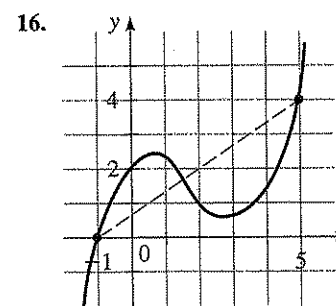
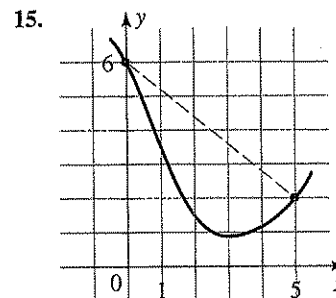
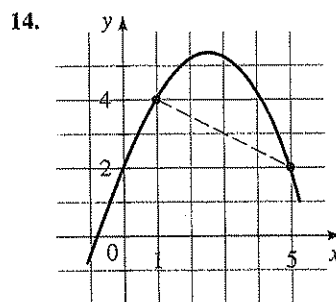
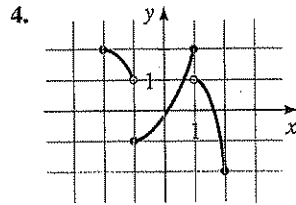
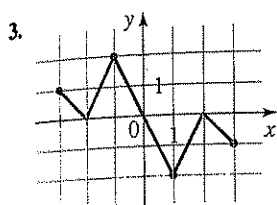
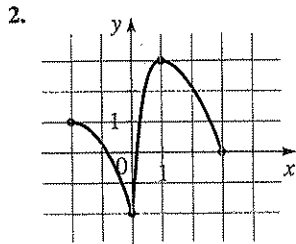
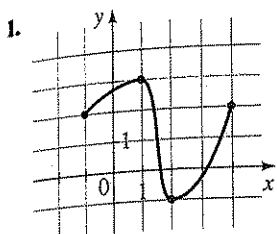


2.3 Exercises

1-4 ■ The graph of a function is given. Determine the intervals on which the function is (a) increasing and (b) decreasing.



5-12 ■ A function f is given.

- (a) Use a graphing device to draw the graph of f .
 (b) State approximately the intervals on which f is increasing and on which f is decreasing.

5. $f(x) = x^{2/5}$

6. $f(x) = 4 - x^{2/3}$

7. $f(x) = x^2 - 5x$

8. $f(x) = x^3 - 4x$

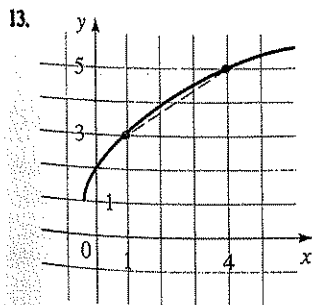
9. $f(x) = 2x^3 - 3x^2 - 12x$

10. $f(x) = x^4 - 16x^2$

11. $f(x) = x^3 + 2x^2 - x - 2$

12. $f(x) = x^4 - 4x^3 + 2x^2 + 4x - 3$

13-16 ■ The graph of a function is given. Determine the average rate of change of the function between the indicated values of the variable.



17-28 ■ A function is given. Determine the average rate of change of the function between the given values of the variable.

17. $f(x) = 3x - 2$; $x = 2, x = 3$

18. $g(x) = 5 + \frac{1}{2}x$; $x = 1, x = 5$

19. $h(t) = t^2 + 2t$; $t = -1, t = 4$

20. $f(z) = 1 - 3z^2$; $z = -2, z = 0$

21. $f(x) = x^3 - 4x^2$; $x = 0, x = 10$

22. $f(x) = x + x^4$; $x = -1, x = 3$

23. $f(x) = 3x^2$; $x = 2, x = 2 + h$

24. $f(x) = 4 - x^2$; $x = 1, x = 1 + h$

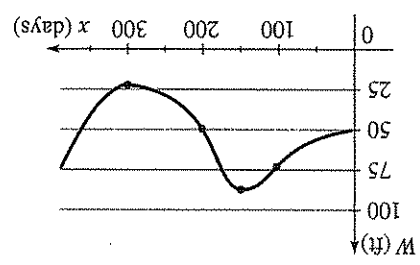
25. $g(x) = \frac{1}{x}$; $x = 1, x = a$

26. $g(x) = \frac{2}{x+1}$; $x = 0, x = h$

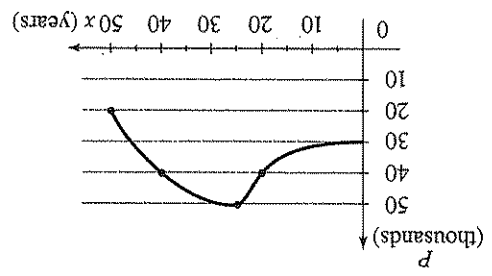
Applications

27. $f(t) = \frac{t}{2}$; $t = a, t = a + h$
 28. $f(t) = \sqrt{t}$; $t = a, t = a + h$
 29–30 ■ A linear function is given.
 (a) Find the average rate of change of the function between $x = a$ and $x = a + h$.
 (b) Show that the average rate of change is the same as the slope of the line.
 29. $f(x) = \frac{1}{2}x + 3$
 30. $g(x) = -4x + 2$

31. **Changing Water Levels** The graph shows the depth of water W in a reservoir over a one-year period, as a function of the number of days x since the beginning of the year.
 (a) Determine the intervals on which the function W is increasing and on which it is decreasing.
 (b) What was the average rate of change of W between $x = 100$ and $x = 200$?



