ME 2210 Dynamics Handout #1: Homework: 11.16, 11.25, 11.42, 11.48, 11.101, 11.124, 11.144, 11.156, 11.172

11.1 The motion of a particle is defined by the relation $x = 1.5t^4 - 30t^2 + 5t + 10$, where x and t are expressed in meters and seconds, respectively. Determine the position, the velocity, and the acceleration of the particle when $t = 4$ s.

11.2 The motion of a particle is defined by the relation $x = 12t^3 - 18t^2 + 2t + 5$, where x and t are expressed in meters and seconds, respectively. Determine the position and the velocity when the acceleration of the particle is equal to zero.

11.15 The acceleration of a particle is defined by the relation $a = -k/x$. It has been experimentally determined that $v = 15$ ft/s when $x = 0.6$ ft and that $v = 9$ ft/s when $x = 1.2$ ft. Determine (a) the velocity of the particle when $x = 1.5$ ft, (b) the position of the particle at which its velocity is zero.

11.16 A particle starting from rest at $x = 1$ ft is accelerated so that its velocity doubles in magnitude between $x = 2$ ft and $x = 8$ ft. Knowing that the acceleration of the particle is defined by the relation $a = k[x - (A/x)]$, determine the values of the constants A and k if the particle has a velocity of 29 ft/s when $x = 16$ ft.

11.24 A bowling ball is dropped from a boat so that it strikes the surface of a lake with a speed of 25 ft/s. Assuming the ball experiences a downward acceleration of $a = 10 - 0.9v^2$ when in the water, determine the velocity of the ball when it strikes the bottom of the lake.

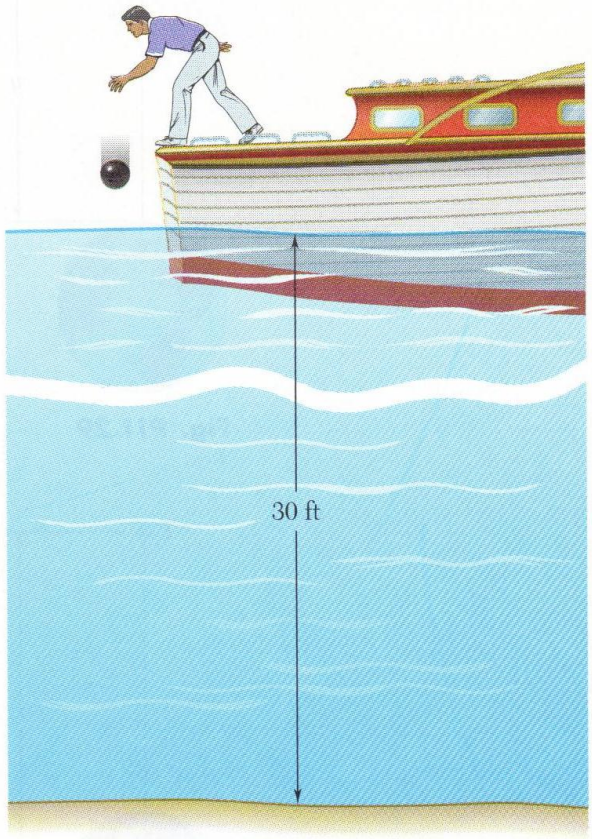

Fig. P11.24

11.25 The acceleration of a particle is defined by the relation $a = 0.4(1 - kv)$, where k is a constant. Knowing that at $t = 0$ the particle starts from rest at $x = 4$ m and that when $t = 15$ s, $v = 4$ m/s, determine (*a*) the constant k, (*b*) the position of the particle when $v = 6$ m/s, (*c*) the maximum velocity of the particle.

11.33 A motorist enters a freeway at 45 km/h and accelerates uniformly to 99 km/h. From the odometer in the car, the motorist knows that she traveled 0.2 km while accelerating. Determine (*a*) the acceleration of the car, (*b*) the time required to reach 99 km/h.

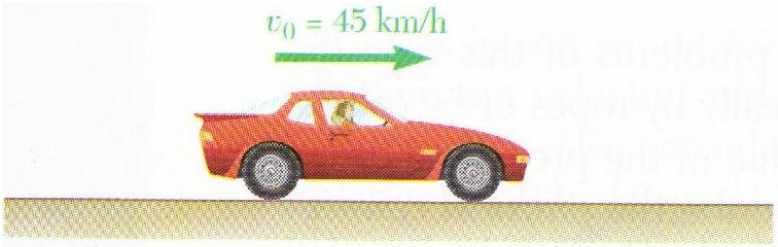

Fig. P11.33

11.34 A truck travels 220 m in 10 s while being decelerated at a constant rate of 0.6 m/s^2. Determine (*a*) its initial velocity, (*b*) its final velocity, (*c*) the distance traveled during the first 1.5 s.

