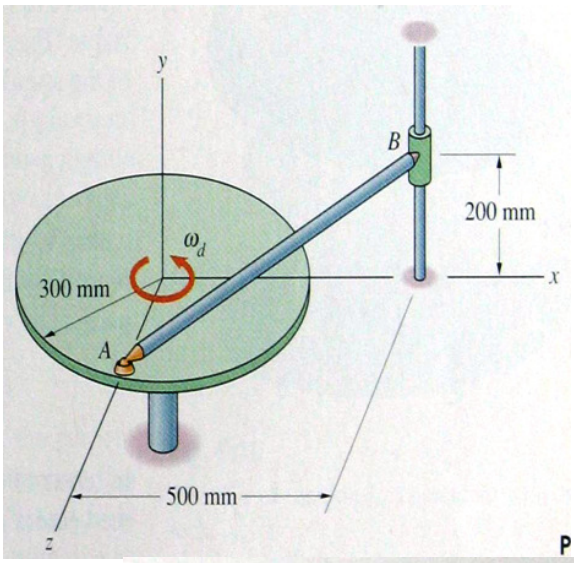
9.16. Relative to the primary reference frame, the gyroscope's circular frame rotates about the vertical axis at 2 rad/s in the counterclockwise direction when viewed from above. The 2.4-in-diameter wheel rotates relative to the frame at 10 rad/s. Determine the velocities of points A and B relative to the primary reference frame.



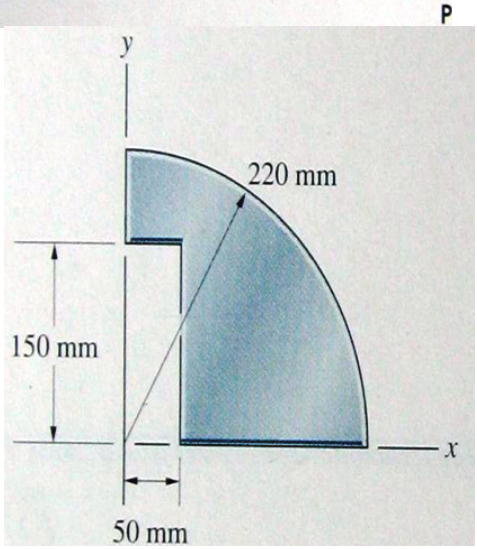
9.20 The cone's curved surface rolls on the horizontal surface. The x axis of the secondary coordinate system remains coincident with the cone's axis and the z axis remains horizontal. The z axis has a constant angular velocity ω_0 in the horizontal plane. In terms of components in the secondary coordinate system, determine: a) the angular velocity of the secondary coordinate system; b) the angular velocity of the cone relative to the secondary coordinate system; c) the cone's angular velocity relative to the primary reference frame.



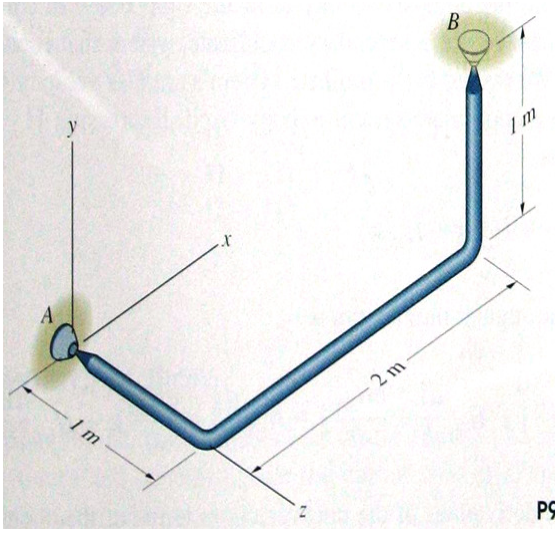
9.26. The bar AB is connected by ball and socket joints to the edge of the horizontal circular disk at A and to a collar that slides on the vertical bar at B. The disk rotates with constant angular velocity $\omega_d = 4$ rad/s and the angular velocity of bar AB about its axis is 0. Determine the velocity of the collar at B and the angular velocity of bar AB.



