Exercise 1

Rectilinear kinematics: Continuous motion

1. (Prob. 12-4) Starting from rest, a particle moving in straight line has an acceleration of $a = (2t - 6)$ m/s^2 , where t is in seconds. What is the particle's velocity when $t=6$ sec., and what is its position when $t=11$ sec.?

2. (Prob. 12-12) A Particle, initially at the origin, moves along a straight line through a fluid medium such that its velocity is defined as $v = 1.8(1 - e^{-0.3t})$ m/s, where t is in seconds. Determine the displacement of the particle during the first 3 sec.

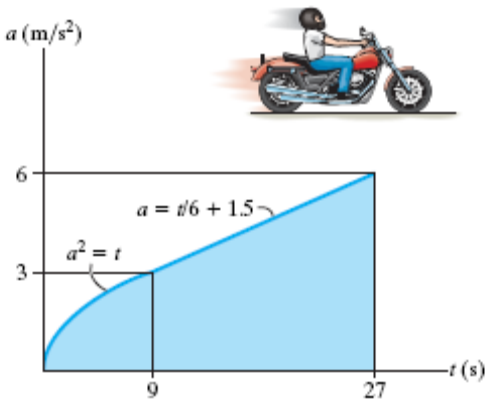
3. (Prob. 12-23) The acceleration of a rocket traveling upward is given by $a = (6 + 0.02s)$ m/s^2, where s is the vertical displacement measured relative to the ground and its unit is in meters. Determine the time needed for the rocket to reach an altitude of $s=100$ m. Initially, $v=0$ and $s=0$ when $t=0$.

4. (Prob. 12-36) When a particle falls through the air, its initial acceleration $a=g$ diminishes until it is zero, and thereafter it falls at a constant or terminal velocity v_f. If this variation of the acceleration can be expressed as $a = (g / v_f^2)(v_f^2 - v^2)$, determine the time needed for the velocity to become $v=v_f$. Initially the particle falls from rest.

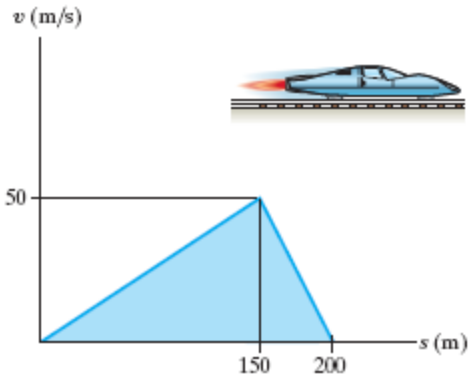
Rectilinear kinematics: Erratic motion

5. (Prob. 12-55) The a-t graph for a motorcycle traveling along a straight road has been estimated as shown. Determine the time needed for the motorcycle to reach a maximum speed of 30 m/s and the distance traveled in this time. Draw the v-t and s-t graphs. The motorcycle starts from rest as $s=0$.

6. (Prob. 12-64) Starting from rest at $s=0$, a boat travels in a straight line with an acceleration as shown by the a-s graph. Determine the boat's speed when $s=40$, 90, and 200 m.



Prob. 12–55

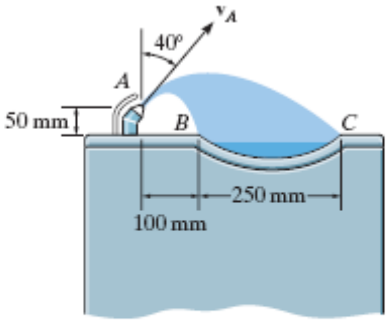


Prob. 12–64

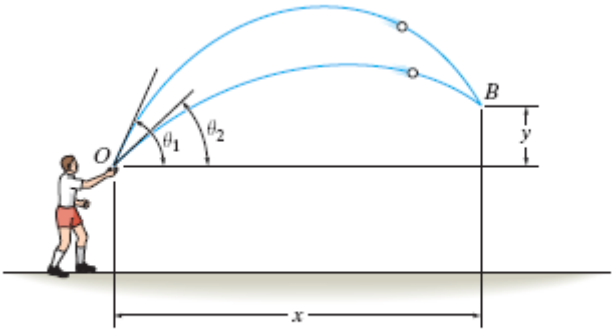
Curvilinear motion: Rectangular coordinates

7. (Prob. 12-95) The drinking fountain is designed such that the nozzle is located from the edge of the basin as shown. Determine the maximum and minimum speed at which water can be ejected from the nozzle so that it does not splash over the sides of the basin at B and C.