32. **Population Growth and Decline** The graph shows the population P in a small industrial city from 1950 to 2000. The variable x represents the number of years since 1950.
 (a) Determine the intervals on which the function P is increasing and on which it is decreasing.
 (b) What was the average rate of change of P between $x = 20$ and $x = 40$?
 (c) Interpret the value of the average rate of change that you found in part (b).



33. **Population Growth and Decline** The table gives the population in a small coastal community for the period 1997–2006. Figures shown are for January 1 in each year.
 (a) What was the average rate of change of population between 1998 and 2001?
 (b) What was the average rate of change of population between 2002 and 2004?
 (c) For what period of time was the population increasing?
 (d) For what period of time was the population decreasing?

Year	Population
1997	624
1998	856
1999	1,336
2000	1,578
2001	1,591
2002	1,483
2003	994
2004	826
2005	801
2006	745

34. **Running Speed** A man is running around a circular track 200 m in circumference. An observer uses a stopwatch to record the runner's time at the end of each lap, obtaining the data in the following table.
 (a) What was the man's average speed (rate) between 68 s and 152 s?
 (b) What was the man's average speed between 263 s and 412 s?
 (c) Calculate the man's speed for each lap. Is he slowing down, speeding up, or neither?

Time (s)	Distance (m)
32	200
68	400
108	600
152	800
203	1000
263	1200
335	1400
412	1600

35. **CD Player Sales** The table shows the number of CD players sold in a small electronics store in the years 1993–2003.
 (a) What was the average rate of change of sales between 1993 and 2003?

36. Book Collector pu
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Discovery

- (b) What was the average rate of change of sales between 1993 and 1994?
- (c) What was the average rate of change of sales between 1994 and 1996?
- (d) Between which two successive years did CD player sales *increase* most quickly? *Decrease* most quickly?

Year	CD players sold
1993	512
1994	520
1995	413
1996	410
1997	468
1998	510
1999	590
2000	607
2001	732
2002	612
2003	584

36. **Book Collection** Between 1980 and 2000, a rare book collector purchased books for his collection at the rate of 40 books per year. Use this information to complete the following table. (Note that not every year is given in the table.)

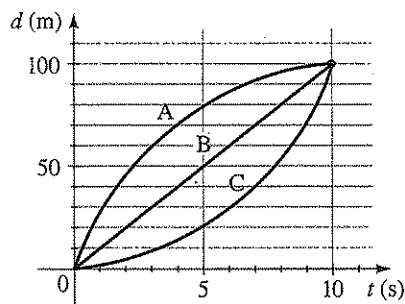
Year	Number of books
1980	420
1981	460
1982	
1985	
1990	
1992	
1995	
1997	
1998	
1999	
2000	1220

Discovery • Discussion

37. **100-meter Race** A 100-m race ends in a three-way tie for first place. The graph shows distance as a function of time for each of the three winners.

- (a) Find the average speed for each winner.

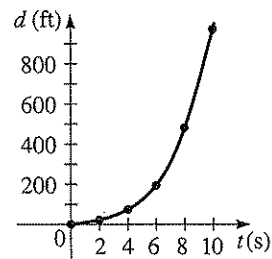
- (b) Describe the differences between the way the three runners ran the race.



38. **Changing Rates of Change: Concavity** The two tables and graphs give the distances traveled by a racing car during two different 10-s portions of a race. In each case, calculate the average speed at which the car is traveling between the observed data points. Is the speed increasing or decreasing? In other words, is the car *accelerating* or *decelerating* on each of these intervals? How does the shape of the graph tell you whether the car is accelerating or decelerating? (The first graph is said to be *concave up* and the second graph *concave down*.)

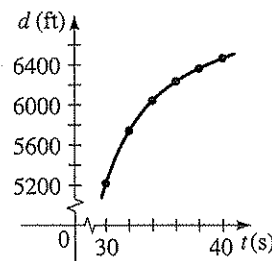
(a)

Time (s)	Distance (ft)
0	0
2	34
4	70
6	196
8	490
10	964



(b)

Time (s)	Distance (ft)
30	5208
32	5734
34	6022
36	6204
38	6352
40	6448



39. **Functions That Are Always Increasing or Decreasing** Sketch rough graphs of functions that are defined for all real numbers and that exhibit the indicated behavior (or explain why the behavior is impossible).

- (a) f is always increasing, and $f(x) > 0$ for all x
- (b) f is always decreasing, and $f(x) > 0$ for all x
- (c) f is always increasing, and $f(x) < 0$ for all x
- (d) f is always decreasing, and $f(x) < 0$ for all x