ME 2210 Dynamics Handout #5a: Homework: 15.11, 15.27, 15.33, 15.42, 15.52, 15.69, 15.76, 15.93

15.1 The motion of a cam is defined by the relation $\theta = t^3 - 9t^2 + 15t$, where θ is expressed in radians and t in seconds. Determine the angular coordinate, the angular velocity, and the angular acceleration of the cam when (*a*) $t = 0$, (*b*) $t = 3$ s.

15.2 For the cam of Prob. 15.1, determine the time, angular coordinate, and angular acceleration when the angular velocity is zero.

15.7 When the power to an electric motor is turned on the motor reaches its rated speed of 3300 rpm in 6 s, and when the power is turned off the motor coasts to rest in 80 s. Assuming uniformly accelerated motion, determine the number of revolutions that the motor executes (*a*) in reaching its rated speed, (*b*) in coasting to rest.

15.8 The rotor of a gas turbine is rotating at a speed of 6900 rpm when the turbine is shut down. It is observed that 4 min is required for the rotor to coast to rest. Assuming uniformly accelerated motion, determine (*a*) the angular acceleration, (*b*) the number of revolutions that the rotor executes before coming to rest.

15.10 The assembly shown consists of the straight rod *ABC* which passes through and is welded to the rectangular plate *DEFH*. The assembly rotates about the axis *AC* with a constant angular velocity of 9 rad/s. Knowing that the motion when viewed from *C* is counterclockwise, determine the velocity and acceleration of corner *F*.

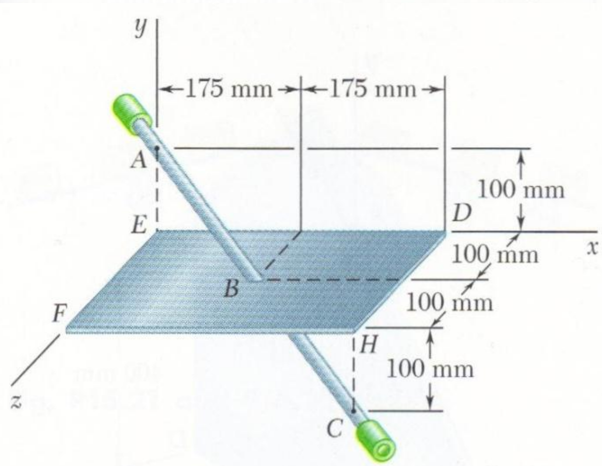

Fig. P15.10

15.11 In Prob. 15.10, determine the acceleration of corner H, assuming that the angular velocity is 9 rad/s and decreases at a rate of 18 rad/s^2.

15.18 The circular plate shown is initially at rest. Knowing that r = 200 mm and that the plate has a constant angular acceleration of 0.3 rad/s^2, determine the magnitude of the total acceleration of point B when (*a*) $t = 0$, (*b*) $t = 2$ s, (*c*) $t = 4$ s.

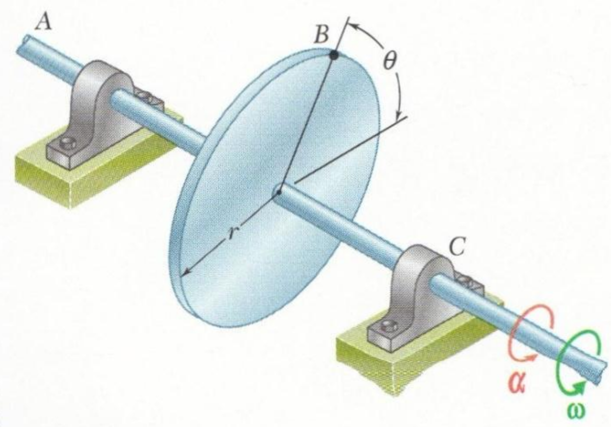

Fig. P15.18, P15.19, and P15.20

15.19 The angular acceleration of the 600-mm-radius circular plate shown is defined by the relation $\alpha = \alpha_0 e^{-t}$. Knowing that the plate is at rest when $t = 0$ and that $\alpha_0 = 10$ rad/s^2, determine the magnitude of the total acceleration of point B when (*a*) $t = 0$, (*b*) $t = 0.5$ s, (*c*) $t = \infty$.

15.21 A series of small machine components being moved by a conveyor belt pass over a 6-in.-radius idler pulley. At the instant shown, the velocity of point A is 15 in./s to the left and its acceleration is 9 in./s^2 to the right. Determine (*a*) the angular velocity and angular acceleration of the idler pulley, (*b*) the total acceleration of the machine component at B.

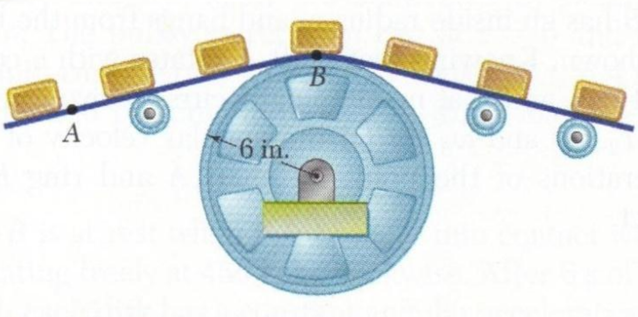

Fig. P15.21 and P15.22

15.22 A series of small machine components being moved by a conveyor belt pass over a 6-in.-radius idler pulley. At the instant shown, the angular velocity of the idler pulley is 4 rad/s clockwise. Determine the angular acceleration of the pulley for which the magnitude of the total acceleration of the machine component at B is 120 in./s^2.