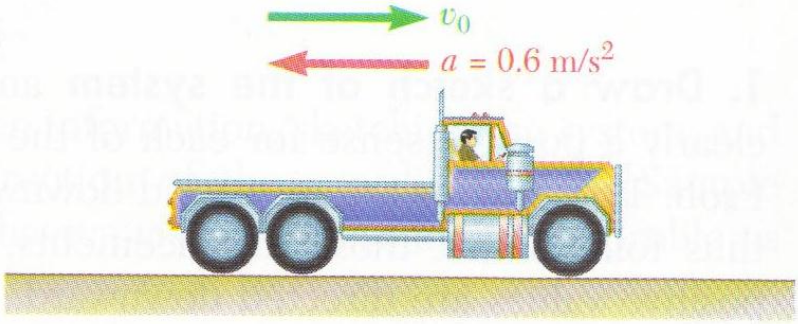

Fig. P11.34

11.41 Automobiles *A* and *B* are traveling in adjacent highway lanes and at $t = 0$ have the positions and speeds shown. Knowing that automobile *A* has a constant acceleration of 1.8 ft/s^2 and that *B* has a constant deceleration of 1.2 ft/s^2, determine (*a*) when and where *A* will overtake *B*, (*b*) the speed of each automobile at that time.

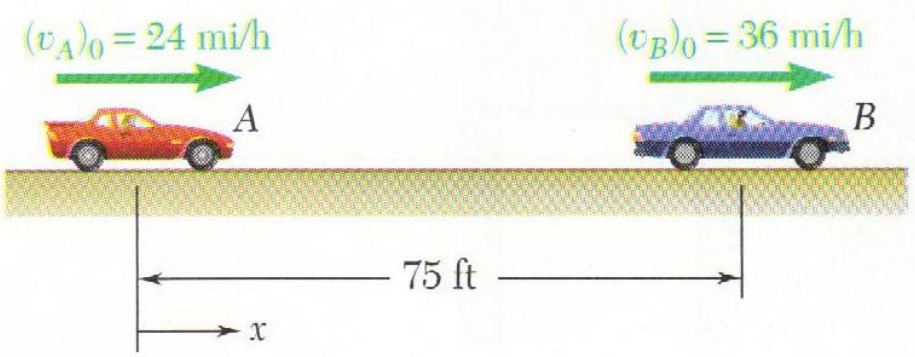

Fig. P11.41

11.42 In a boat race, boat A is leading boat B by 120 ft and both boats are traveling at a constant speed of 105 mi/h. At $t = 0$, the boats accelerate at constant rates. Knowing that when B passes A, $t = 8$ s and $v_A = 135$ mi/h, determine (a) the acceleration of A, (b) the acceleration of B.

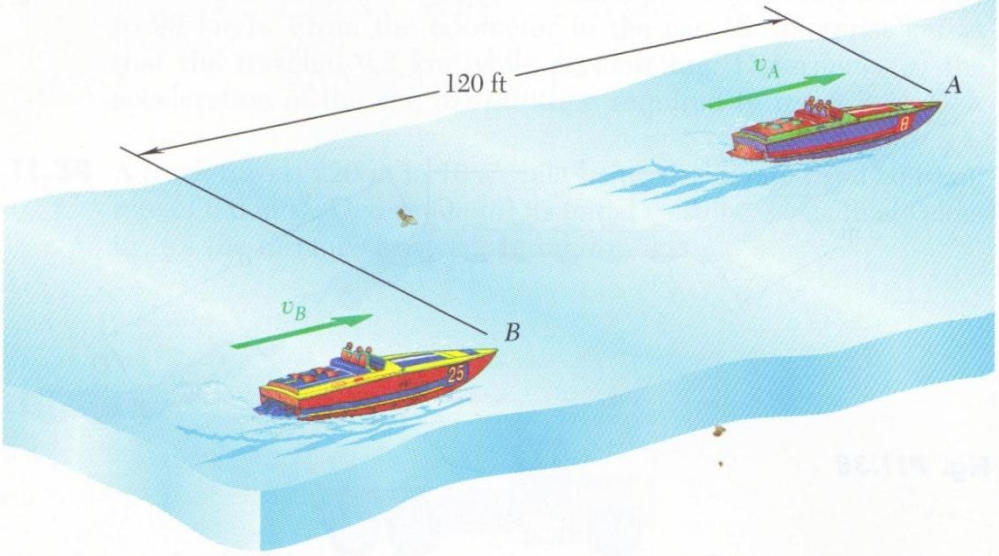

Fig. P11.42

11.47 Slider block A moves to the left with a constant velocity of 6 m/s. Determine (a) the velocity of block B, (b) the velocity of portion D of the cable, (c) the relative velocity of portion C of the cable with respect to portion D.

