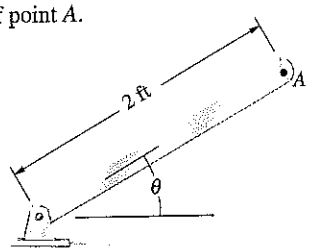
Problems

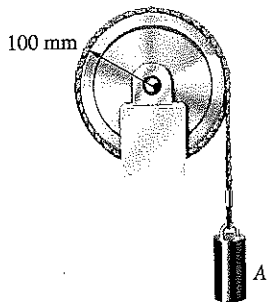
▶ 17.1 In Active Example 17.1, suppose that at a given instant the hook H is moving downward at 2 m/s. What is the angular velocity of gear A at that instant?

17.2 The angle θ (in radians) is given as a function of time by $\theta = 0.2\pi t^2$. At $t = 4$ s, determine the magnitudes of (a) the velocity of point A and (b) the tangential and normal components of acceleration of point A.



Problem 17.2

17.3 The mass A starts from rest at $t = 0$ and falls with a constant acceleration of 8 m/s^2. When the mass has fallen one meter, determine the magnitudes of (a) the angular velocity of the pulley and (b) the tangential and normal components of acceleration of a point at the outer edge of the pulley.

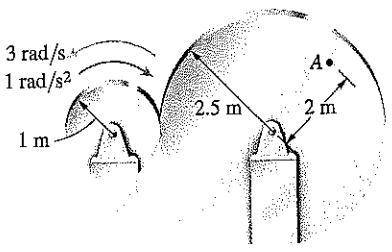


Problem 17.3

17.4 At the instant shown, the left disk has an angular velocity of 3 rad/s counterclockwise and an angular acceleration of 1 rad/s^2 clockwise.

(a) What are the angular velocity and angular acceleration of the right disk? (Assume that there is no relative motion between the disks at their point of contact.)

(b) What are the magnitudes of the velocity and acceleration of point A?

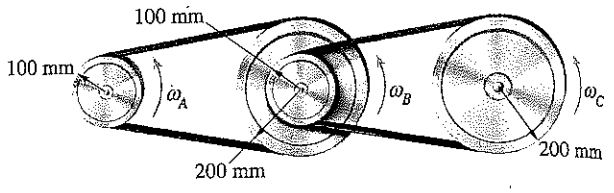


Problem 17.4

17.5 The angular velocity of the left disk is given as a function of time by $\omega_A = 4 + 0.2t$ rad/s.

(a) What are the angular velocities ω_B and ω_C at $t = 5$ s?

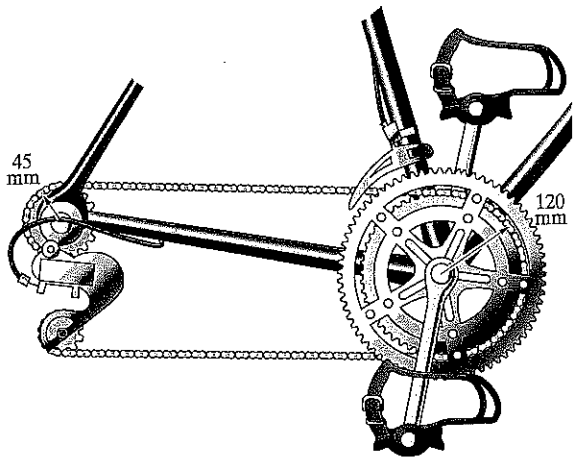
(b) Through what angle does the right disk turn from $t = 0$ to $t = 5$ s?



Problem 17.5

17.6 (a) If the bicycle's 120-mm sprocket wheel rotates through one revolution, through how many revolutions does the 45-mm gear turn? (b) If the angular velocity of the sprocket wheel is 1 rad/s, what is the angular velocity of the gear?

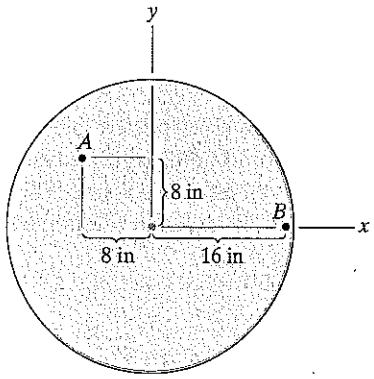
17.7 The rear wheel of the bicycle has a 330-mm radius and is rigidly attached to the 45-mm gear. If the rider turns the pedals, which are rigidly attached to the 120-mm sprocket wheel, at one revolution per second, what is the bicycle's velocity?