15.25 Ring C has an inside radius of 55 mm and an outside radius of 60 mm and is positioned between two wheels A and B, each of 24-mm outside radius. Knowing that wheel A rotates with a constant angular velocity of 300 rpm and that no slipping occurs, determine (*a*) the angular velocity of the ring C and of wheel B, (*b*) the acceleration of the points A and B which are in contact with C.

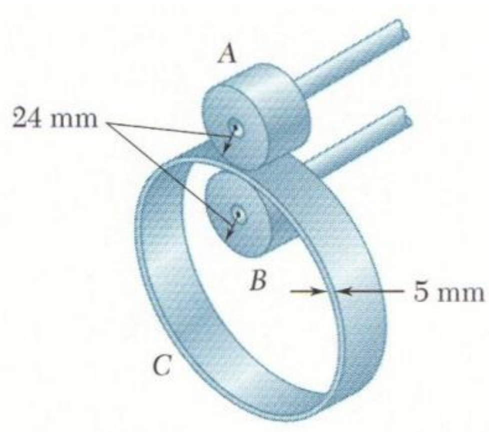

Fig. P15.25

15.27 Ring B has an inside radius r_2 and hangs from the horizontal shaft A as shown. Shaft A rotates with a constant angular velocity of 25 rad/s and no slipping occurs. Knowing that $r_1 = 12$ mm, $r_2 = 30$ mm, and $r_3 = 40$ mm, determine (*a*) the angular velocity of ring B, (*b*) the accelerations of the points of shaft A and ring B which are in contact, (*c*) the magnitude of the acceleration of a point on the outside surface of ring B.

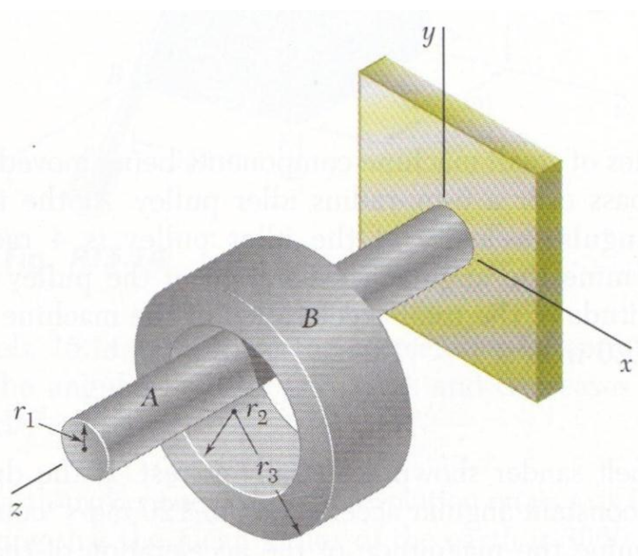

Fig. *P15.26* and P15.27

15.28 Cylinder *A* is moving downward with a velocity of 9 ft/s when the brake is suddenly applied to the drum. Knowing that the cylinder moves 18 ft downward before coming to rest and assuming uniformly accelerated motion, determine (*a*) the angular acceleration of the drum, (*b*) the time required for the cylinder to come to rest.

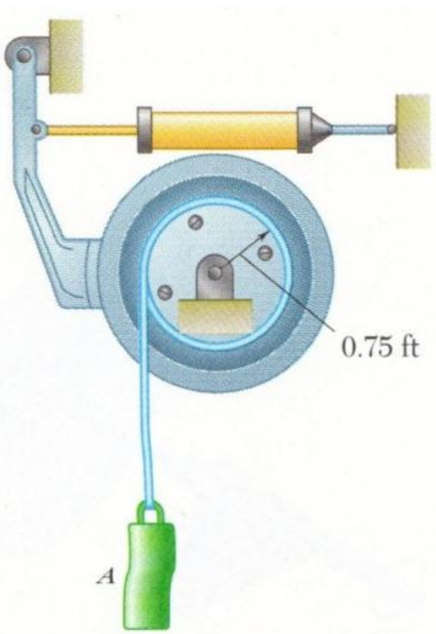

Fig. P15.28 and P15.29

15.29 The system shown is held at rest by the brake-and-drum system. After the brake is partially released at $t = 0$, it is observed that the cylinder moves 16 ft in 5 s. Assuming uniformly accelerated motion, determine (*a*) the angular acceleration of the drum, (*b*) the angular velocity of the drum at $t = 4$ s.

15.32 Disk *B* is at rest when it is brought into contact with disk *A* which is rotating freely at 450 rpm clockwise. After 6 s of slippage, during which each disk has a constant angular acceleration, disk *A* reaches a final angular velocity of 140 rpm clockwise. Determine the angular acceleration of each disk during the period of slippage.

