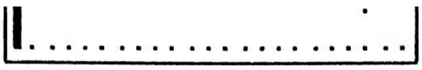
airs of shoes
)x and $y_2 = 50x$; these
)00 pairs of shoes. The point
ds to the break-even point,

+ 0.03x + 0.004x. Then
2,300 dollars.

23x.

23x + 8x = 125,000 + 31x.

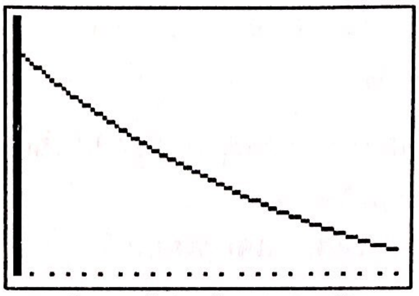
stringing the rackets; fewer
e sold to begin making a profit
f y_2 and y_4 occurs for smaller x
y_1 and y_3).



[0, 22] by [100, 200]

(b) List L3 = {112.3, 106.5, 101.5, 96.6, 92.0, 87.2, 83.1, 79.8, 75.0, 71.7, 68, 64.1, 61.5, 58.5, 55.9, 53.0, 50.8, 47.9, 45.2, 43.2}

(c) The regression equation is $y = 118.07 \times 0.951^x$. It fits the data extremely well.



[0, 22] by [100, 200]

52. Answers will vary in **(a)–(e)**, depending on the conditions of the experiment.

(f) Some possible answers: the thickness of the liquid, the darkness of the liquid, the type of cup it is in, the amount of surface exposed to the air, the specific heat of the substance (a technical term that may have been learned in physics), etc.

Chapter 1 Review

1. (d)

2. (f)

3. (i)

4. (h)

5. (b)

6. (j)

7. (g)

8. (c)

9. (a)

10. (e)

11. **(a)** All reals **(b)** All reals

12. **(a)** All reals **(b)** All reals

13. **(a)** All reals

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(b) $g(x) = x^2 + 2x + 1 = (x + 1)^2$.
At $x = -1$, $g(x) = 0$, the function's minimum.
The range is $[0, \infty)$.

14. (a) All reals

(b) $(x - 2)^2 \geq 0$ for all x, so $(x - 2)^2 + 5 \geq 5$ for all x. The range is $[5, \infty)$.

15. (a) All reals

(b) $|x| \geq 0$ for all x, so $3|x| \geq 0$ and $3|x| + 8 \geq 8$ for all x. The range is $[8, \infty)$.

16. (a) We need $\sqrt{4 - x^2} \geq 0$ for all x, so $4 - x^2 \geq 0$, $4 \geq x^2$, $-2 \leq x \leq 2$. The domain is $[-2, 2]$.

(b) $0 \leq \sqrt{4 - x^2} \leq 2$ for all x, so $-2 \leq \sqrt{4 - x^2} - 2 \leq 0$ for all x. The range is $[-2, 0]$.

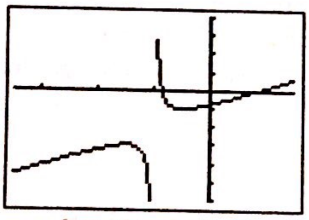
17. (a) $f(x) = \dfrac{x}{x^2 - 2x} = \dfrac{x}{x(x - 2)}$. $x \neq 0$ and $x - 2 \neq 0$, $x \neq 2$. The domain is all reals except 0 and 2.

(b) For $x > 2$, $f(x) > 0$ and for $x < 2$, $f(x) < 0$. $f(x)$ does not cross $y = 0$, so the range is all reals except $f(x) = 0$.

18. (a) We need $\sqrt{9 - x^2} > 0$, $9 - x^2 > 0$, $9 > x^2$, $-3 < x < 3$. The domain is $(-3, 3)$.

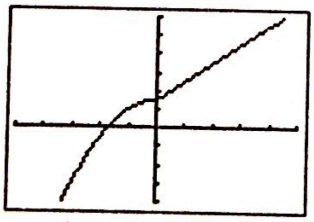
(b) Since $\sqrt{9 - x^2} > 0$, $\dfrac{1}{\sqrt{9 - x^2}} > 0$. On the domain $(-3, 3)$, $k(0) = \dfrac{1}{3}$, a minimum, while $k(x)$ approaches ∞ when x approaches both -3 and 3, maximums for $k(x)$. The range is $\left(\dfrac{1}{3}, \infty\right)$.

19. Continuous



$[-7, 3]$ by $[-12, 8]$

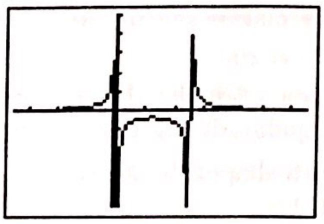
20. Continuous



$[-5, 5]$ by $[-8, 12]$

21. (a) $x^2 - 5x \neq 0$, $x(x - 5) \neq 0$, so $x \neq 0$ and $x \neq 5$. We expect vertical asymptotes at $x = 0$ and $x = 5$.