11.48 Block B starts from rest and moves downward with a constant acceleration. Knowing that after slider block A has moved 400 mm its velocity is 4 m/s, determine (a) the accelerations of A and B, (b) the velocity and the change in position of B after 2 s.

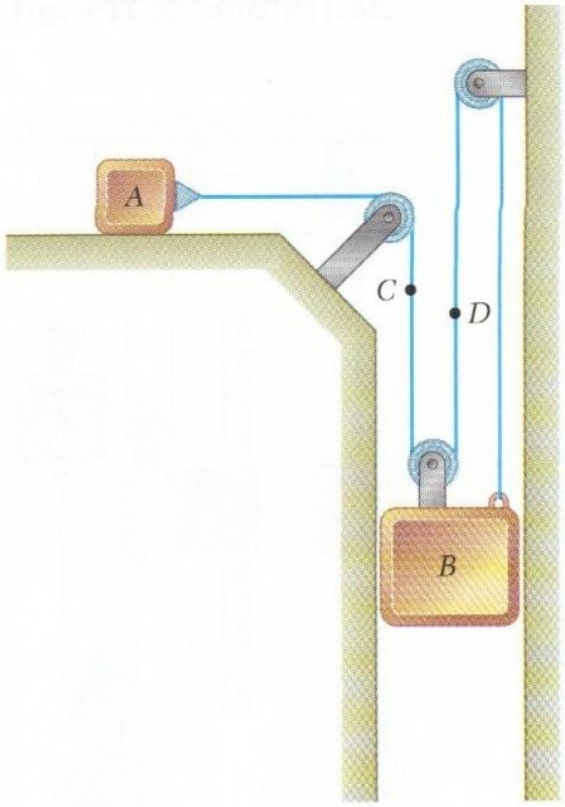

Fig. P11.47 and P11.48

11.53 Slider block B moves to the right with a constant velocity of 300 mm/s. Determine (a) the velocity of slider block A, (b) the velocity of portion C of the cable, (c) the velocity of portion D of the cable, (d) the relative velocity of portion C of the cable with respect to slider block A.

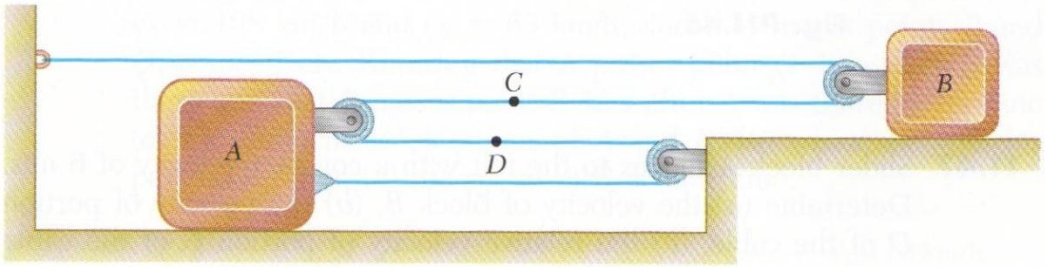

Fig. P11.53 and P11.54

11.54 At the instant shown, slider block B is moving with a constant acceleration, and its speed is 150 mm/s. Knowing that after slider block A has moved 240 mm to the right its velocity is 60 mm/s, determine (a) the accelerations of A and B, (b) the acceleration of portion D of the cable, (c) the velocity and the change in position of slider block B after 4 s.

11.57 Collar A starts from rest at $t = 0$ and moves downward with a constant acceleration of 7 in./s^2. Collar B moves upward with a constant acceleration, and its initial velocity is 8 in./s. Knowing that collar B moves through 20 in. between $t = 0$ and $t = 2$ s, determine (a) the accelerations of collar B and block C, (b) the time at which the velocity of block C is zero, (c) the distance through which block C will have moved at that time.