Problems 17.6/17.7

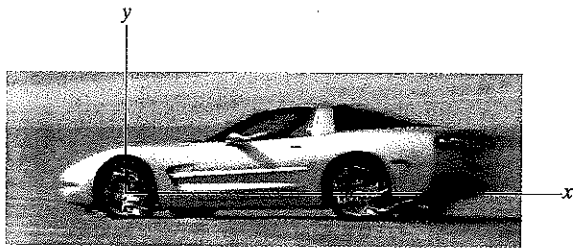
17.8 The disk is rotating about the origin with a constant clockwise angular velocity of 100 rpm. Determine the x and y components of velocity of points A and B (in in/s).

17.9 The disk is rotating about the origin with a constant clockwise angular velocity of 100 rpm. Determine the x and y components of acceleration of points A and B (in in/s^2).



Problems 17.8/17.9

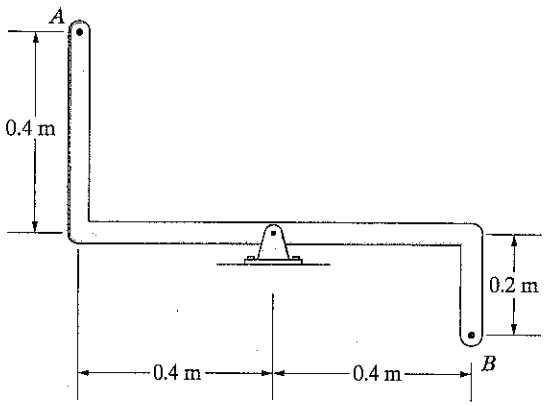
17.10 The radius of the Corvette's tires is 14 in. It is traveling at 80 mi/h when the driver applies the brakes, subjecting the car to a deceleration of 25 ft/s^2. Assume that the tires continue to roll, not skid, on the road surface. At that instant, what are the magnitudes of the tangential and normal components of acceleration (in ft/s^2) of a point at the outer edge of a tire relative to a nonrotating coordinate system with its origin at the center of the tire?



Problem 17.10

17.11 If the bar has a counterclockwise angular velocity of 8 rad/s and a clockwise angular acceleration of 40 rad/s^2, what are the magnitudes of the accelerations of points A and B?

17.12 If the magnitudes of the velocity and acceleration of point A of the rotating bar are $|\mathbf{v}_A| = 3$ m/s and $|\mathbf{a}_A| = 28$ m/s^2, what are $|\mathbf{v}_B|$ and $|\mathbf{a}_B|$?

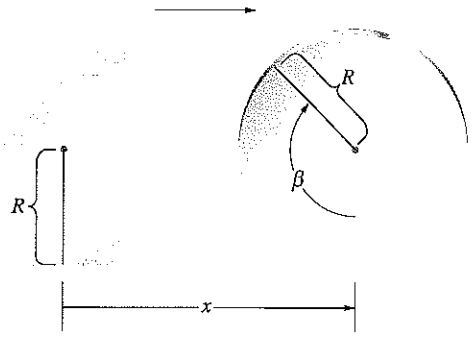


Problems 17.11/17.12

17.13 A disk of radius $R = 0.5$ m rolls on a horizontal surface. The relationship between the horizontal distance x the center of the disk moves and the angle β through which the disk rotates is $x = R\beta$. Suppose that the center of the disk is moving to the right with a constant velocity of 2 m/s.

(a) What is the disk's angular velocity?

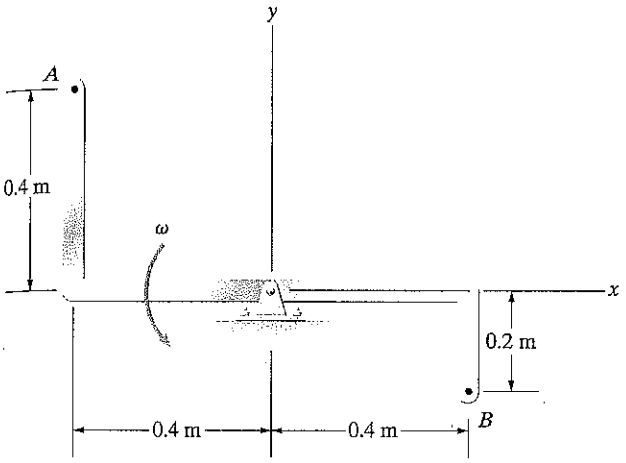
(b) Relative to a nonrotating reference frame with its origin at the center of the disk, what are the magnitudes of the velocity and acceleration of a point on the edge of the disk?



