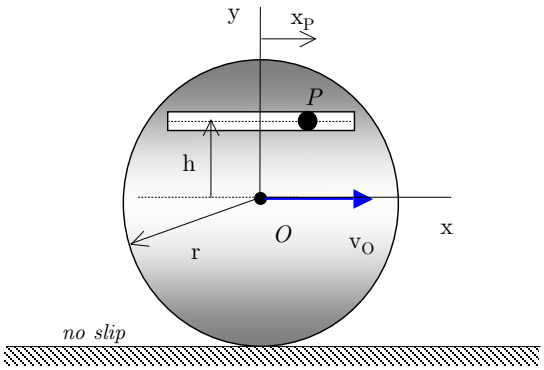
Example 3.A.1

Given: The disk shown below rolls without slipping on a horizontal surface. At the instant shown, the center O is moving to the right with a speed of $v_0 = 5$ m/s with this speed decreasing at a rate of 2 m/s^2. Also for this instant, the particle P is at a position of $x_p = 0.2$ m with $\dot{x}_p = 2$ m/s = *constant*, where x_p is measured relative to the xyz coordinate system that is attached to the disk.

Find: Determine:
(a) The velocity of particle P; and
(b) The acceleration of particle P.

Use the following parameters in your analysis: $h = 0.2$ m and $r = 0.6$ m.



Example 3.A.2

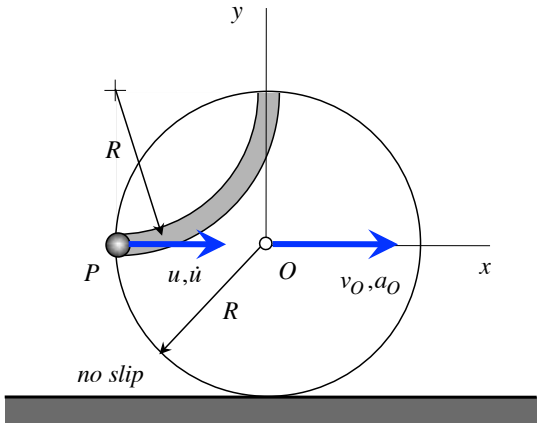
Given: The disk of radius R rolls without slipping on a horizontal surface with the speed and acceleration of the disk center O given by v_O and a_O, respectively. A particle P slides within a semi-circular slot cut in the disk with P moving with a speed of u relative to the disk and a rate of change of speed of $\dot{u}$ relative to the disk. The radius of the slot is R.

Find: Determine:

(a) The velocity of P when P is on the perimeter of the disk and is immediate to the left of O; and

(b) The acceleration of P at the same position.

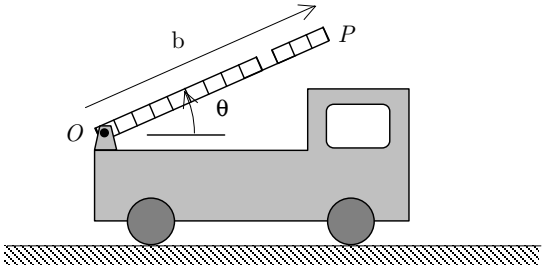
Use the following parameters in your analysis: $v_O = 3$ m/s, $a_O = 5$ m/s^2, $u = 2$ m/s $\dot{u} = 7$ m/s^2, and $R = 0.75$ m.



Example 3.A.3

Given: The fire truck moves forward at a constant speed of 50 ft/s. The ladder is being raised at a constant rate of $\dot{\theta} = 0.3$ rad/s. In addition, the ladder is being extended at a constant rate of $\dot{b} = 2$ ft/s.

Find: The acceleration of end P of the ladder when $b = 25$ ft and $\theta = 30°$.

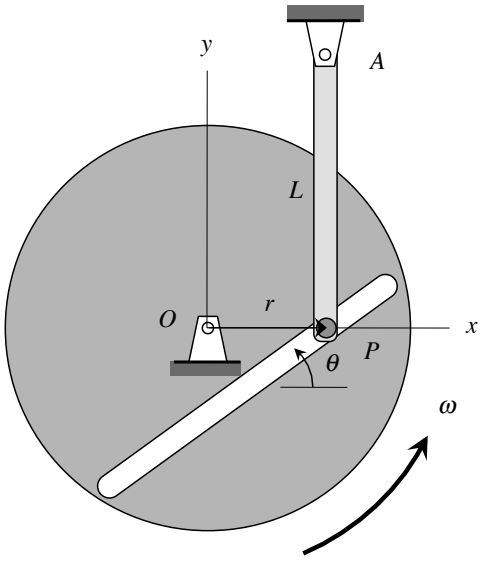


Example 3.A.4

Given: The disk shown below is rotating counterclockwise at a constant rate of ω. Link AP is vertical. Pin P slides within a straight slot cut into the disk. Let the xyz axes be attached to the disk. The slot is oriented at an angle of θ as measured from the x-axis. At the instant shown, P is on the x-axis, and the x-axis is horizontal.

