

EXERCISES 4

In Exercises 23–26, use the definition to find an expression for the instantaneous acceleration of an object moving with rectilinear motion according to the given functions. The instantaneous acceleration of an object is defined as the instantaneous rate of change of the velocity with respect to time. Here, v is the velocity, s is the displacement, and t is the time.

23. $v = 6t^2 - 4t + 2$ 24. $v = \sqrt{6t + 1}$
 25. $s = t^3 + 15t$ (Find v , then find a .)
 26. $s = s_0 + v_0t - \frac{1}{2}at^2$ (s_0 , v_0 , and a are constants.)
 (Find v , then find a .)

In Exercises 27–46, find the indicated instantaneous rates of change.

27. In Example 3, calculate v for $t = 4.5$ s, 4.1 s, 4.01 s, 4.001 s. This is finding the instantaneous velocity as $h \rightarrow 0$ through negative values of h .
 28. In Example 4, calculate v for $t = 3.0$ s, 2.1 s, 2.01 s, 2.001 s. This is finding the instantaneous velocity as $h \rightarrow 0$ through negative values of h .
 29. A metal circular ring is being cooled. Find the rate at which the circumference changes if the radius is decreasing at the rate of 0.0015 cm/min.
 30. Liquid is poured into a tank with vertical sides and a square horizontal cross section of edge 6.25 in. Find the instantaneous rate of change of volume with respect to the depth h .
 31. The distance s (in m) above the ground for a projectile fired vertically upward with a velocity of 44 m/s as a function of time t (in s) is given by $s = 44t - 4.9t^2$. Find t for $v = 0$.
(W) 32. For the projectile in Exercise 31, find v for $t = 4.0$ s and for $t = 5.0$ s. What conclusion can be drawn?
 33. The electric current i at a point in an electric circuit is the instantaneous rate of change of the electric charge q that passes the point, with respect to the time t . Find i in a circuit for which $q = 30 - 2t$.
 34. A load L (in N) is distributed along a beam 10 m long such that $L = 5x - 0.5x^2$, where x is the distance from one end of the beam. Find the expression for the instantaneous rate of change of L with respect to x .
 35. A rectangular metal plate contracts while cooling. Find the expression for the instantaneous rate of change of the area A of the plate with respect to its width w , if the length of the plate is constantly three times as long as the width.
 36. A circular oil spill is increasing in area. Find the difference in the rate of change of the area A of the spill with respect to the radius r for $r = 240$ m and $r = 480$ m.
 37. The total power P (in W) transmitted by an AM radio station is given by $P = 500 + 250m^2$, where m is the modulation index. Find the instantaneous rate of change of P with respect to m for $m = 0.92$.

38. The bottom of a soft-drink can is being designed as an inverted spherical segment, the volume of which is $V = \frac{1}{6}\pi h^3 + 2.00\pi h$, where h is the depth (in cm) of the segment. Find the instantaneous rate of change of V with respect to h for $h = 0.60$ cm.
 39. The total solar radiation H (in W/m²) on a particular surface during an average clear day is given by $H = \frac{5000}{t^2 + 10}$, where t ($-6 \leq t \leq 6$) is the number of hours from noon (6 A.M. is equivalent to $t = -6$ h). Find the instantaneous rate of change of H with respect to t at 3 P.M.
 40. For the solar radiator in Exercise 39, find the average rate of change of H between 2 P.M. and 4 P.M. Compare with the instantaneous rate of change at 3 P.M.
 41. The value (in thousands of dollars) of a certain car is given by the function $V = \frac{48}{t + 3}$, where t is measured in years. Find a general expression for the instantaneous rate of change of V with respect to t and evaluate this expression when $t = 3$ years.
 42. For the car in Exercise 41, find the average rate of change of V between $t = 2$ years and $t = 4$ years. Compare with the instantaneous rate of change for $t = 3$ years.

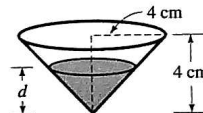


Fig. 25

43. Oil in a certain machine is stored in a conical reservoir, for which the radius and height are both 4 cm (see Fig. 25). Find the instantaneous rate of change of the volume V of oil in the reservoir with respect to the depth d of the oil.
 44. The time t required to test a computer memory unit is directly proportional to the square of the number n of memory cells in the unit. For a particular type of unit, $n = 6400$ for $t = 25.0$ s. Find the instantaneous rate of change of t with respect to n for this type of unit for $n = 8000$.
 45. A holograph (an image formed without using a lens) of concentric circles is formed. The radius r of each circle varies directly as the square root of the wavelength λ of the light used. If $r = 3.72$ cm for $\lambda = 592$ nm, find the expression for the instantaneous rate of change of r with respect to λ .
 46. The force F between two electric charges varies inversely as the square of the distance r between them. For two charged particles, $F = 0.12$ N for $r = 0.060$ m. Find the instantaneous rate of change of F with respect to r for $r = 0.120$ m.

Answers to Practice Exercises

1. 36 m/s 2. 15 W/A