Problem 17.13

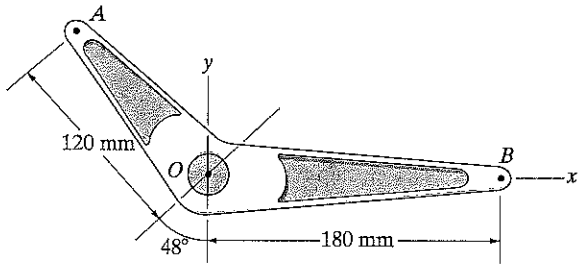
17.19 The bar is rotating in the counterclockwise direction with angular velocity ω. The magnitude of the velocity of point A is 6 m/s. Determine the velocity of point B.

17.20 The bar is rotating in the counterclockwise direction with angular velocity ω. The magnitude of the velocity of point A relative to point B is 6 m/s. Determine the velocity of point B.



Problems 17.19/17.20

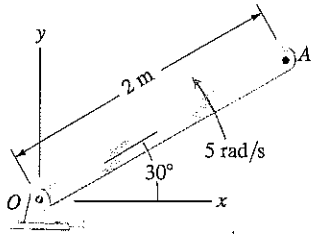
17.21 The bracket is rotating about point O with counterclockwise angular velocity ω. The magnitude of the velocity of point A relative to point B is 4 m/s. Determine ω.



Problem 17.21

17.22 Determine the x and y components of the velocity of point A.

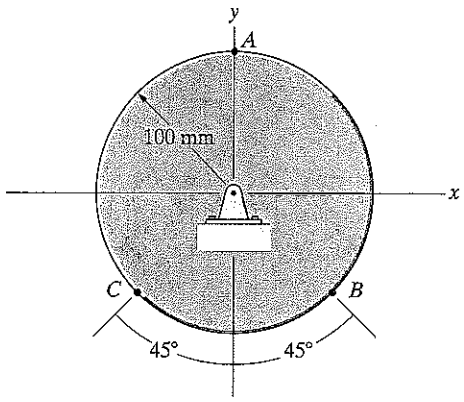
17.23 If the angular velocity of the bar is constant, what are the x and y components of the velocity of point A 0.1 s after the instant shown?



Problems 17.22/17.23

17.24 The disk is rotating about the z axis at 50 rad/s in the clockwise direction. Determine the x and y components of the velocities of points A, B, and C.

17.25 If the magnitude of the velocity of point A relative to point B is 4 m/s, what is the magnitude of the disk's angular velocity?

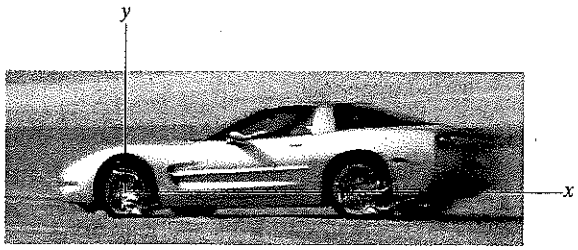


Problems 17.24/17.25

17.26 The radius of the Corvette's tires is 14 in. It is traveling at 80 mi/h. Assume that the tires roll, not skid, on the road surface.

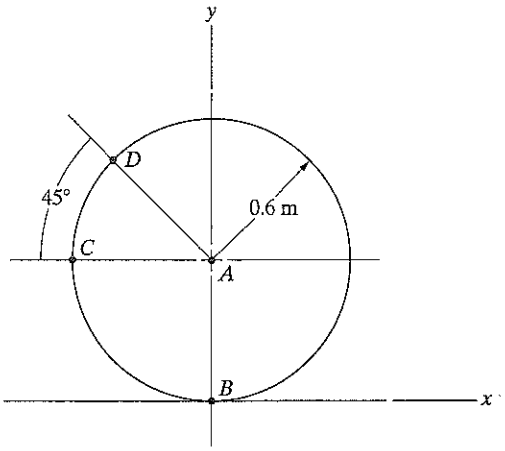
(a) What is the angular velocity of its wheels?

