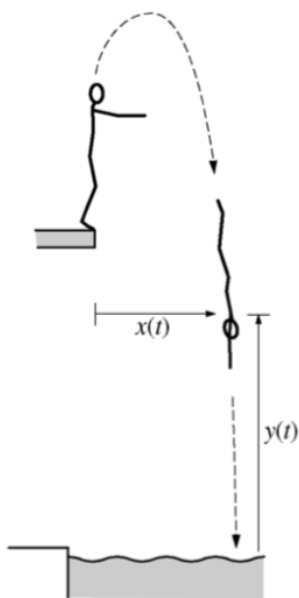


1.



Note: Figure not drawn to scale.

A diver leaps from the edge of a diving platform into a pool below. The figure above shows the initial position of the diver and her position at a later time. At time  $t$  seconds after she leaps, the horizontal distance from the front edge of the platform to the diver's shoulders is given by  $x(t)$ , and the vertical distance from the water surface to her shoulders is given by  $y(t)$ , where  $x(t)$  and  $y(t)$  are measured in meters. Suppose that the diver's shoulders are 11.4 meters above the water when she makes her leap and that

$$\frac{dx}{dt} = 0.8 \text{ and } \frac{dy}{dt} = 3.6 - 9.8t$$

for  $0 \leq t \leq A$ , where  $A$  is the time that the diver's shoulders enter the water.

(a) (3 points) Find the maximum vertical distance from the water surface to the diver's shoulders.

(b) (2 points) Find  $A$ , the time that the diver's shoulders enter the water.

- (c) (2 points) Find the total distance traveled by the diver's shoulders from the time she leaps from the platform until the time her shoulders enter the water.

- (d) (2 points) Find the angle  $\theta$ ,  $0 < \theta < \frac{\pi}{2}$ , between the path of the diver and the water at the instant the diver's shoulders enter the water.

2. A particle is moving along a curve so that its position at time  $t$  is  $(x(t), y(t))$ , where  $x(t) = t^2 - 4t + 8$  and  $y(t)$  is not explicitly given. Both  $x$  and  $y$  are measured in meters, and  $t$  is measured in seconds. It is known that  $\frac{dy}{dt} = te^{t-3} - 1$ .

(a) (1 point) Find the speed of the particle at time  $t = 3$  seconds.

(b) (2 points) Find the total distance traveled by the particle for  $0 \leq t \leq 4$  seconds.

- (c) (3 points) Find the time  $t$ ,  $0 \leq t \leq 4$ , when the line tangent to the path of the particle is horizontal. Is the direction of motion of the particle toward the left or toward the right at that time? Give a reason for your answer.
- (d) (3 points) There is a point with  $x$ -coordinate 5 through which the particle passes twice. Find each of the following.
- (i) The two values of  $t$  when that occurs
  - (ii) The slopes of the lines tangent to the particle's path at that point
  - (iii) The  $y$ -coordinate of that point, given  $y(2) = 3 + \frac{1}{e}$

3. At time  $t$ , a particle moving in the  $xy$ -plane is at position  $(x(t), y(t))$ , where  $x(t)$  and  $y(t)$  are not explicitly given. For  $t \geq 0$ ,  $\frac{dx}{dt} = 4t + 1$  and  $\frac{dy}{dt} = \sin(t^2)$ . At time  $t = 0$ ,  $x(0) = 0$  and  $y(0) = -4$ .
- (a) (2 points) Find the speed of the particle at time  $t = 3$ , (and—chapter 12 topic—find the acceleration vector of the particle at time  $t = 3$ ).

- (b) (1 point) Find the slope of the line tangent to the path of the particle at time  $t = 3$ .

(c) (4 points) Find the position of the particle at time  $t = 3$ .

(d) (2 points) Find the total distance traveled by the particle over the time interval  $0 \leq t \leq 3$ .

4. For  $t \geq 0$ , a particle is moving along a curve so that its position at time  $t$  is  $(x(t), y(t))$ . At time  $t = 2$ , the particle is at position  $(1, 5)$ . It is known that  $\frac{dx}{dt} = \frac{\sqrt{t+2}}{e^t}$  and  $\frac{dy}{dt} = \sin^2 t$ .

(a) (3 points) Is the horizontal movement of the particle to the left or to the right at time  $t = 2$ ? Explain your answer. Find the slope of the path of the particle at time  $t = 2$ .

(b) (2 points) Find the  $x$ -coordinate of the particle's position at time  $t = 4$ .

- (c) (2 points) Find the speed of the particle at time  $t = 4$ . (Chapter 12 topic: Find the acceleration vector of the particle at time  $t = 4$ ).

- (d) (2 points) Find the distance traveled by the particle from time  $t = 2$  to  $t = 4$ .