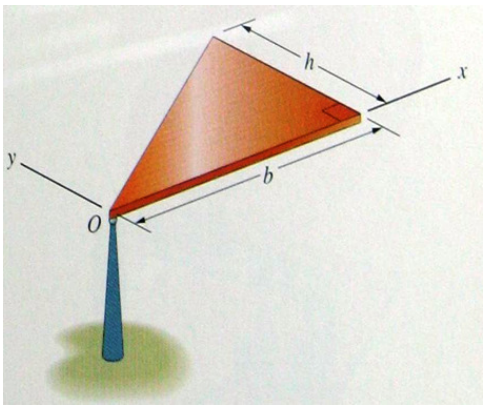
9.38. Determine the inertia matrix of the 2.4-kg steel plate in terms of the coordinate system shown.



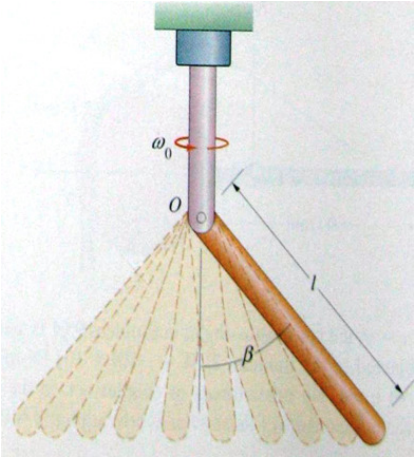
9.46. The 8-kg homogeneous slender bar has ball and socket supports at A and B. If the bar rotates at 4 rad/s, what is the magnitude of its angular momentum about its axis of rotation?



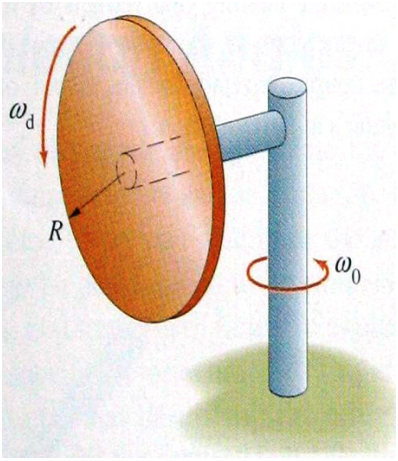
9.64. A thin triangular plate of mass m is supported by a ball and socket at O. If it is held in the horizontal position and released from rest, what are the components of its angular acceleration at that instant?



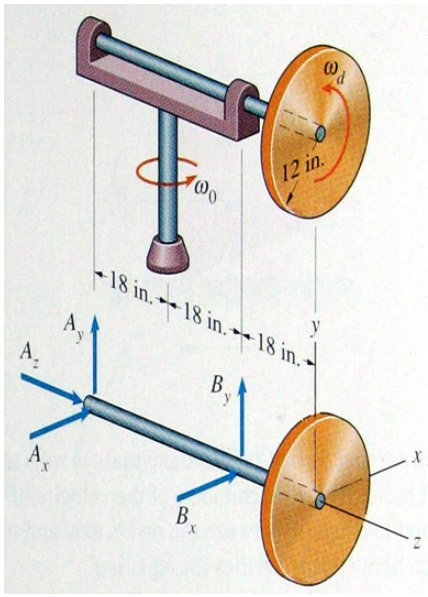
9.72. The slender bar of length l and mass m is pinned to the vertical shaft at O. The vertical shaft rotates with a constant angular velocity ω_0. What value of ω_0 is necessary for the bar to remain at a constant angle β relative to the vertical? (Answer $\omega = \sqrt{3g/(2l\cos\beta)}$



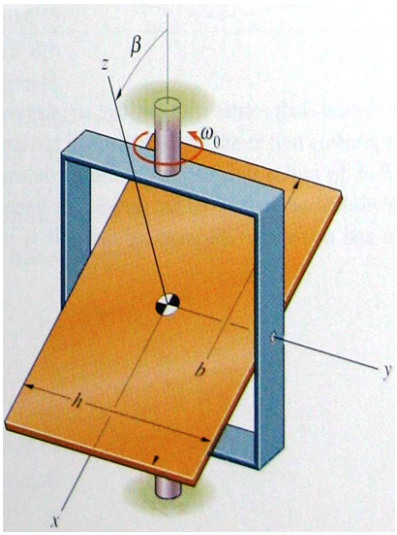
9.74. A thin circular disk of mass m mounted on a horizontal shaft rotates relative to the shaft with constant angular velocity ω_d. The horizontal shaft is rigidly attached to a vertical shaft rotating with constant angular velocity ω_0. Determine the magnitude of the couple exerted on the disk by the horizontal shaft.