(b) In terms of the earth-fixed coordinate system shown, determine the velocity (in ft/s) of the point of the tire with coordinates (−14 in, 0, 0).



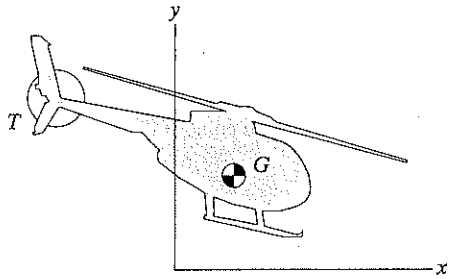
Problem 17.26

17.27 Point A of the rolling disk is moving toward the right. The magnitude of the velocity of point C is 5 m/s. Determine the velocities of points B and D.



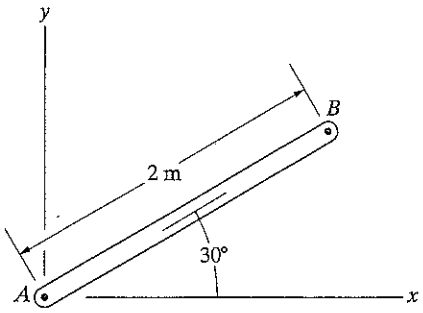
Problem 17.27

17.28 The helicopter is in planar motion in the x–y plane. At the instant shown, the position of the craft's center of mass, G, is $x = 2$ m, $y = 2.5$ m; and its velocity is $\mathbf{v}_G = 12\mathbf{i} + 4\mathbf{j}$ (m/s). The position of point T where the tail rotor is mounted is $x = -3.5$ m, $y = 4.5$ m. The helicopter's angular velocity is 0.2 rad/s clockwise. What is the velocity of point T?



Problem 17.28

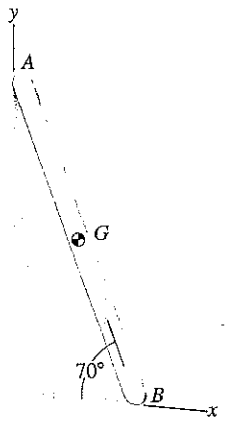
17.29 The bar is moving in the x–y plane and is rotating in the counterclockwise direction. The velocity of point A relative to the reference frame is $\mathbf{v}_A = 12\mathbf{i} - 2\mathbf{j}$ (m/s). The magnitude of the velocity of point A relative to point B is 8 m/s. What is the velocity of point B relative to the reference frame?



Problem 17.29

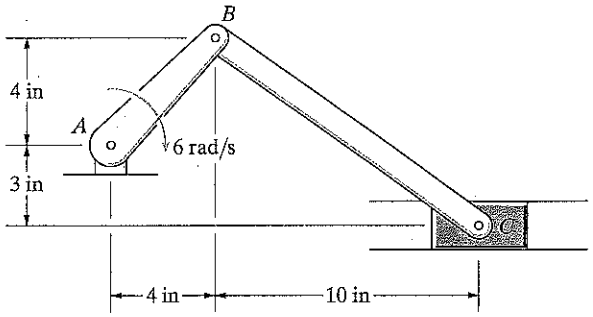
17.30 Points A and B of the 2-m bar slide on the plane surfaces. Point B is moving to the right at 3 m/s. What is the velocity of the midpoint G of the bar?

Strategy: First apply Eq. (17.6) to points A and B to determine the bar's angular velocity. Then apply Eq. (17.6) to points B and G.



