

12. A 5-ft-tall person walks toward a wall at a rate of 2 ft/sec. A spotlight is located on the ground 40 ft from the wall. How fast does the height of the person's shadow on the wall change when the person is 10 ft from the wall?

13. Using the previous problem, what is the rate at which the shadow changes when the person is 10 ft from the wall, if the person is walking away from the wall at a rate of 2 ft/sec?

14. A helicopter starting on the ground is rising directly into the air at a rate of 25 ft/sec. You are running on the ground starting directly under the helicopter at a rate of 10 ft/sec. Find the rate of change of the distance between the helicopter and yourself after 5 sec.

15. Using the previous problem, what is the rate at which the distance between you and the helicopter is changing when the helicopter has risen to a height of 60 ft in the air, assuming that, initially, it was 30 ft above you?

For the following exercises, draw and label diagrams to help solve the related-rates problems.

16. The side of a cube increases at a rate of  $\frac{1}{2}$  m/sec. Find the rate at which the volume of the cube increases when the side of the cube is 4 m.

17. The volume of a cube decreases at a rate of 10 m<sup>3</sup>/sec. Find the rate at which the side of the cube changes when the side of the cube is 2 m.

18. The radius of a circle increases at a rate of 2 m/sec. Find the rate at which the area of the circle increases when the radius is 5 m.

19. The radius of a sphere decreases at a rate of 3 m/sec. Find the rate at which the surface area decreases when the radius is 10 m.

20. The radius of a sphere increases at a rate of 1 m/sec. Find the rate at which the volume increases when the radius is 20 m.

21. The radius of a sphere is increasing at a rate of 9 cm/sec. Find the radius of the sphere when the volume and the radius of the sphere are increasing at the same numerical rate.

22. The base of a triangle is shrinking at a rate of 1 cm/min and the height of the triangle is increasing at a rate of 5 cm/min. Find the rate at which the area of the triangle changes when the height is 22 cm and the base is 10 cm.

23. A triangle has two constant sides of length 3 ft and 5 ft. The angle between these two sides is increasing at a rate of 0.1 rad/sec. Find the rate at which the area of the triangle is changing when the angle between the two sides is  $\pi/6$ .

24. A triangle has a height that is increasing at a rate of 2 cm/sec and its area is increasing at a rate of 4 cm<sup>2</sup>/sec. Find the rate at which the base of the triangle is changing when the height of the triangle is 4 cm and the area is 20 cm<sup>2</sup>.

For the following exercises, consider a right cone that is leaking water. The dimensions of the conical tank are a height of 16 ft and a radius of 5 ft.

25. How fast does the depth of the water change when the water is 10 ft high if the cone leaks water at a rate of 10 ft<sup>3</sup>/min?

26. Find the rate at which the surface area of the water changes when the water is 10 ft high if the cone leaks water at a rate of 10 ft<sup>3</sup>/min.

27. If the water level is decreasing at a rate of 3 in./min when the depth of the water is 8 ft, determine the rate at which water is leaking out of the cone.

28. A vertical cylinder is leaking water at a rate of 1 ft<sup>3</sup>/sec. If the cylinder has a height of 10 ft and a radius of 1 ft, at what rate is the height of the water changing when the height is 6 ft?

29. A cylinder is leaking water but you are unable to determine at what rate. The cylinder has a height of 2 m and a radius of 2 m. Find the rate at which the water is leaking out of the cylinder if the rate at which the height is decreasing is 10 cm/min when the height is 1 m.

30. A trough has ends shaped like isosceles triangles, with width 3 m and height 4 m, and the trough is 10 m long. Water is being pumped into the trough at a rate of 5 m<sup>3</sup>/min. At what rate does the height of the water change when the water is 1 m deep?