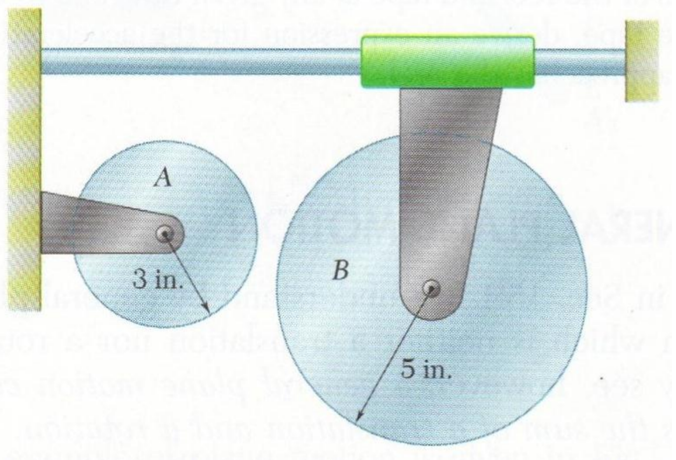

Fig. P15.32 and P15.33

15.33 and *15.34* A simple friction drive consists of two disks *A* and *B*. Initially, disk *A* has a clockwise angular velocity of 500 rpm and disk *B* is at rest. It is known that disk *A* will coast to rest in 60 s. However, rather than waiting until both disks are at rest to bring them together, disk *B* is given a constant angular acceleration of 2.5 rad/s^2 counterclockwise. Determine (*a*) at what time the disks can be brought together if they are not to slip, (*b*) the angular velocity of each disk as contact is made.

15.38 The motion of rod AB is guided by pins attached at A and B which slide in the slots shown. At the instant shown, $\theta = 40°$ and the pin at B moves upward to the left with a constant velocity of 6 in./s. Determine (*a*) the angular velocity of the rod, (*b*) the velocity of the pin at end A.

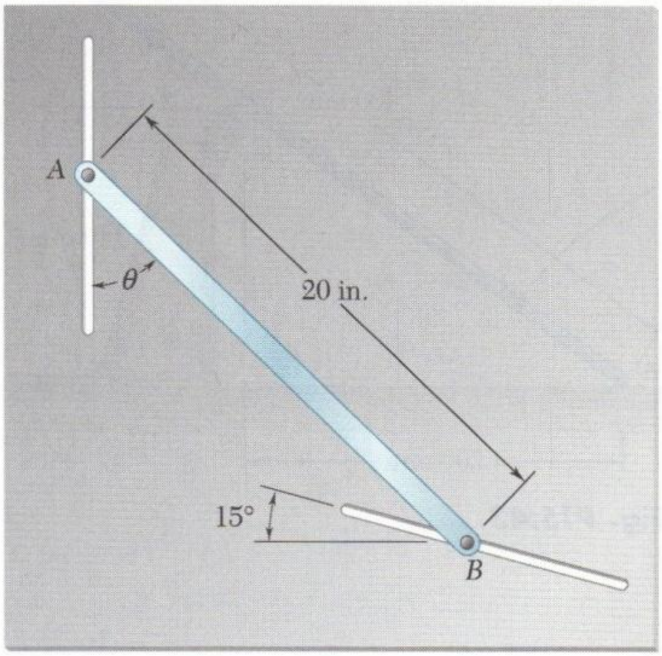

Fig. P15.38 and P15.39

15.39 The motion of rod AB is guided by pins attached at A and B which slide in the slots shown. At the instant shown, $\theta = 30°$ and the pin at A moves downward with a constant velocity of 9 in./s. Determine (*a*) the angular velocity of the rod, (*b*) the velocity of the pin at end B.

15.41 Collar A moves upward with a constant velocity of 1.2 m/s. At the instant shown when $\theta = 25°$, determine (*a*) the angular velocity of rod AB, (*b*) the velocity of collar B.

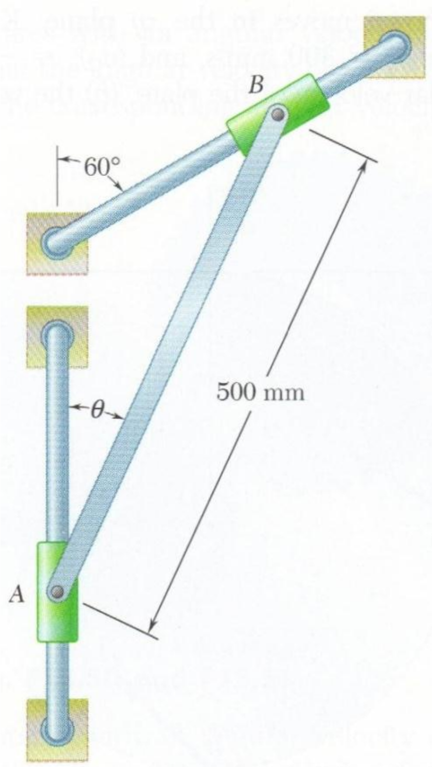

Fig. P15.41 and *P15.42*

15.42 Collar B moves downward to the left with a constant velocity of 1.6 m/s. At the instant shown when $\theta = 40°$, determine (*a*) the angular velocity of rod AB, (*b*) the velocity of collar A.

15.44 The plate shown moves in the xy plane. Knowing that $(v_A)_x = 12$ in./s, $(v_B)_x = -4$ in./s, and $(v_C)_y = -24$ in./s, determine (*a*) the angular velocity of the plate, (*b*) the velocity of point B.