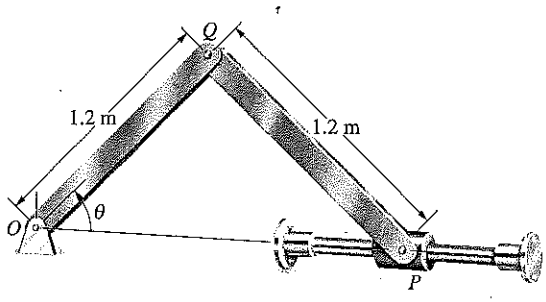
Problem 17.30

17.31 Bar AB rotates at 6 rad/s in the clockwise direction. Determine the velocity (in in/s) of the slider C.



Problem 17.31

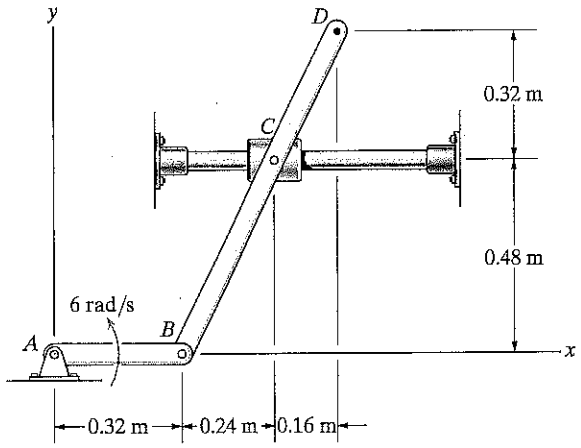
17.32 If $\theta = 45°$ and the sleeve P is moving to the right at 2 m/s, what are the angular velocities of bars OQ and PQ?



Problem 17.32

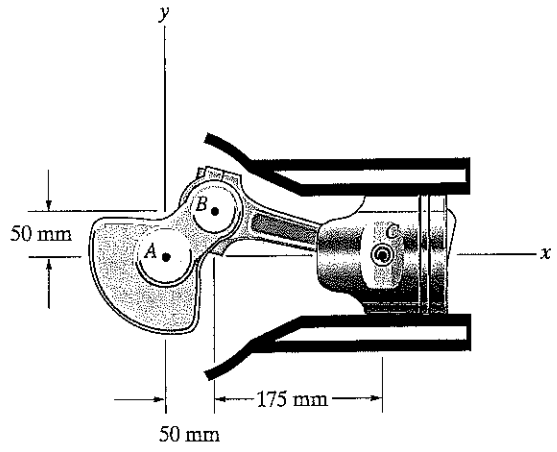
▶ 17.33 In Active Example 17.2, consider the instant when bar AB is vertical and rotating in the clockwise direction at 10 rad/s. Draw a sketch showing the positions of the two bars at that instant. Determine the angular velocity of bar BC and the velocity of point C.

17.34 Bar AB rotates in the counterclockwise direction at 6 rad/s. Determine the angular velocity of bar BD and the velocity of point D.



Problem 17.34

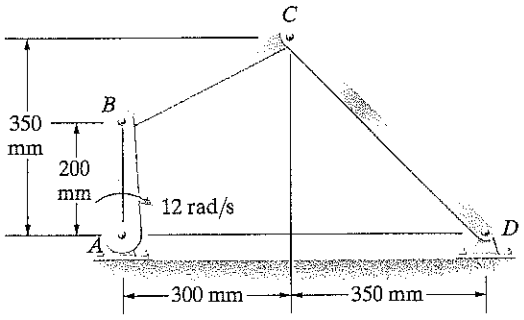
17.35 At the instant shown, the piston's velocity is $\mathbf{v}_C = -14\mathbf{i}$ (m/s). What is the angular velocity of the crank AB?



Problem 17.35

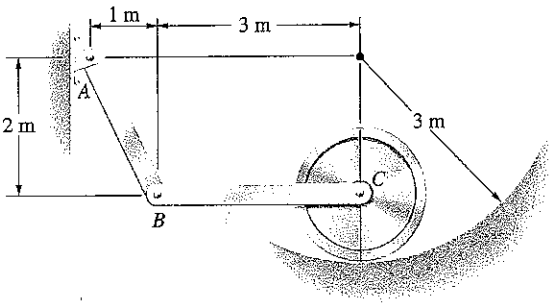
▶ 17.36 In Example 17.3, determine the angular velocity of the bar AB that would be necessary so that the downward velocity of the rack $v_R = 10$ ft/s at the instant shown.

17.37 Bar AB rotates at 12 rad/s in the clockwise direction. Determine the angular velocities of bars BC and CD.



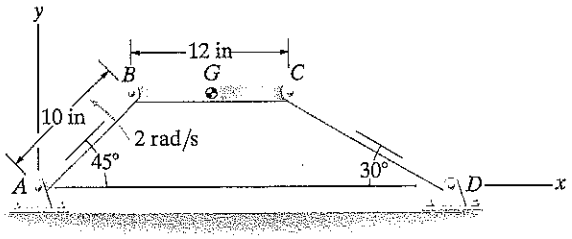
Problem 17.37

17.38 Bar AB is rotating at 10 rad/s in the counterclockwise direction. The disk rolls on the circular surface. Determine the angular velocities of bar BC and the disk at the instant shown.



