Additional Problems

**79** . A Formula One race car is traveling at 89.0 m/s along a straight track enters a turn on the race track with radius of curvature of 200.0 m. What centripetal acceleration must the car have to stay on the track?

80 . A particle travels in a circular orbit of radius 10 m. Its speed is changing at a rate of 15.0 m/s^2 at an instant when its speed is 40.0 m/s. What is the magnitude of the acceleration of the particle?

81 . The driver of a car moving at 90.0 km/h presses down on the brake as the car enters a circular curve of radius 150.0 m. If the speed of the car is decreasing at a rate of 9.0 km/h each second, what is the magnitude of the acceleration of the car at the instant its speed is 60.0 km/h?

82 . A race car entering the curved part of the track at the Daytona 500 drops its speed from 85.0 m/s to 80.0 m/s in 2.0 s. If the radius of the curved part of the track is 316.0 m, calculate the total acceleration of the race car at the beginning and ending of reduction of speed.

83 . An elephant is located on Earth's surface at a latitude λ. Calculate the centripetal acceleration of the elephant resulting from the rotation of Earth around its polar axis. Express your answer in terms of λ, the radius R_E of Earth, and time T for one rotation of Earth. Compare your answer with g for $\lambda = 40°$.

Equator
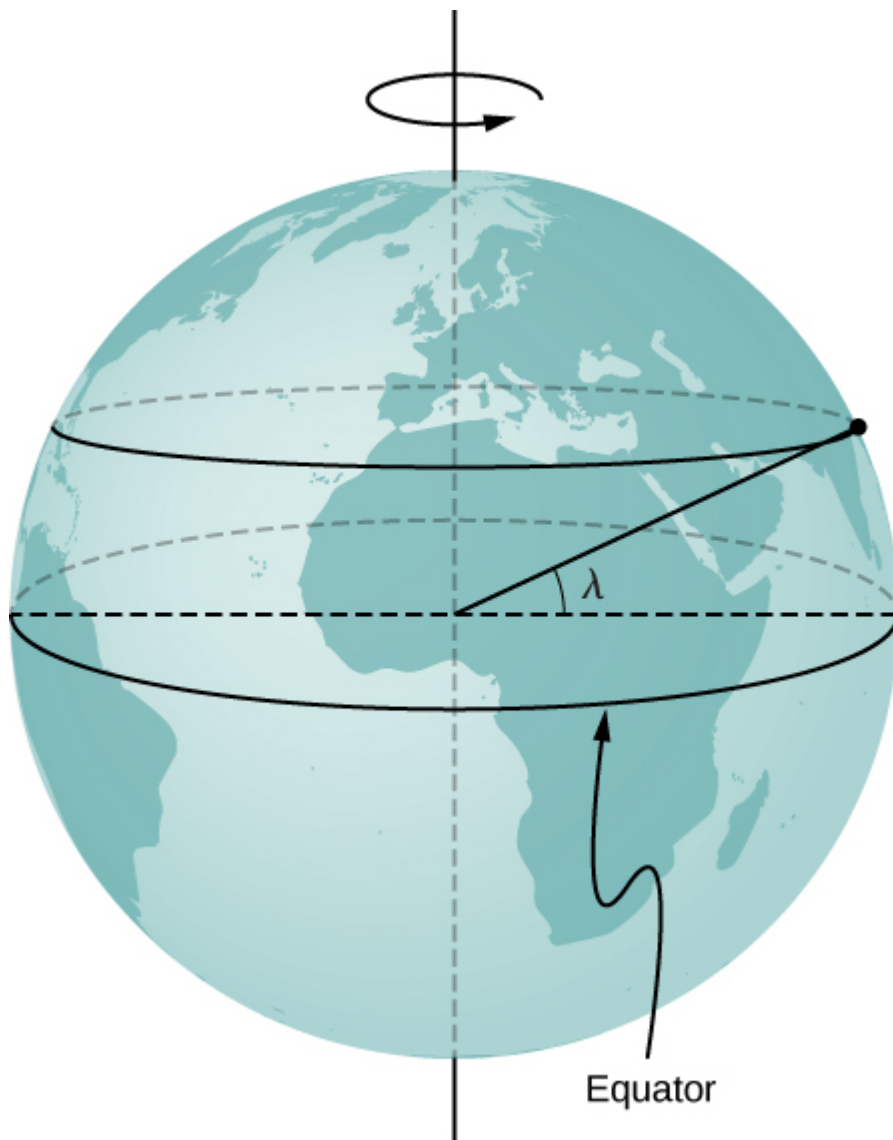
84 . A proton in a synchrotron is moving in a circle of radius 1 km and increasing its speed by $v(t) = c_1 + c_2 t^2$, where $c_1 = 2.0 \times 10^5 \text{m/s}$, $c_2 = 10^5 \text{m/s}^3$. (a) What is the proton's total acceleration at $t = 5.0$ s? (b) At what time does the expression for the velocity become unphysical?