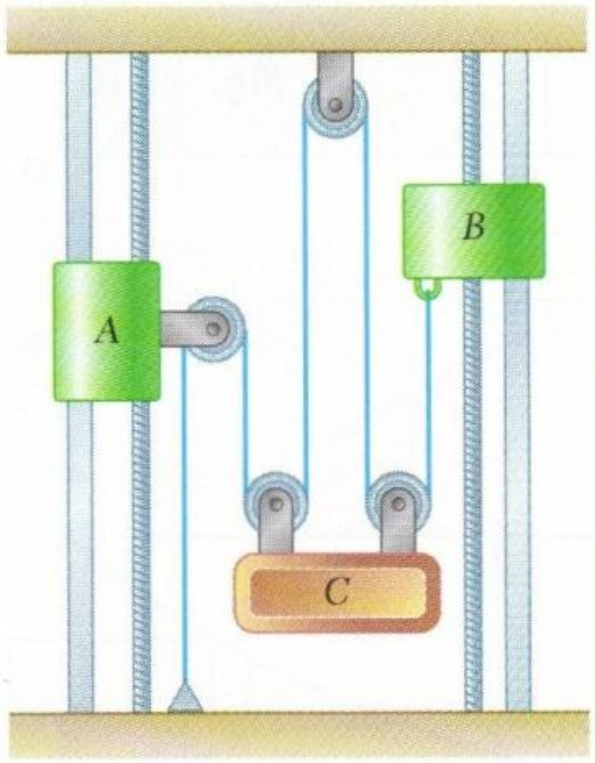

Fig. P11.57 and P11.58

11.89 The motion of a particle is defined by the equations $x = 4t^3 - 5t^2 + 5t$ and $y = 5t^2 - 15t$, where x and y are expressed in millimeters and t is expressed in seconds. Determine the velocity and the acceleration when (*a*) $t = 1$ s, (*b*) $t = 2$ s.

11.90 The motion of a particle is defined by the equations $x = 2 \cos \pi t$ and $y = 1 - 4 \cos 2\pi t$, where x and y are expressed in meters and t is expressed in seconds. Show that the path of the particle is part of the parabola shown, and determine the velocity and the acceleration when (*a*) $t = 0$, (*b*) $t = 1.5$ s.

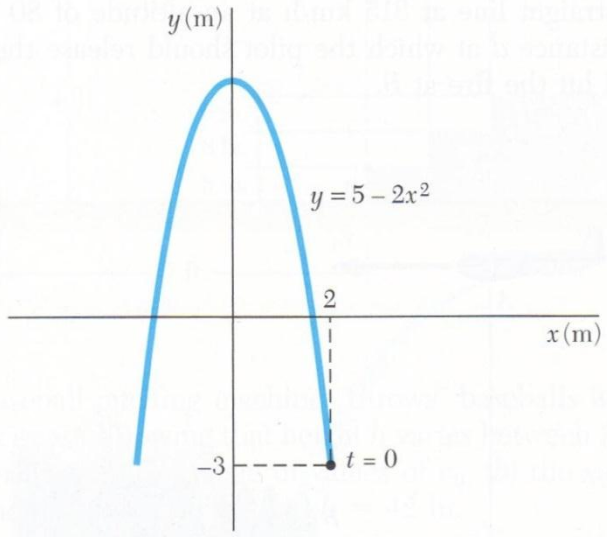

Fig. P11.90

11.100 A baseball pitching machine "throws" baseballs with a horizontal velocity $\mathbf{v}_0$. Knowing that height h varies between 31 in. and 42 in., determine (*a*) the range of values of v_0, (*b*) the values of α corresponding to $h = 31$ in. and $h = 42$ in.

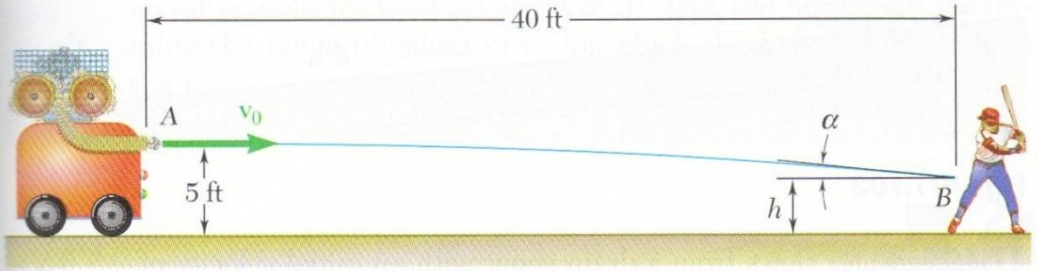

Fig. P11.100

11.101 A volleyball player serves the ball with an initial velocity $\mathbf{v}_0$ of magnitude 13.40 m/s at an angle of 20° with the horizontal. Determine (*a*) if the ball will clear the top of the net, (*b*) how far from the net the ball will land.