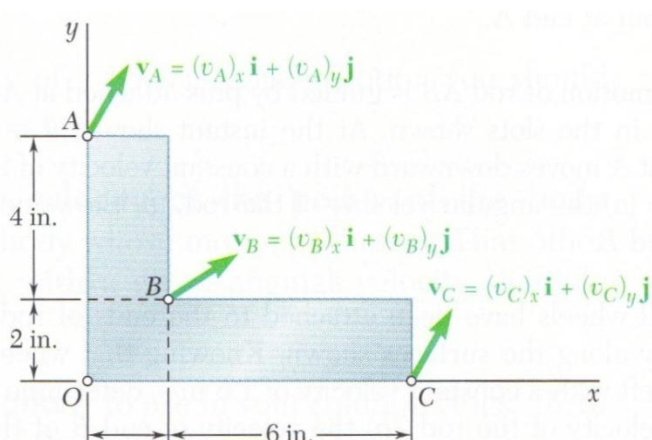

Fig. P15.44

15.45 In Prob. 15.44, determine (*a*) the velocity of point *A*, (*b*) the point on the plate with zero velocity.

15.48 In the planetary gear system shown, the radius of gears *A*, *B*, *C*, and *D* is 3 in. and the radius of the outer gear *E* is 9 in. Knowing that gear *E* has an angular velocity of 120 rpm clockwise and that the central gear has an angular velocity of 150 rpm clockwise, determine (*a*) the angular velocity of each planetary gear, (*b*) the angular velocity of the spider connecting the planetary gears.

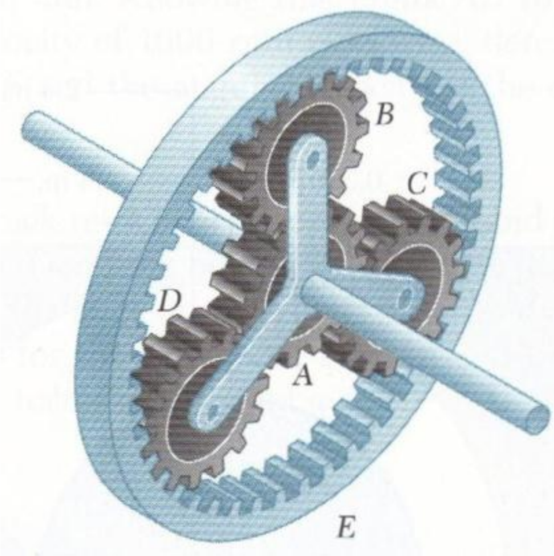

Fig. P15.48 and P15.49

15.50 Gear *A* rotates with an angular velocity of 120 rpm clockwise. Knowing that the angular velocity of arm *AB* is 90 rpm clockwise, determine the corresponding angular velocity of gear *B*.

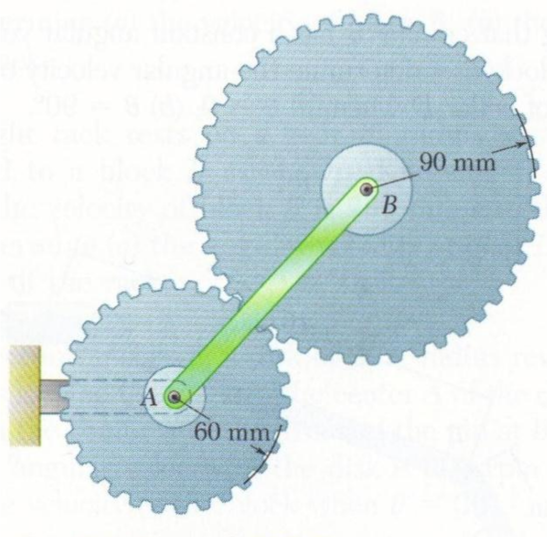

Fig. P15.50 and P15.51

15.51 Arm AB rotates with an angular velocity of 42 rpm clockwise. Determine the required angular velocity of gear A for which (*a*) the angular velocity of gear B is 20 rpm counterclockwise, (*b*) the motion of gear B is a curvilinear translation.

15.52 Arm AB rotates with an angular velocity of 20 rad/s counterclockwise. Knowing that the outer gear C is stationary, determine (*a*) the angular velocity of gear B, (*b*) the velocity of the gear tooth located at point D.

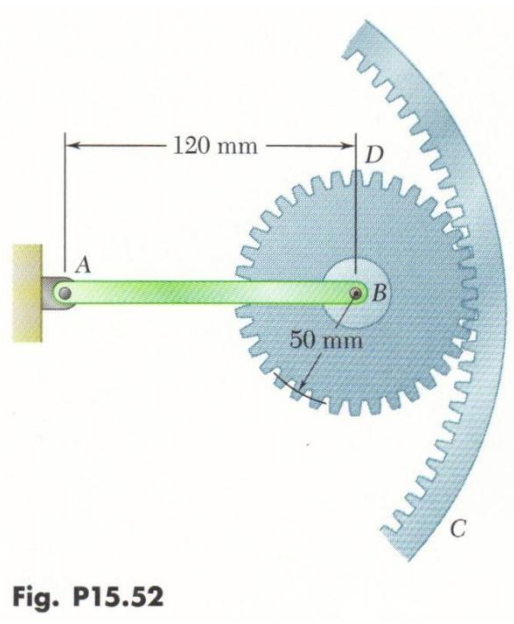

Fig. P15.52

15.55 Knowing that crank AB has a constant angular velocity of 160 rpm counterclockwise, determine the angular velocity of rod BD and the velocity of collar D when (*a*) $\theta = 0$, (*b*) $\theta = 90°$.