Find: Determine:
(a) The angular velocity of link AP at this instant; and
(b) The angular acceleration of link AP at this instant.

Use the following parameters in your analysis: $\omega = 8$ rad/s, $r = 0.2$ m, $L = 0.3$ m and $\theta = 36.87°$.

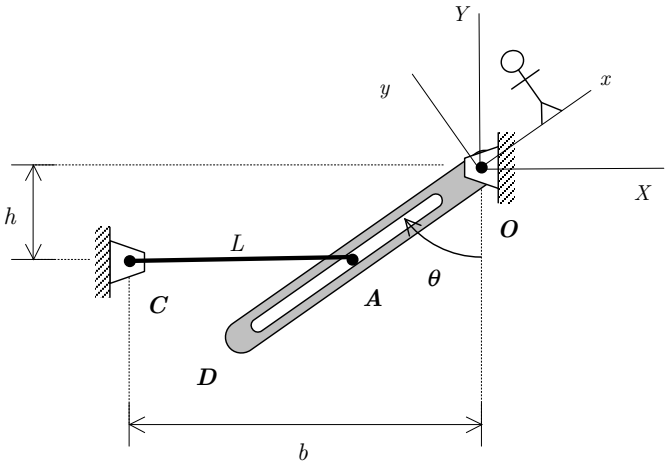


Example 3.A.6

Given: Link OD is rotating clockwise at a constant rate of $\dot{\theta} = 2$ rad/s. When $\theta = 45°$, link CA is horizontal.

Find: Determine:
(a) The velocity of A when $\theta = 45°$; and
(b) The acceleration of A at the same position

Use the following parameters in your analysis: $L = 0.225$ m, $h = 0.225$ m and $b = 0.45$ m.

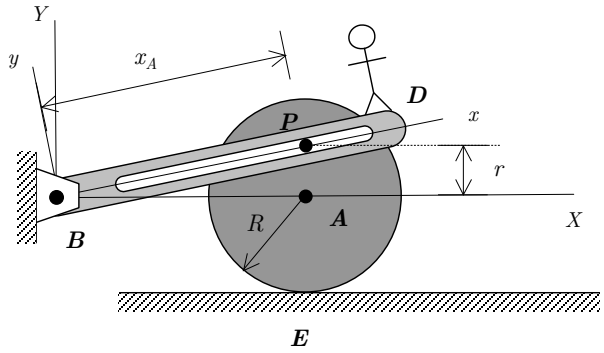


Example 3.A.7

Given: The disk rolls without slipping to the right with a constant angular speed of ω_d. At the instant shown, pin P is directly above the center A of the disk.

Find: Determine:
(a) The angular acceleration of the disk; and
(b) The acceleration of P as seen by an observer on arm BD.

Use the following parameters in your analysis: $\omega_d = 20$ rad/s (clockwise), $x_A = 0.48$ m, $r = 0.14$ m and $R = 0.2$ m.



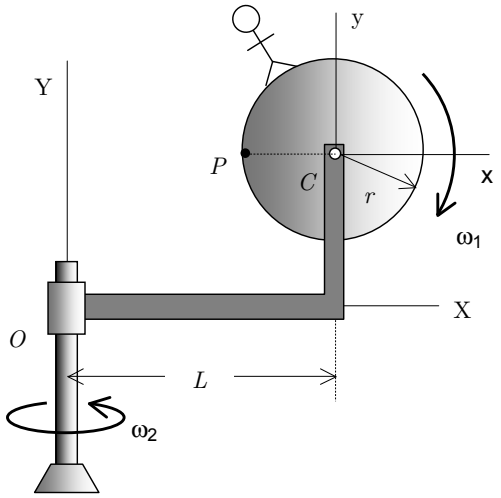
Example 3.B.3

Given: A disk rotates with a constant rate of $\omega_1 = 20$ rad/s with respect to the arm OC as the arm OC rotates about a fixed vertical axis with a constant rate of $\omega_2 = 5$ rad/s. The observer and the xyz axes are attached to the disk, while the XYZ axes are fixed. At this instant, the XYZ and xyz axes are aligned.