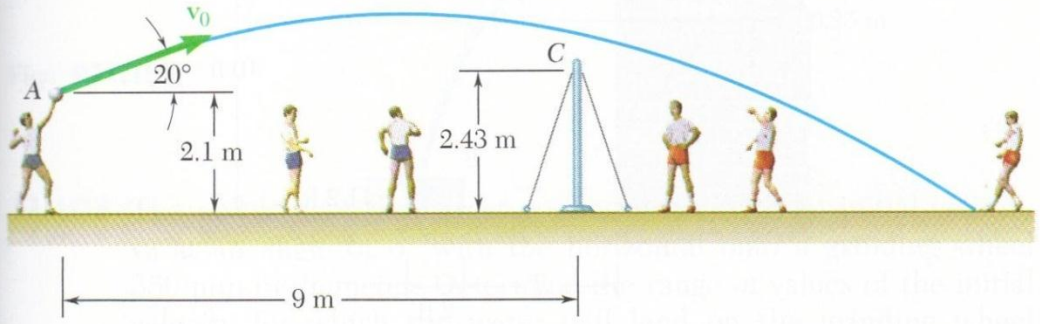

Fig. P11.101

11.118 The velocities of skiers A and B are as shown. Determine the velocity of A with respect to B.

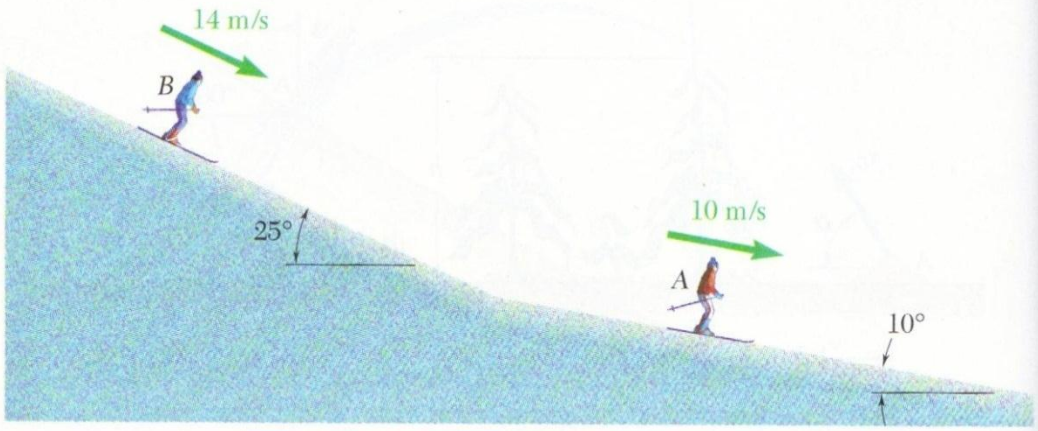

Fig. P11.118

11.119 Shore-based radar indicates that a ferry leaves its slip with a velocity $\mathbf{v} = 9.8$ knots $\nearrow 70°$, while instruments aboard the ferry indicate a speed of 10 knots and a heading of 30° west of south relative to the river. Determine the velocity of the river.

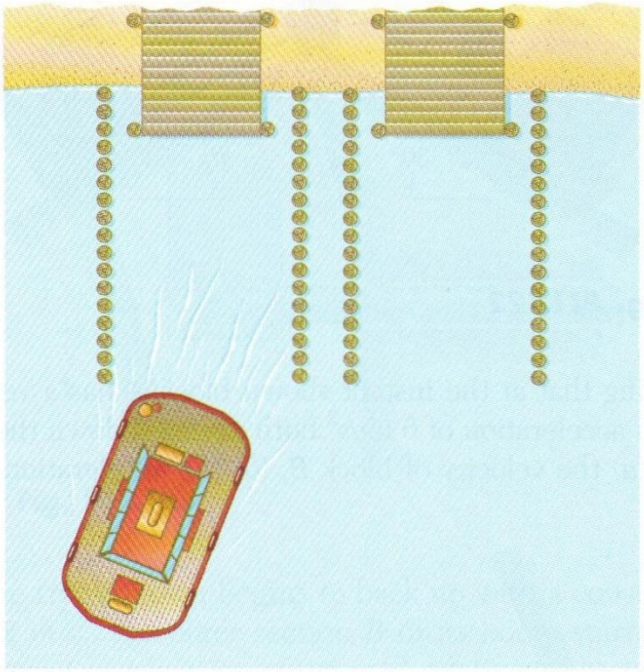

Fig. P11.119

11.120 Airplanes A and B are flying at the same altitude and are tracking the eye of hurricane C. The relative velocity of C with respect to A is $\mathbf{v}_{C/A} = 235$ mi/h $\nearrow 75°$, and the relative velocity of C with respect to B is $\mathbf{v}_{C/B} = 260$ mi/h $\nwarrow 40°$. Determine (*a*) the relative velocity of B with respect to A, (*b*) the velocity of A if ground-based radar indicates that the hurricane is moving at a speed of 24 mi/h due north, (*c*) the change in position of C with respect to B during a 15-min interval.