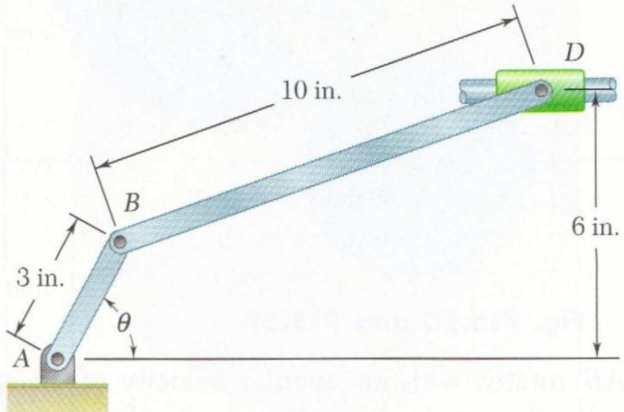

Fig. P15.55 and P15.56

15.56 Knowing that crank AB has a constant angular velocity of 160 rpm counterclockwise, determine the angular velocity of rod BD and the velocity of collar D when $\theta = 60°$.

15.63 through 15.65 In the position shown, bar AB has an angular velocity of 4 rad/s clockwise. Determine the angular velocity of bars BD and DE.

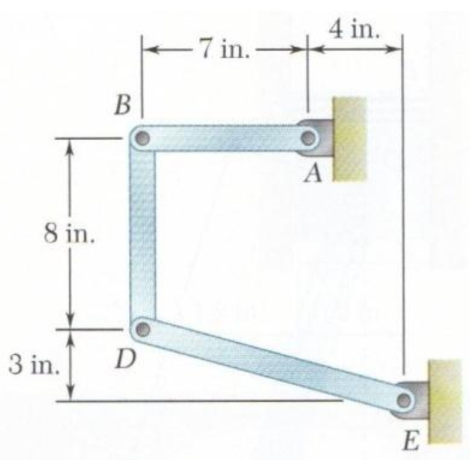

Fig. P15.63

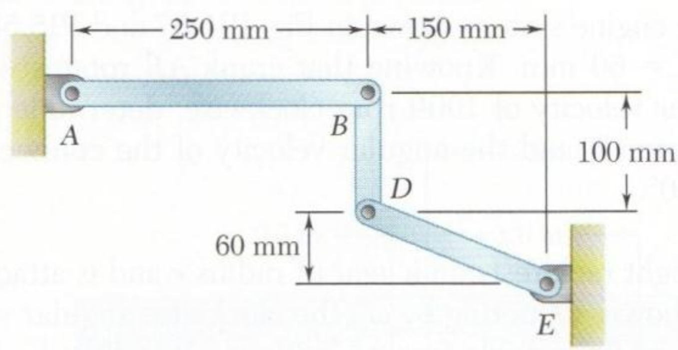

Fig. P15.64

15.68 In the position shown, bar AB has zero angular acceleration and an angular velocity of 20 rad/s counterclockwise. Determine (*a*) the angular velocity of member BDH, (*b*) the velocity of point G.

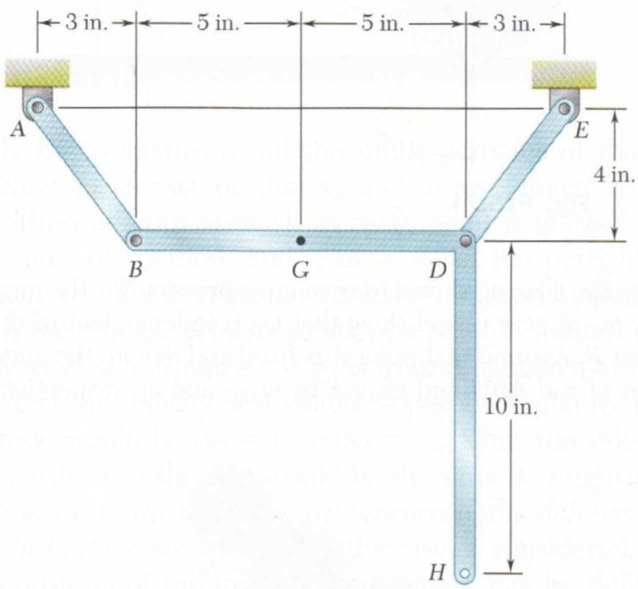

Fig. P15.68 and P15.69

15.69 In the position shown, bar AB has zero angular acceleration and an angular velocity of 20 rad/s counterclockwise. Determine (*a*) the angular velocity of member BDH, (*b*) the velocity of point H.

15.73 A 10-ft beam AE is being lowered by means of two overhead cranes. At the instant shown it is known that the velocity of point D is 24 in./s downward and the velocity of point E is 36 in./s downward. Determine (*a*) the instantaneous center of rotation of the beam, (*b*) the velocity of point A.

