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In the definition of an increasing function it is important to realize that the inequality $f(x_1) < f(x_2)$ must be satisfied for every pair of numbers x_1 and x_2 in I with $x_1 < x_2$.

You can see from Figure 18 that the function $f(x) = x^2$ is decreasing on the interval $(-\infty, 0]$ and increasing on the interval $[0, \infty)$.

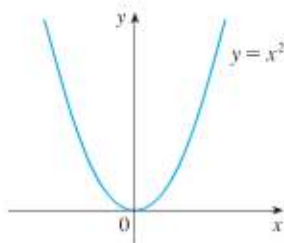
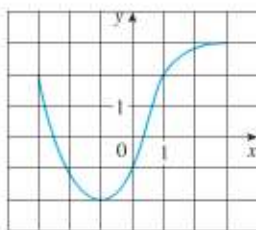


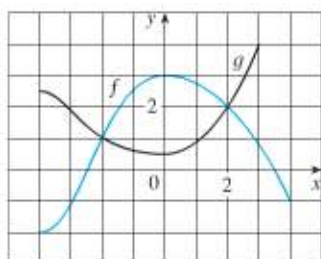
FIGURE 18

1.1 EXERCISES

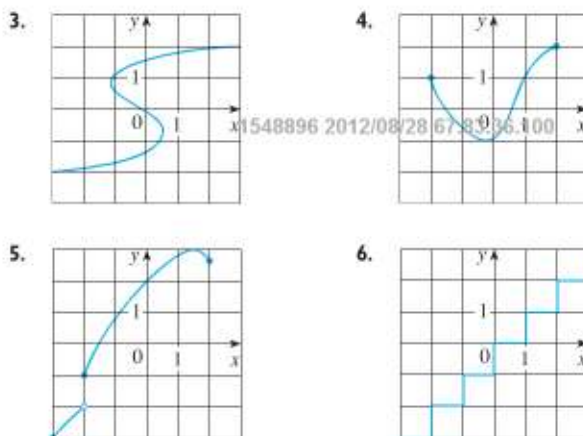
1. The graph of a function f is given.
 - (a) State the value of $f(-1)$.
 - (b) Estimate the value of $f(2)$.
 - (c) For what values of x is $f(x) = 2$?
 - (d) Estimate the values of x such that $f(x) = 0$.
 - (e) State the domain and range of f .
 - (f) On what interval is f increasing?



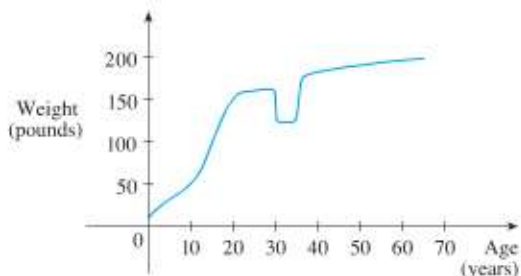
2. The graphs of f and g are given.
 - (a) State the values of $f(-4)$ and $g(3)$.
 - (b) For what values of x is $f(x) = g(x)$?
 - (c) Estimate the solution of the equation $f(x) = -1$.
 - (d) On what interval is f decreasing?
 - (e) State the domain and range of f .
 - (f) State the domain and range of g .



- 3–6 • Determine whether the curve is the graph of a function of x . If it is, state the domain and range of the function.

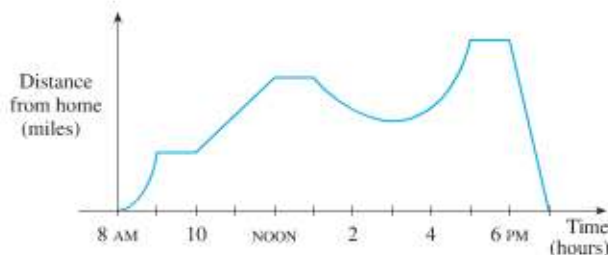


7. The graph shown gives the weight of a certain person as a function of age. Describe in words how this person's weight varies over time. What do you think happened when this person was 30 years old?



SECTION 1.1 FUNCTIONS AND THEIR REPRESENTATIONS • 9

8. The graph shown gives a salesman's distance from his home as a function of time on a certain day. Describe in words what the graph indicates about his travels on this day.