Find: Determine:

(a) The angular velocity of the observer at the instant shown; and

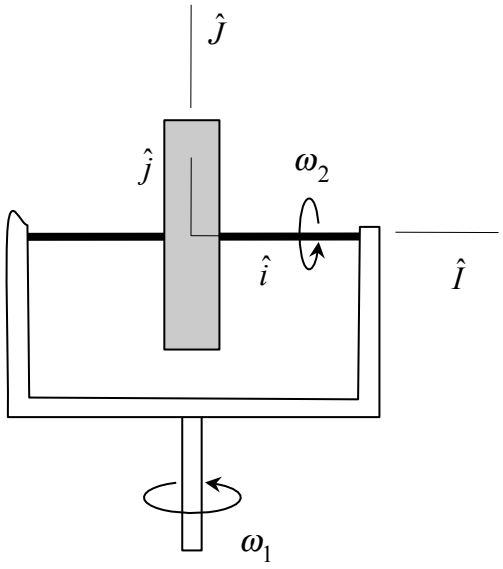
(b) The angular acceleration of the observer at the instant shown.



Example 3.B.5

Given: The disk of a gyroscope rotates about its own axis at a constant rate of $\omega_2 = 600$ rev/min. The gimbal support is rotating at a constant rate of $\omega_1 = 10$ rad/s about a fixed vertical axis. The observer and the xyz axes are attached to the disk. The XYZ axes are fixed in space.

Find: Determine:
(a) The angular velocity of the observer at the instant shown; and
(b) The angular acceleration of the observer at the instant shown.

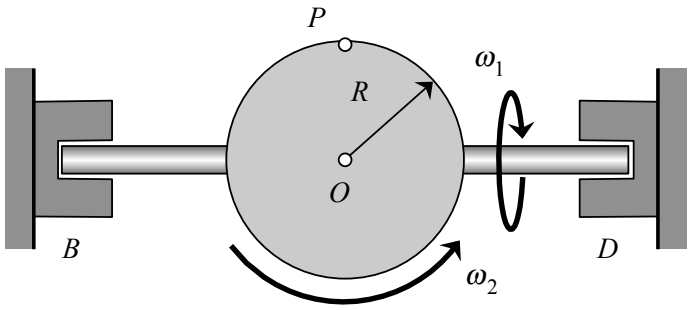


Example 3.B.6

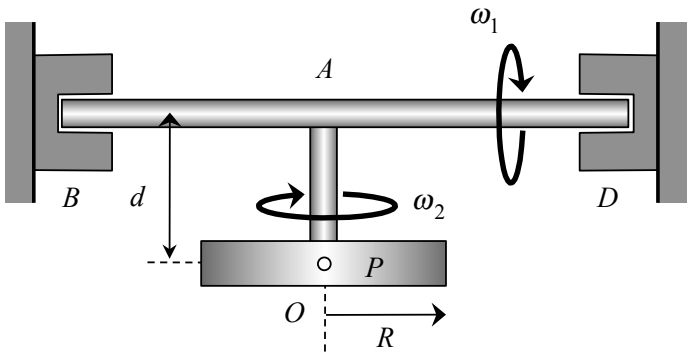
Given: Shaft BD rotates about a fixed axis with a constant rate of ω_1. Shaft OA is rigidly attached to shaft BD with OA being perpendicular to BD. A disk rotates about shaft OA with a constant rate of ω_2 relative to OA.

Find: The acceleration of point P on the edge of the disk for the position shown.