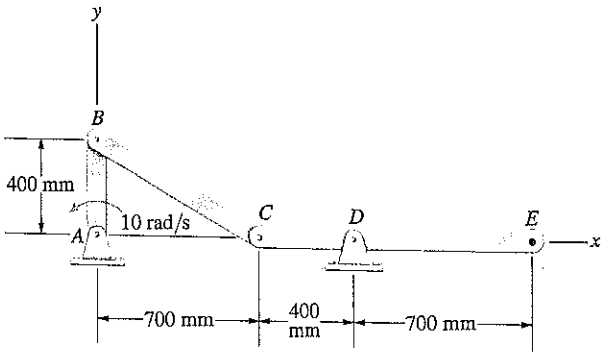
Problem 17.38

17.39 Bar AB rotates at 2 rad/s in the counterclockwise direction. Determine the velocity of the midpoint G of bar BC.



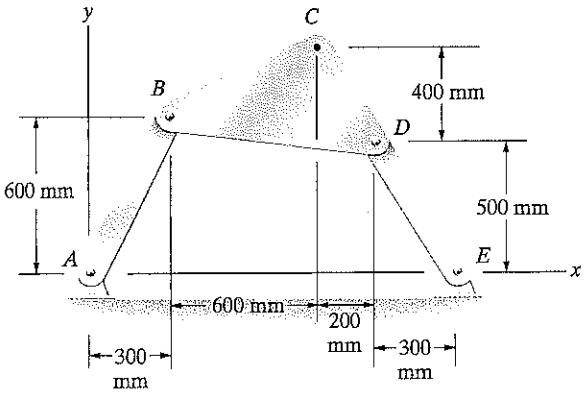
Problem 17.39

17.40 Bar AB rotates at 10 rad/s in the counterclockwise direction. Determine the velocity of point E.



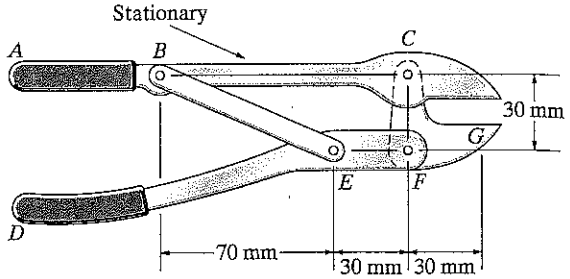
Problem 17.40

17.41 Bar AB rotates at 4 rad/s in the counterclockwise direction. Determine the velocity of point C.



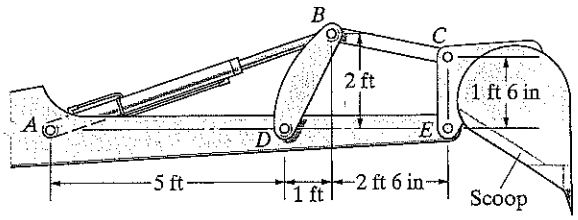
Problem 17.41

17.42 The upper grip and jaw of the pliers ABC is stationary. The lower grip DEF is rotating a 0.2 rad/s in the clockwise direction. At the instant shown, what is the angular velocity of the lower jaw CFG?



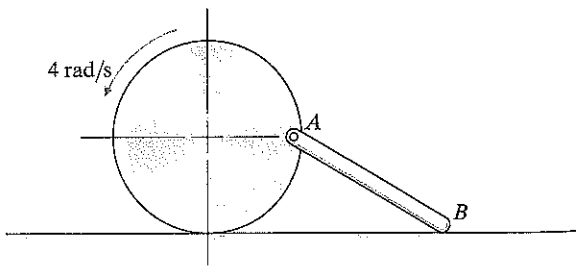
Problem 17.42

17.43 The horizontal member ADE supporting the scoop is stationary. If the link BD is rotating in the clockwise direction at 1 rad/s, what is the angular velocity of the scoop?



Problem 17.43

17.44 The diameter of the disk is 1 m, and the length of bar AB is 1 m. The disk is rolling, and point B slides on the plane surface. Determine the angular velocity of bar AB and the velocity of point B.



Problem 17.44