85 . A propeller blade at rest starts to rotate from $t = 0$ s to $t = 5.0$ s with a tangential acceleration of the tip of the blade at 3.00 m/s^2. The tip of the blade is 1.5 m from the axis of rotation. At $t = 5.0$ s, what is the total acceleration of the tip of the blade?

86 . A particle is executing circular motion with a constant angular frequency of $\omega = 4.00 \text{ rad/s}$. If time $t = 0$ corresponds to the position of the particle being located at $y = 0$ m and $x = 5$ m, (a) what is the position of the particle at $t = 10$ s? (b) What is its velocity at this time? (c) What is its acceleration?

87 . A particle's centripetal acceleration is $a_C = 4.0 \text{ m/s}^2$ at $t = 0$ s where it is on the x-axis and moving counterclockwise in the xy plane. It is executing uniform circular motion about an axis at a distance of 5.0 m. What is its velocity at $t = 10$ s?

88 . A rod 3.0 m in length is rotating at 2.0 rev/s about an axis at one end. Compare the centripetal accelerations at radii of (a) 1.0 m, (b) 2.0 m, and (c) 3.0 m.

89 . A particle located initially at $(1.5\hat{j} + 4.0\hat{k})$m undergoes a displacement of $(2.5\hat{i} + 3.2\hat{j} - 1.2\hat{k})$ m. What is the final position of the particle?

90 . The position of a particle is given by $\vec{r}(t) = (50 \text{ m/s})t\hat{i} - (4.9 \text{ m/s}^2)t^2\hat{j}$. (a) What are the particle's velocity and acceleration as functions of time? (b) What are the initial conditions to produce the motion?

91 . A spaceship is traveling at a constant velocity of $\vec{v}(t) = 250.0\hat{i}$m/s when its rockets fire, giving it an acceleration of $\vec{a}(t) = (3.0\hat{i} + 4.0\hat{k})$m/s^2. What is its velocity 5 s after the rockets fire?

92 . A crossbow is aimed horizontally at a target 40 m away. The arrow hits 30 cm below the spot at which it was aimed. What is the initial velocity of the arrow?

93 . A long jumper can jump a distance of 8.0 m when he takes off at an angle of $45°$ with respect to the horizontal. Assuming he can jump with the same initial speed at all angles, how much distance does he lose by taking off at $30°$?

94 . On planet Arcon, the maximum horizontal range of a projectile launched at 10 m/s is 20 m. What is the acceleration of gravity on this planet?

95 . A mountain biker encounters a jump on a race course that sends him into the air at $60°$ to the horizontal. If he lands at a horizontal distance of 45.0 m and 20 m below his launch point, what is his initial speed?

96 . Which has the greater centripetal acceleration, a car with a speed of 15.0 m/s along a circular track of radius 100.0 m or a car with a speed of 12.0 m/s along a circular track of radius 75.0 m?

97 . A geosynchronous satellite orbits Earth at a distance of 42,250.0 km and has a period of 1 day. What is the centripetal acceleration of the satellite?

98 . Two speedboats are traveling at the same speed relative to the water in opposite directions in a moving river. An observer on the riverbank sees the boats moving at 4.0 m/s and 5.0 m/s. (a) What is the speed of the boats relative to the river? (b) How fast is the river moving relative to the shore?