In Problems 19–30:

(a) Find the domain of each function.
(b) Locate any intercepts.
(c) Graph each function by hand.
(d) Based on the graph, find the range.
(e) Verify your results using a graphing utility.

19. $f(x) = \begin{cases} 2x & \text{if } x \neq 0 \\ 1 & \text{if } x = 0 \end{cases}$

20. $f(x) = \begin{cases} 3x & \text{if } x \neq 0 \\ 4 & \text{if } x = 0 \end{cases}$

21. $f(x) = \begin{cases} -2x + 3 & x < 1 \\ 3x - 2 & x \geq 1 \end{cases}$

22. $f(x) = \begin{cases} x + 3 & x < -2 \\ -2x - 3 & x \geq -2 \end{cases}$

23. $f(x) = \begin{cases} x + 3 & -2 \leq x < 1 \\ 5 & x = 1 \\ -x + 2 & x > 1 \end{cases}$

24. $f(x) = \begin{cases} 2x + 5 & -3 \leq x < 0 \\ -3 & x = 0 \\ -5x & x > 0 \end{cases}$

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

26. $f(x) = \begin{cases} \dfrac{1}{x} & \text{if } x < 0 \\ \sqrt{x} & \text{if } x \geq 0 \end{cases}$

27. $f(x) = \begin{cases} |x| & \text{if } -2 \leq x < 0 \\ 1 & \text{if } x = 0 \\ x^3 & \text{if } x > 0 \end{cases}$

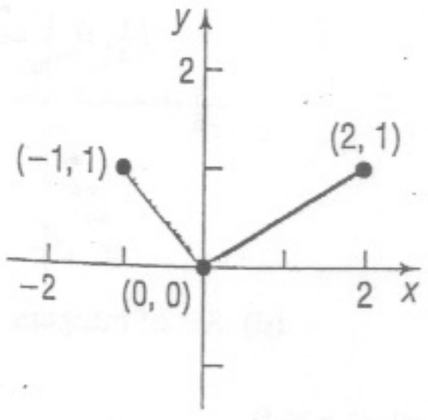
28. $f(x) = \begin{cases} 3 + x & \text{if } -3 \leq x < 0 \\ 3 & \text{if } x = 0 \\ \sqrt{x} & \text{if } x > 0 \end{cases}$

29. $h(x) = 2\,\text{int}(x)$

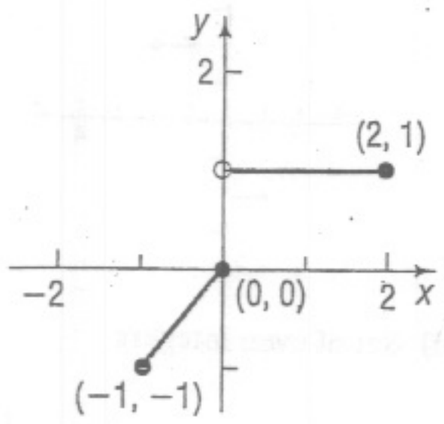
30. $f(x) = \text{int}(2x)$

In Problems 31–34, the graph of a piecewise-defined function is given. Write a definition for each function.

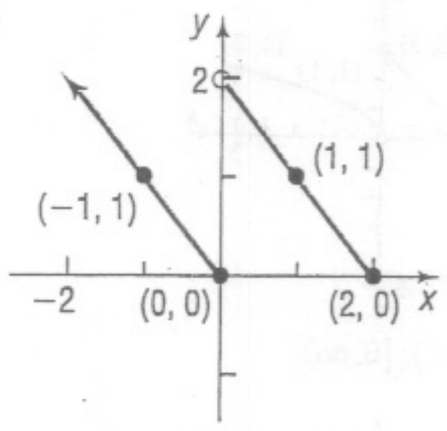
31.



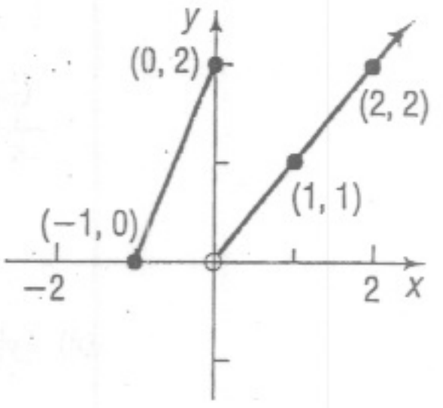
32.