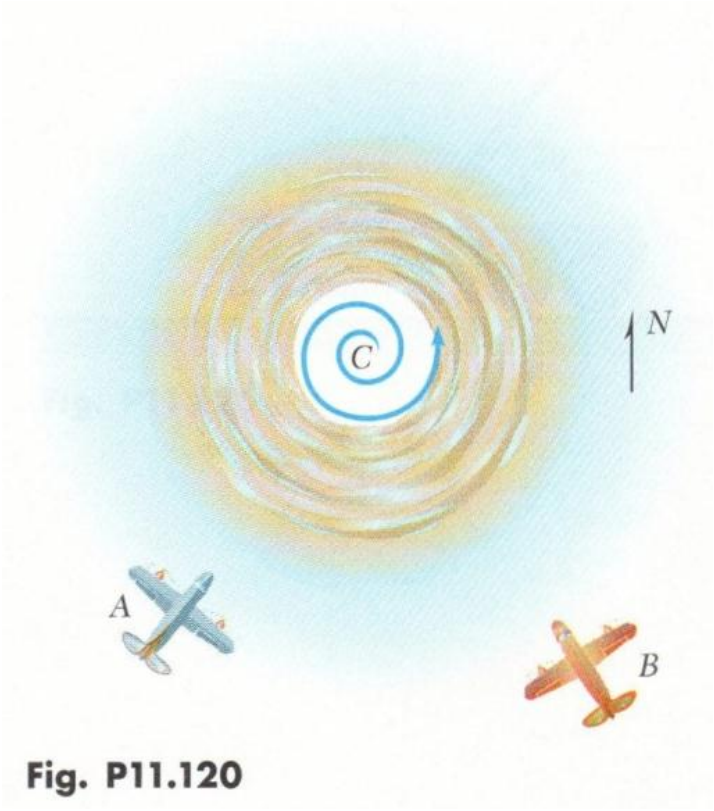

Fig. P11.120

11.123 Knowing that at the instant shown block A has a velocity of 8 in./s and an acceleration of 6 in./s^2 both directed down the incline, determine (*a*) the velocity of block B, (*b*) the acceleration of block B.

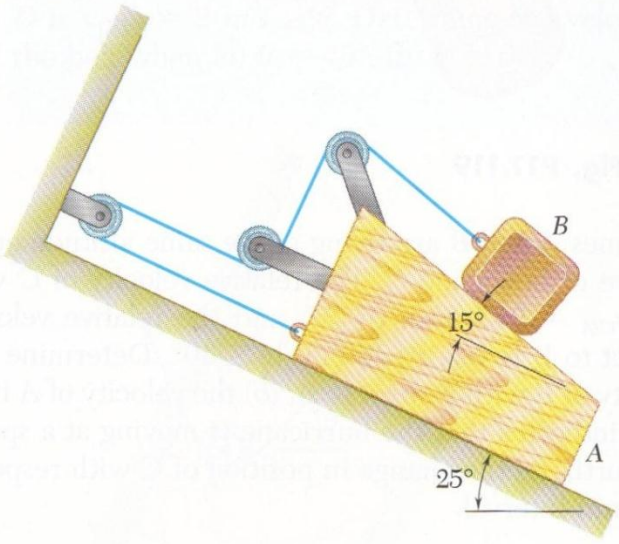

Fig. P11.123

11.124 Knowing that at the instant shown assembly A has a velocity of 9 in./s and an acceleration of 15 in./s^2 both directed downwards, determine (*a*) the velocity of block B, (*b*) the acceleration of block B.

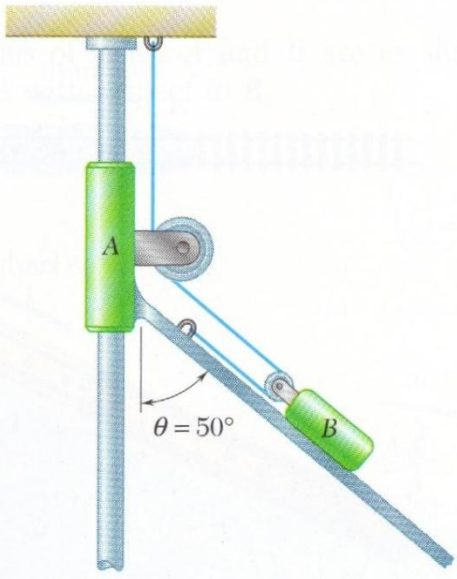

Fig. P11.124

11.133 Determine the peripheral speed of the centrifuge test cab A for which the normal component of the acceleration is 10g.