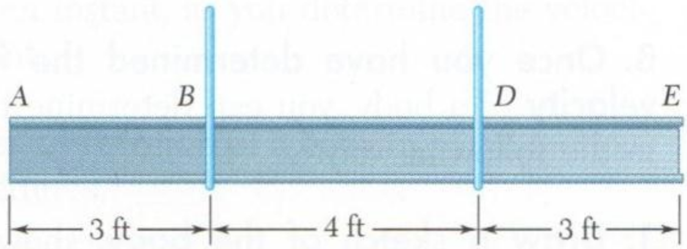

Fig. P15.73

15.74 A helicopter moves horizontally in the x direction at a speed of 120 mi/h. Knowing that the main blades rotate clockwise with an angular velocity of 180 rpm, determine the instantaneous axis of rotation of the main blades.

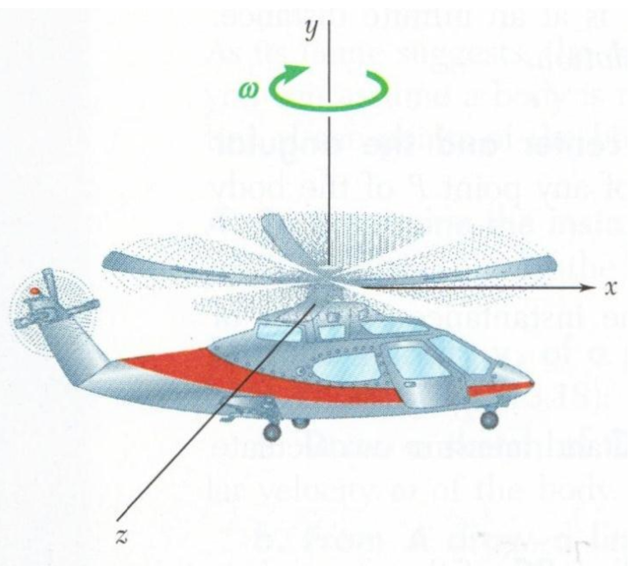

Fig. P15.74

15.75 The spool of tape shown and its frame assembly are pulled upward at a speed v_A = 750 mm/s. Knowing that the 80-mm-radius spool has an angular velocity of 15 rad/s clockwise and that at the instant shown the total thickness of the tape on the spool is 20 mm, determine (*a*) the instantaneous center of rotation of the spool, (*b*) the velocities of points B and D.

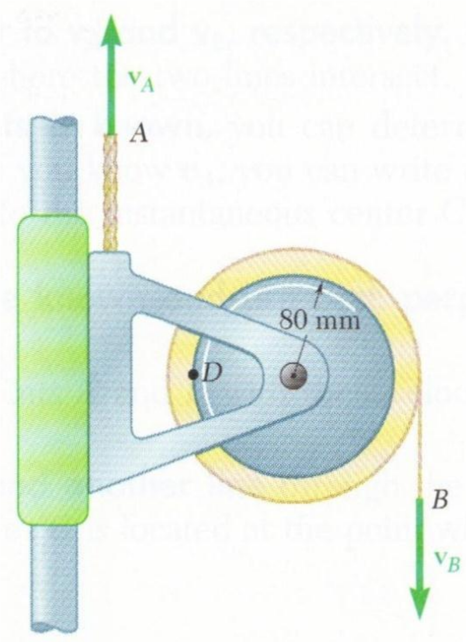

Fig. P15.75 and P15.76

15.76 The spool of tape shown and its frame assembly are pulled upward at a speed $v_A = 100$ mm/s. Knowing that end B of the tape is pulled downward with a velocity of 300 mm/s and that at the instant shown the total thickness of the tape on the spool is 20 mm, determine (*a*) the instantaneous center of rotation of the spool, (*b*) the velocity of point D of the spool.

15.78 A double pulley is attached to a slider block by a pin at A. The 30-mm-radius inner pulley is rigidly attached to the 60-mm-radius outer pulley. Knowing that each of the two cords is pulled at a constant speed as shown, determine (*a*) the instantaneous center of rotation of the double pulley, (*b*) the velocity of the slider block, (*c*) the number of millimeters of cord wrapped or unwrapped on each pulley per second.

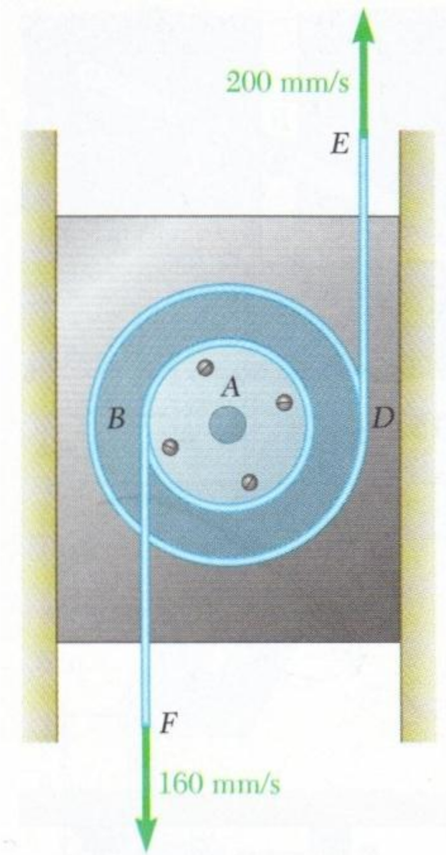

Fig. P15.78

15.79 Solve Prob. 15.78, assuming that cord E is pulled upward at a speed of 160 mm/s and cord F is pulled downward at a speed of 200 mm/s.