33.



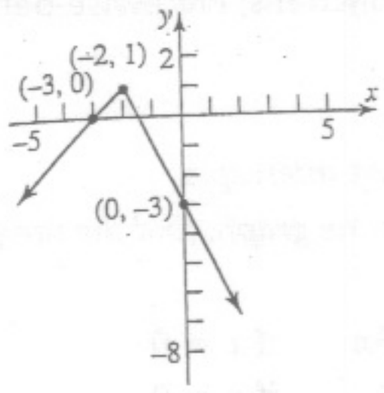
34.



11. (a) All real numbers

(b) $(-3, 0), (0, -3), \left(-\frac{3}{2}, 0\right)$

(c)

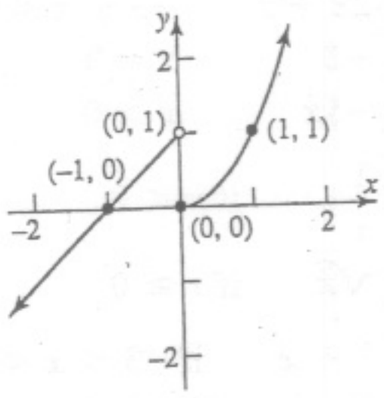


(d) $\{y|y \le 1\}; (-\infty, 1]$

15. (a) All real numbers

(b) $(-1, 0), (0, 0)$

(c)

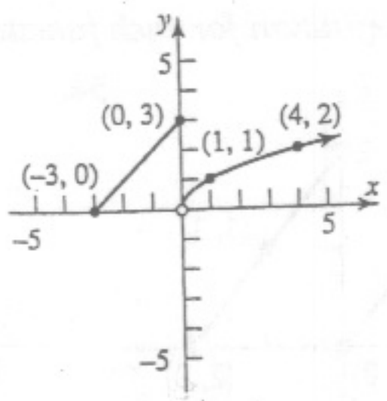


(d) All real numbers

18. (a) $\{x|x \ge -3\}; [-3, \infty)$

(b) $(-3, 0), (0, 3)$

(c)

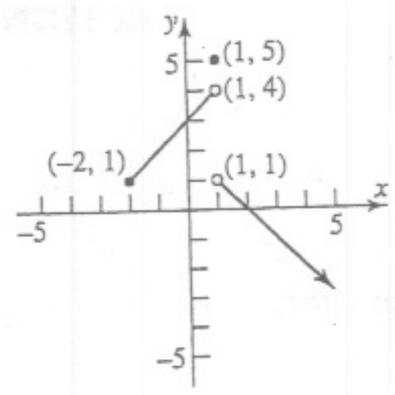


(d) $\{y|y \ge 0\}; [0, \infty)$

23. (a) $\{x|x \ge -2\}; [-2, \infty)$

(b) $(0, 3), (2, 0)$

(c)

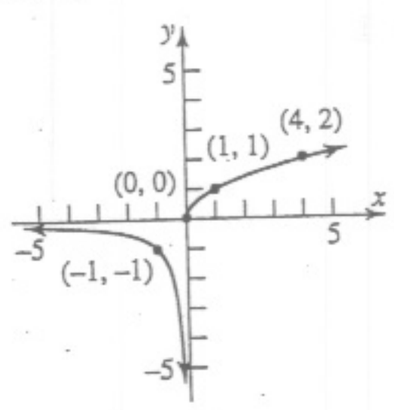


(d) $\{y|y < 4, y = 5\}; (-\infty, 4)$ or $\{5\}$

26. (a) All real numbers

(b) $(0, 0)$

(c)

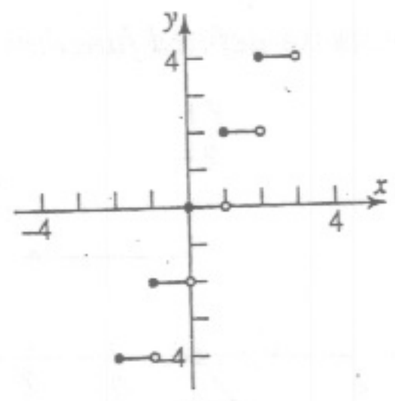


(d) All real numbers

29. (a) All real numbers

(b) $(x, 0)$ for $0 \le x < 1$

(c)