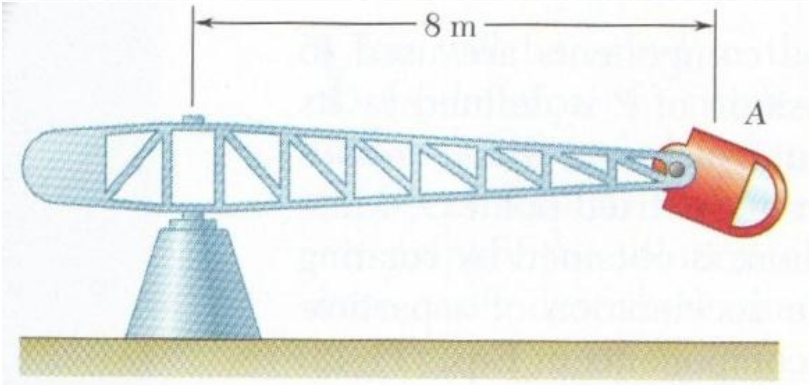

Fig. P11.133

11.134 To test its performance, an automobile is driven around a circular test track of diameter d. Determine (*a*) the value of d if when the speed of the automobile is 72 km/h, the normal component of the acceleration is 3.2 m/s^2, (*b*) the speed of the automobile if d = 180 m and the normal component of the acceleration is measured to be 0.6g.

11.143 A golfer hits a golf ball from point A with an initial velocity of 50 m/s at an angle of 25° with the horizontal. Determine the radius of curvature of the trajectory described by the ball (*a*) at point A, (*b*) at the highest point of the trajectory.

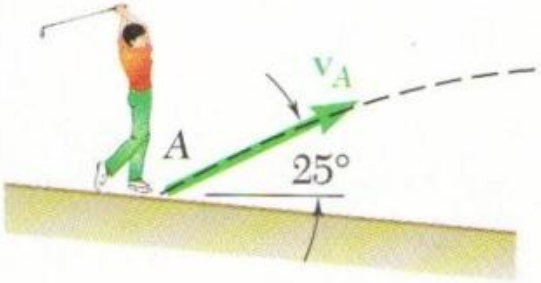

Fig. P11.143

11.144 From a photograph of a homeowner using a snowblower, it is determined that the radius of curvature of the trajectory of the snow was 8.5 m as the snow left the discharge chute at *A*. Determine (*a*) the discharge velocity $\mathbf{v}_A$ of the snow, (*b*) the radius of curvature of the trajectory at its maximum height.

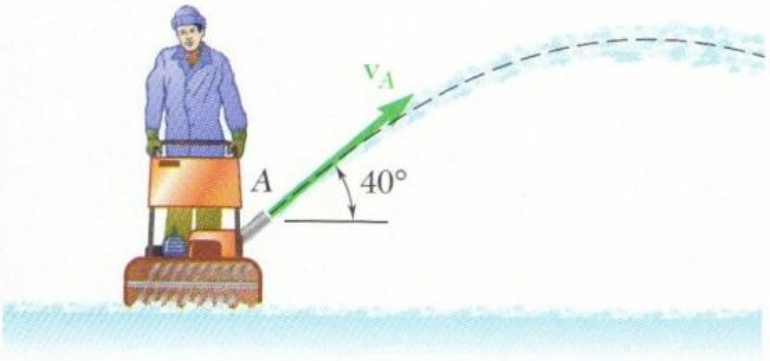

Fig. P11.144

11.153 through 11.155 A satellite will travel indefinitely in a circular orbit around a planet if the normal component of the acceleration of the satellite is equal to $g(R/r)^2$, where g is the acceleration of gravity at the surface of the planet, R is the radius of the planet, and r is the distance from the center of the planet to the satellite. Determine the speed of a satellite relative to the indicated planet if the satellite is to travel indefinitely in a circular orbit 160 km above the surface of the planet.

11.153 Venus: $g = 8.53$ m/s^2, $R = 6161$ km.

11.156 and 11.157 Knowing that the diameter of the sun is 864,000 mi and that the acceleration of gravity at its surface is 900 ft/s^2, determine the radius of the orbit of the indicated planet around the sun assuming that the orbit is circular. (See information given in Probs. 11.153–11.155.)