15.82 Knowing that at the instant shown the angular velocity of rod AB is 15 rad/s clockwise, determine (*a*) the angular velocity of rod BD, (*b*) the velocity of the midpoint of rod BD.

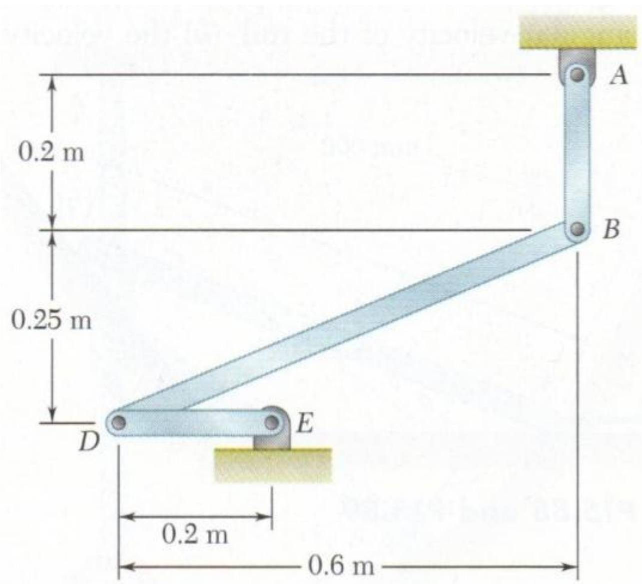

Fig. P15.82 and P15.83

15.83 Knowing that at the instant shown the velocity of point D is 2.4 m/s upward, determine (*a*) the angular velocity of rod AB, (*b*) the velocity of the midpoint of rod BD.

15.84 Rod ABD is guided by wheels at A and B that roll in horizontal and vertical tracks. Knowing that at the instant $\beta = 60°$ and the velocity of wheel B is 40 in./s downward, determine (*a*) the angular velocity of the rod, (*b*) the velocity of point D.

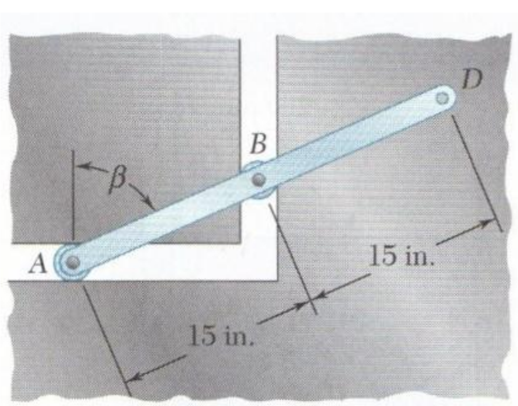

Fig. P15.84

15.85 An overhead door is guided by wheels at A and B that roll in horizontal and vertical tracks. Knowing that when $\theta = 40°$ the velocity of wheel B is 1.5 ft/s upward, determine (*a*) the angular velocity of the door, (*b*) the velocity of end D of the door.

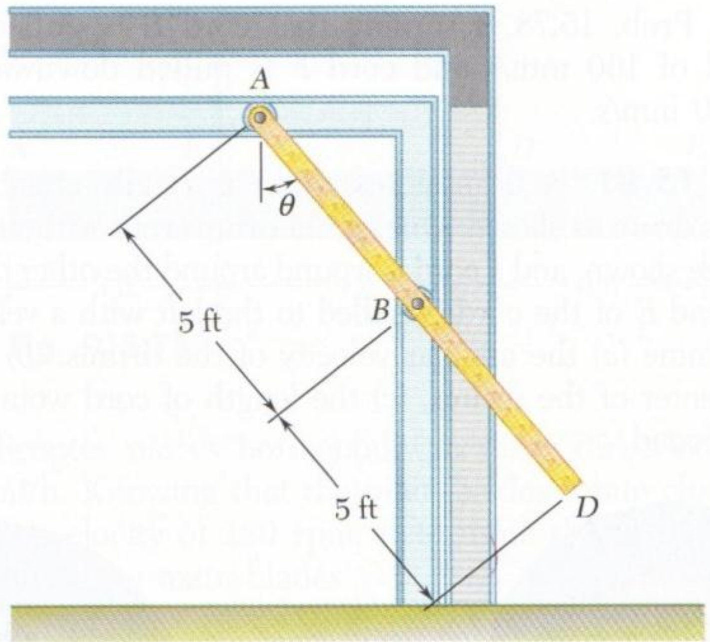

Fig. P15.85

15.92 Two slots have been cut in plate FG and the plate has been placed so that the slots fit two fixed pins A and B. Knowing that at the instant shown the angular velocity of crank DE is 6 rad/s clockwise, determine (*a*) the velocity of point F, (*b*) the velocity of point G.