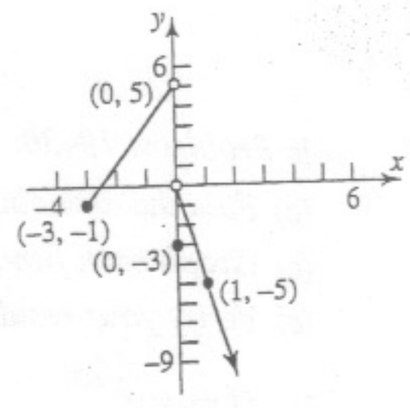


(d) Set of even integers

24. (a) $\{x|x \ge -3\}; [-3, \infty)$

(b) $\left(-\frac{5}{2}, 0\right), (0, -3)$

(c)

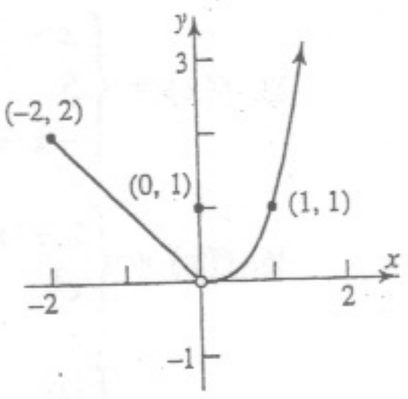


(d) $\{y|y < 5\}; (-\infty, 5)$

27. (a) $\{x|x \ge -2\}; [-2, \infty)$

(b) $(0, 1)$

(c)

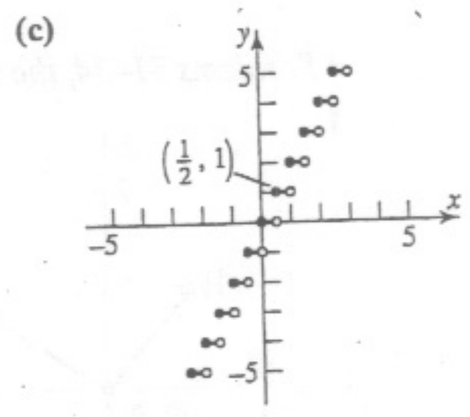


(d) $\{y|y > 0\}; (0, \infty)$

30. (a) All real numbers

(b) $(x, 0)$ for $0 \le x < \frac{1}{2}$

(c)



(d) Set of integers

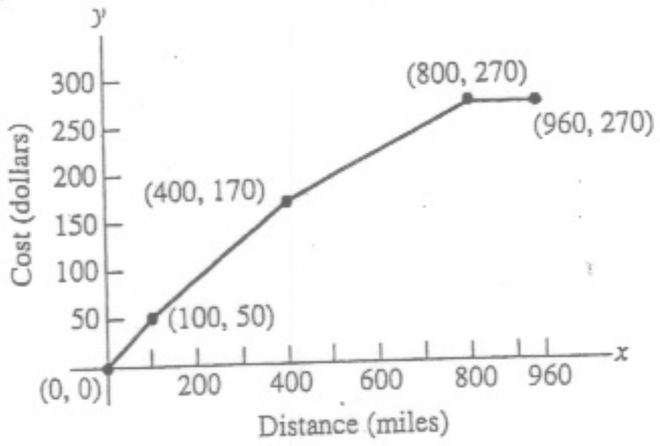
31. $f(x) = \begin{cases} -x & \text{if } -1 \le x \le 0 \\ \frac{1}{2}x & \text{if } 0 < x \le 2 \end{cases}$ (Other answers are possible.)

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

33. $f(x) = \begin{cases} -x & \text{if } x \le 0 \\ -x + 2 & \text{if } 0 < x \le 2 \end{cases}$ (Other answers are possible.)

34. $f(x) = \begin{cases} 2x + 2 & \text{if } -1 \le x \le 0 \\ x & \text{if } x > 0 \end{cases}$

35. (a)



(b) $C = 50 + 0.4(x - 100)$

(c) $C = 170 + 0.25(x - 400)$

21. (a) All real numbers

(b) $(0, 3)$

(c)