11.156 Earth: $(v_{\text{mean}})_{\text{orbit}} = 66{,}600$ mi/h

11.171 For the race car of Prob. 11.167, it was found that it took 0.5 s for the car to travel from the position $\theta = 60°$ to the position $\theta = 35°$. Knowing that $b = 25$ m, determine the average speed of the car during the 0.5-s interval.

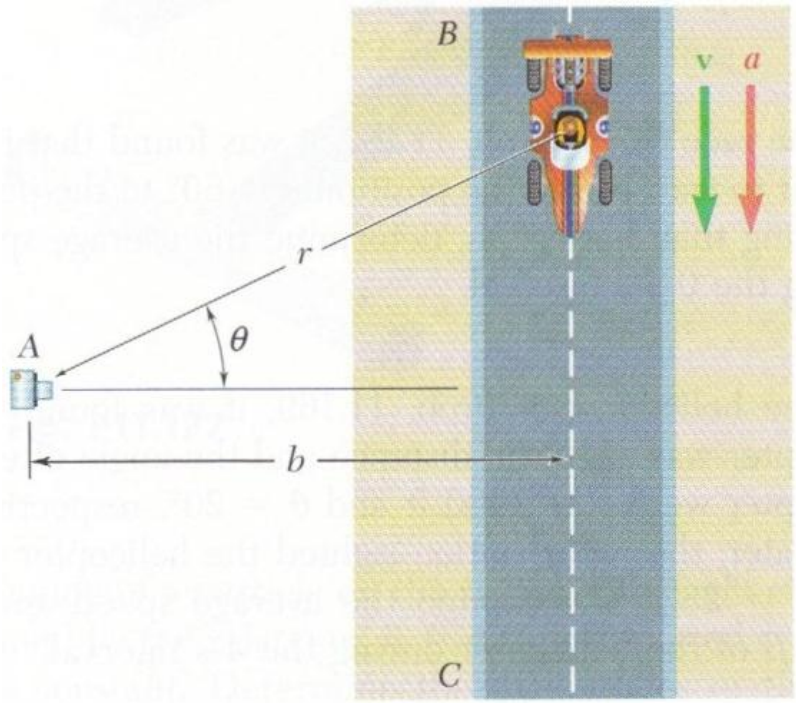

Fig. *P11.167*

11.172 For the helicopter of Prob. 11.169, it was found that when the helicopter was at B, the distance and the angle of elevation of the helicopter were $r = 3000$ ft and $\theta = 20°$, respectively. Four seconds later, the radar station sighted the helicopter at $r = 3320$ ft and $\theta = 23.1°$. Determine the average speed and the angle of climb β of the helicopter during the 4-s interval.

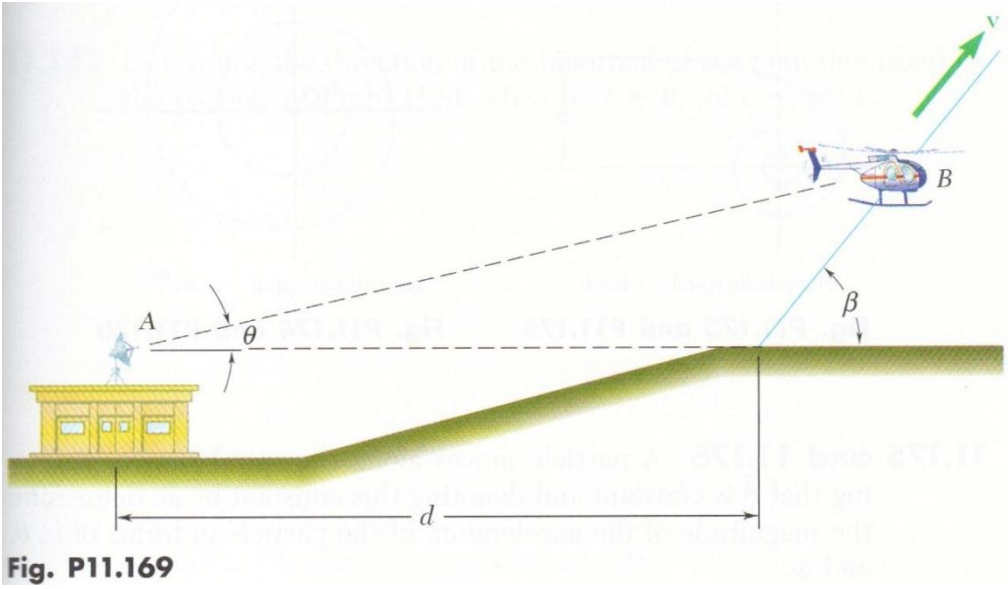

Fig. P11.169