8. (Prob. 12-96) A boy at *O* throws a ball in the air with a speed v_0 at an angle θ_1. if the then throws another ball at the same speed v_0 at an angle $\theta_2 < \theta_1$, determine the time between the throws so the balls collide in mid air at *B*.



Prob. 12–95

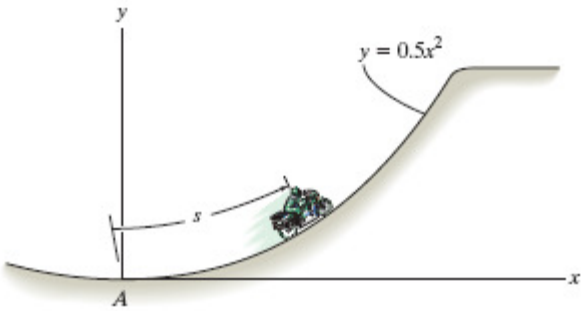


Prob. 12–96

Curvilinear motion: Normal and tangential coordinates

9. (Prob. 12-109) A particle P moves along the curve $y = \left(x^2 - 4\right)$ m with a constant speed of 5 m/s. Determine the point on the curve where the maximum magnitude of acceleration occurs and compute its value.

10. (Prob. 12-121) The motorcycle is traveling at 1 m/s when it is at A. If the speed is then increased at $\dot{v} = 0.1$ m/s^2, determine its speed and acceleration at the instant *t*=*5* sec.



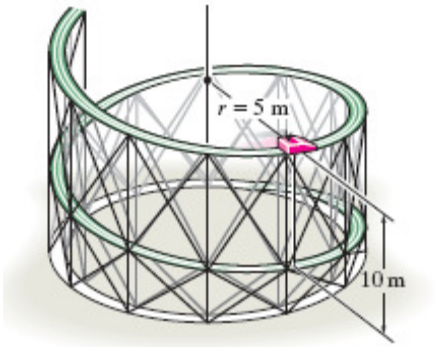
Prob. 12–121

Curvilinear motion: Cylindrical coordinates

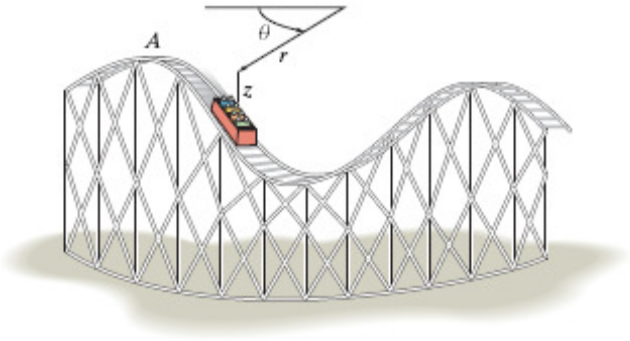
11. (Prob. 12-166) The roller coaster is traveling down along the spiral ramp with a constant speed v=6 m/s. if the track descends a distance of 10 m for every full revolution, $\theta = 2\pi$ rad., determine the magnitude of the roller coaster's acceleration as it moves along the track, r=5m.

Hint: For part of the solution, not that the tangent to the ramp at any point is at an angle $\phi = \tan^{-1}\left[10/2\pi(5)\right] = 17.66^\circ$ from the horizontal. Use this to determine the velocity components v_θ and v_z, which in turn are used to determine $\dot{\theta}$ and $\dot{z}$.

12. (Prob. 12-169) For a short time the position of the roller coaster car along its path is defined by the equations *r=25* m, *θ=(0.3t)* rad., and $z = (-8\cos\theta)$ m, where t is in seconds. Determine the magnitude of the car's velocity and acceleration when *t=4* s.



Prob. 12–166



Prob. 12–169