9. You put some ice cubes in a glass, fill the glass with cold water, and then let the glass sit on a table. Describe how the temperature of the water changes as time passes. Then sketch a rough graph of the temperature of the water as a function of the elapsed time.
10. Sketch a rough graph of the number of hours of daylight as a function of the time of year.
11. Sketch a rough graph of the outdoor temperature as a function of time during a typical spring day.
12. Sketch a rough graph of the market value of a new car as a function of time for a period of 20 years. Assume the car is well maintained.
13. Sketch the graph of the amount of a particular brand of coffee sold by a store as a function of the price of the coffee.
14. You place a frozen pie in an oven and bake it for an hour. Then you take it out and let it cool before eating it. Describe how the temperature of the pie changes as time passes. Then sketch a rough graph of the temperature of the pie as a function of time.
15. A homeowner mows the lawn every Wednesday afternoon. Sketch a rough graph of the height of the grass as a function of time over the course of a four-week period.
16. A jet takes off from an airport and lands an hour later at another airport, 400 miles away. If t represents the time in minutes since the plane has left the terminal, let $x(t)$ be the horizontal distance traveled and $y(t)$ be the altitude of the plane.
 (a) Sketch a possible graph of $x(t)$.
 (b) Sketch a possible graph of $y(t)$.
 (c) Sketch a possible graph of the ground speed.
 (d) Sketch a possible graph of the vertical velocity.
17. If $f(x) = 3x^2 - x + 2$, find $f(2)$, $f(-2)$, $f(a)$, $f(-a)$, $f(a + 1)$, $2f(a)$, $f(2a)$, $f(a^2)$, $[f(a)]^2$, and $f(a + h)$.
18. A spherical balloon with radius r inches has volume $V(r) = \frac{4}{3}\pi r^3$. Find a function that represents the amount of air required to inflate the balloon from a radius of r inches to a radius of $r + 1$ inches.

- 19–22 • Evaluate the difference quotient for the given function. Simplify your answer.

19. $f(x) = 4 + 3x - x^2$, $\frac{f(3+h) - f(3)}{h}$

20. $f(x) = x^3$, $\frac{f(a+h) - f(a)}{h}$

21. $f(x) = \frac{1}{x}$, $\frac{f(x) - f(a)}{x - a}$

22. $f(x) = \frac{x+3}{x+1}$, $\frac{f(x) - f(1)}{x - 1}$

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- 23–27 • Find the domain of the function.

23. $f(x) = \frac{x}{3x - 1}$

24. $f(x) = \frac{5x + 4}{x^2 + 3x + 2}$

25. $f(t) = \sqrt{t} + \sqrt[3]{t}$

26. $g(u) = \sqrt{u} + \sqrt{4 - u}$

27. $h(x) = \frac{1}{\sqrt{x^2 - 5x}}$

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28. Find the domain and range and sketch the graph of the function $h(x) = \sqrt{4 - x^2}$.

- 29–40 • Find the domain and sketch the graph of the function.

29. $f(x) = 5$

30. $F(x) = \frac{1}{2}(x + 3)$

31. $f(t) = t^2 - 6t$

32. $H(t) = \frac{4 - t^2}{2 - t}$

33. $g(x) = \sqrt{x - 5}$

34. $F(x) = |2x + 1|$

35. $G(x) = \frac{3x + |x|}{x}$

36. $g(x) = \frac{|x|}{x^2}$

37. $f(x) = \begin{cases} x + 2 & \text{if } x < 0 \\ 1 - x & \text{if } x \geq 0 \end{cases}$

38. $f(x) = \begin{cases} 3 - \frac{1}{2}x & \text{if } x \leq 2 \\ 2x - 5 & \text{if } x > 2 \end{cases}$

39. $f(x) = \begin{cases} x + 2 & \text{if } x \leq -1 \\ x^2 & \text{if } x > -1 \end{cases}$

40. $f(x) = \begin{cases} -1 & \text{if } x \leq -1 \\ 3x + 2 & \text{if } |x| < 1 \\ 7 - 2x & \text{if } x \geq 1 \end{cases}$

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