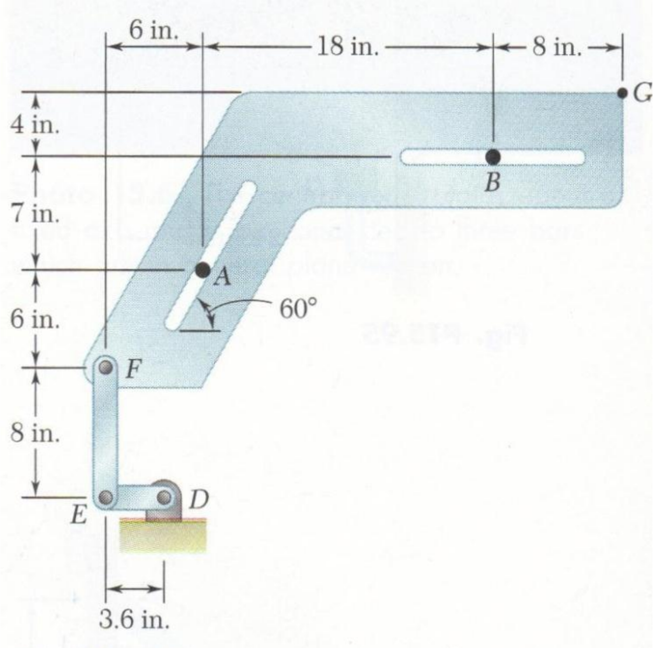

Fig. P15.92

15.93 Two identical rods *ABF* and *DBE* are connected by a pin at *B*. Knowing that at the instant shown the velocity of point *D* is 10 in./s upward, determine the velocity of (*a*) point *E*, (*b*) point *F*.

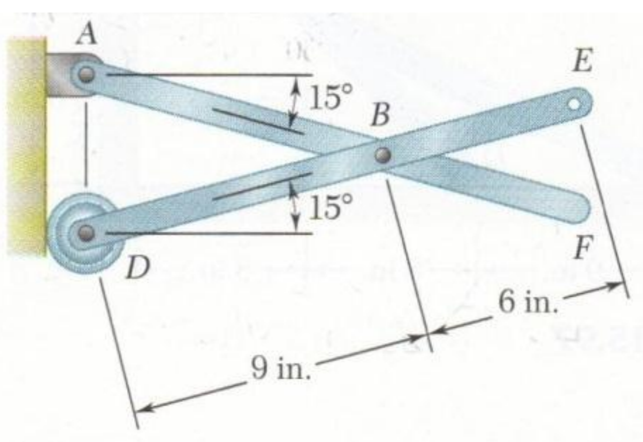

Fig. P15.93

15.97 Two rods *AB* and *DE* are connected as shown. Knowing that point *D* moves to the left with a velocity of 40 in./s, determine (*a*) the angular velocity of each rod, (*b*) the velocity of point *A*.

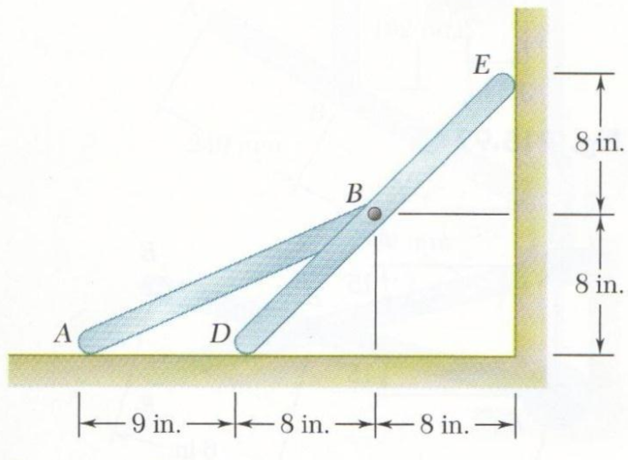

Fig. P15.97

15.98 Two rods *AB* and *DE* are connected as shown. Knowing that point *B* moves downward with a velocity of 60 in./s, determine (*a*) the angular velocity of each rod, (*b*) the velocity of point *E*.

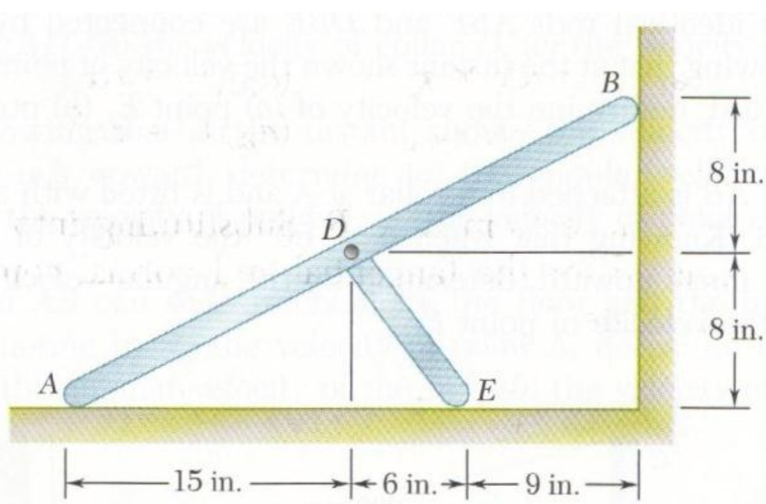

Fig. P15.98