Use the following parameters in your analysis: $\omega_1 = 5$ rad/s, $\omega_2 = 8$ rad/s, $R = 6$ in and $d = 4$ in.



side view

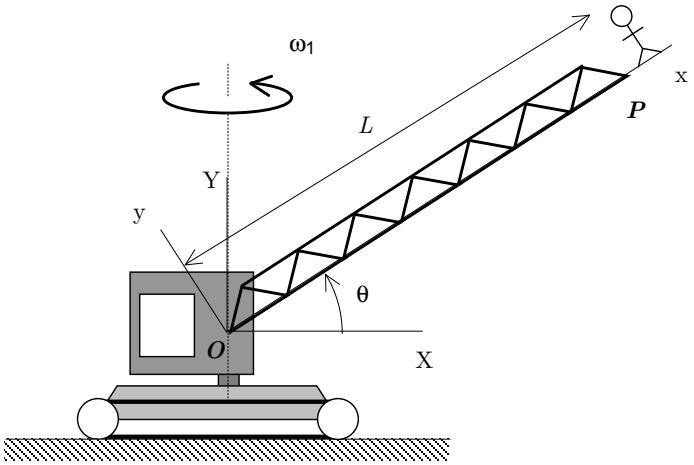


top view

Example 3.B.7

Given: $\omega_1 = 0.30$ rad/s = *constant*, $\dot{\theta} = 0.5$ rad/s = *constant* and $L = 12$ m.

Find: When $\theta = 30°$, determine:
(a) The angular velocity of boom OP;
(b) The angular acceleration of boom OP;
(c) The velocity of end P of the boom; and
(d) The acceleration of end P of the boom.



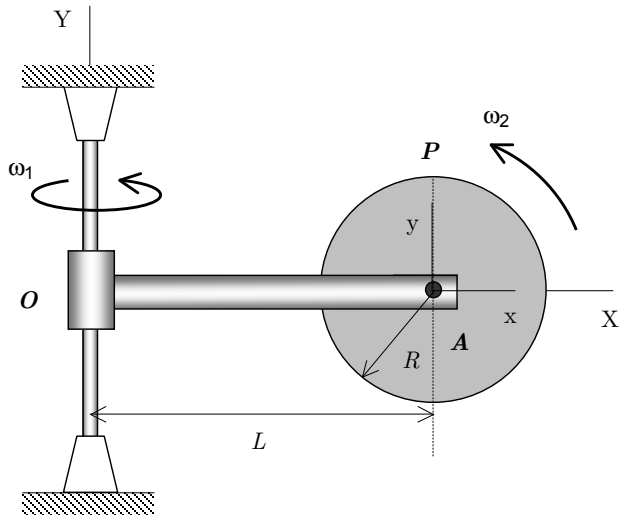
Example 3.B.8

Given: The rotation rates ω_1 and ω_2 are constant.

Find: Determine:

(a) The velocity of point P on the disk at the instant when P is directly above the center A of the disk; and

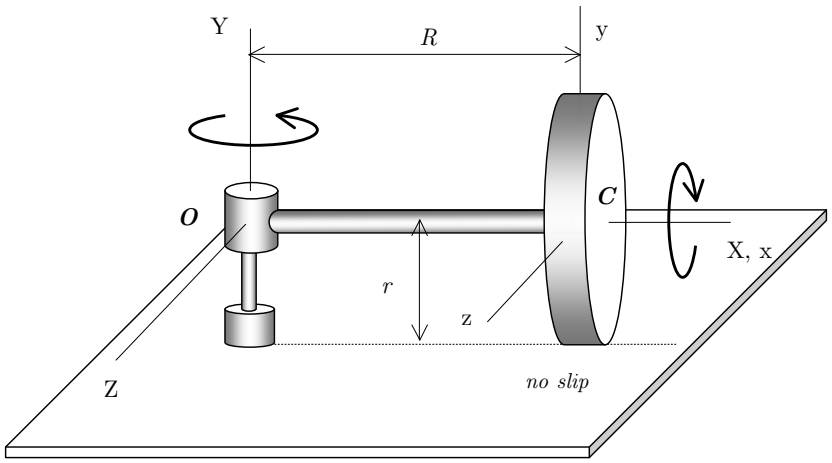
(b) The acceleration of point P at the same instant.



Example 3.B.9

Given: Arm OC rotates about the fixed Y-axis at a constant rate Ω. The disk at C, having a radius of R, is able to rotate about arm OC and rolls without slipping on a fixed horizontal surface. Let the xyz axes be attached to the disk.

Find: Determine the angular acceleration of the disk.



Example 3.B.10

Given: $\dot{L} = 0.06$ m/s = *constant*, $\omega_1 = 1.2$ rad/s = *constant* and $\omega_2 = 1.5$ rad/s = *constant*. At the position shown, AC is aligned with the fixed Y-axis, $L = 0.12$ m, and $d = 0.02$ m.

Find: Determine:

(a) The velocity of end A of the telescoping rod AC; and

(b) The acceleration of the same point.