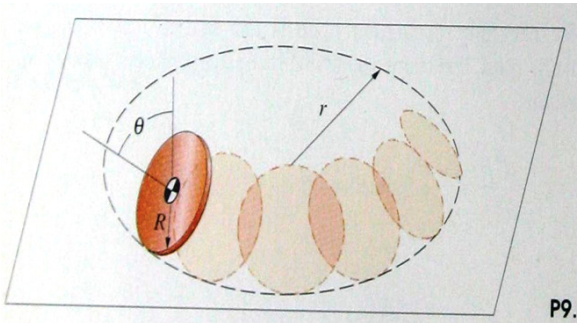
9.76. The 10-lb thin circular disk is rigidly attached to the 12-lb slender horizontal shaft. The disk and the horizontal shaft rotate about the axis of the shaft with constant angular velocity $\omega_d = 20$ rad/s. The entire assembly rotates about the vertical axis with constant angular velocity $\omega_0 = 4$ rad/s. Determine the components of the force and couple exerted on the horizontal shaft by the disk.



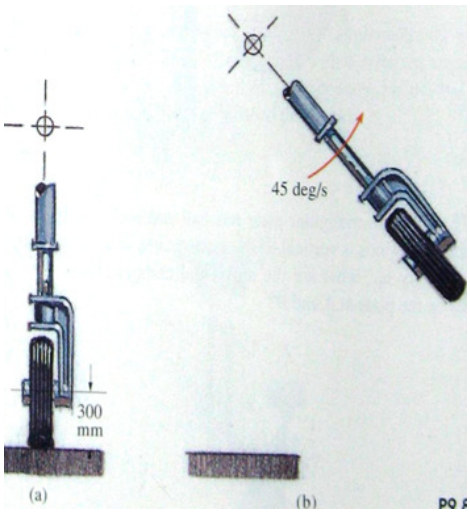
9.78. The thin rectangular plate is attached to the rectangular frame by pins. The frame rotates with constant angular velocity ω_0. Show that $\dfrac{d^2\beta}{dt^2} = -\omega_0^2 \sin\beta\cos\beta$.



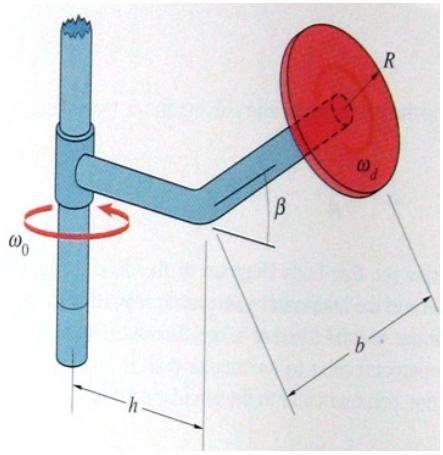
9.80. A thin circular disk of radius R and mass m rolls along a circular path of radius r. The magnitude v of the velocity of the center of the disk and the angle θ between the disk's axis and the vertical are constants. Show that v satisfies the equation: $v^2 = \dfrac{\frac{2}{3} g \cot\theta \left(r - R\cos\theta\right)^2}{r - \frac{5}{6} R\cos\theta}$



9.82. The view of an airplane's landing gear looking from behind is shown below. The radius of the wheel is 300 mm, and its moment of inertia is 2 kg-m^2. The airplane takes off at 30 m/s. After takeoff, the landing gear retracts by rotating toward the right side of the airplane as shown in (b). Determine the magnitude of the couple exerted by the wheel on its support.



9.90. The bent bar is rigidly attached to the vertical shaft, which rotates with constant angular velocity ω_0. The thin circular disk of mass m and radius R is pinned to the bent bar and rotates with constant angular velocity ω_d relative to the bar. Determine the value of the angular velocity ω_d which causes no couple to be exerted on the disk by the bar.



9.94. The top is in steady precession with nutation angle $\theta = 15°$ and precession rate $\dot{\psi} = 1$ revolution per second. The mass of the top is 8 x 10^{-4} slugs, its center of mass is 1 in from the point, and its moments of inertia are I_{xx} = 6 x 10^{-6} slug-ft^2 and I_{zz}=2x10^{-6} slug-ft^2. What is the spin rate $\dot{\phi}$ of the top in revolutions per second?