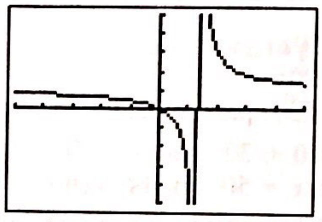
(b) $y = 0$



$[-7, 13]$ by $[-10, 10]$

22. (a) $x - 4 \neq 0$, $x \neq 4$, so we expect a vertical asympto at $x = 4$.

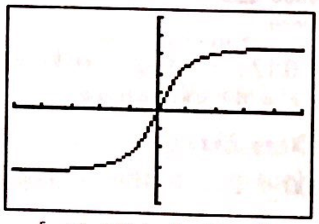
(b) Since $\lim_{x\to\infty} \dfrac{3x}{x - 4} = 3$ and $\lim_{x\to-\infty} \dfrac{3x}{x - 4} = 3$, we al expect a horizontal asymptote at $y = 3$.



$[-15, 15]$ by $[-15, 15]$

23. (a) None

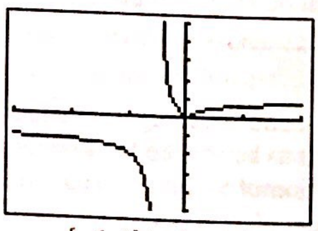
(b) Since $\lim_{x\to\infty} \dfrac{7x}{\sqrt{x^2 + 10}} = 7$ and $\lim_{x\to-\infty} \dfrac{7x}{\sqrt{x^2 + 10}} = -7$, we expect horizontal asymptotes at $y = 7$ and $y = -7$.



$[-15, 15]$ by $[-10, 10]$

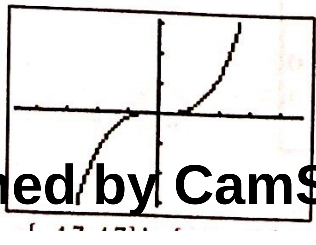
24. (a) $x + 1 \neq 0$, $x \neq -1$, so we expect a vertical asymptote at $x = -1$.

(b) $\lim_{x\to\infty} \dfrac{|x|}{x + 1} = 1$ and $\lim_{x\to-\infty} \dfrac{|x|}{x + 1} = -1$, so we can expect horizontal asymptotes at $y = 1$ and $y = -1$.



$[-6, 4]$ by $[-5, 5]$

25. $(-\infty, \infty)$



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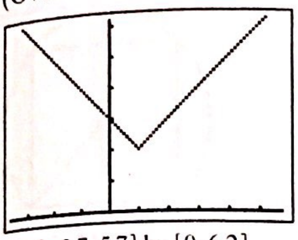
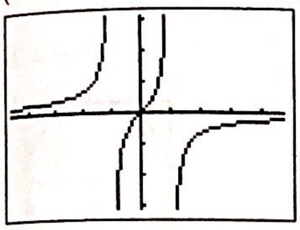
26. $|x - 1| = 0$ when $x = 1$, which is where the function's minimum occurs. y increases over the interval $[1, \infty)$. (Over the interval $(-\infty, 1]$, it is decreasing.)



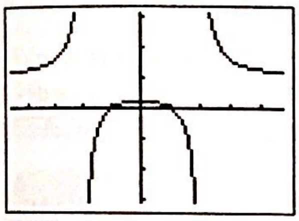
$[-3.7, 5.7]$ by $[0, 6.2]$

27. As the graph illustrates, y is increasing over the intervals $(-\infty, -1)$, $(-1, 1)$, and $(1, \infty)$.



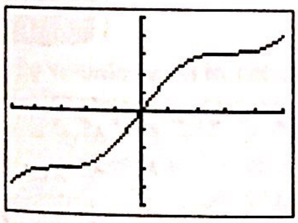
$[-4.7, 4.7]$ by $[-3.1, 3.1]$

28. As the graph illustrates, y is increasing over the intervals $(-\infty, -2)$ and $(-2, 0]$.



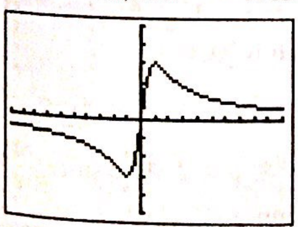
$[-4.7, 4.7]$ by $[-3.1, 3.1]$

29. $-1 \leq \sin x \leq 1$, but $-\infty \leq x \leq \infty$, so $f(x)$ is not bounded.



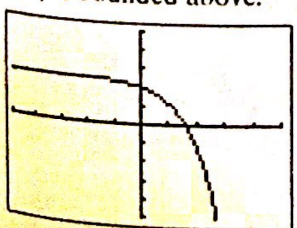
$[-5, 5]$ by $[-5, 5]$

30. $g(x) = 3$ at $x = 1$, a maximum and $g(x) = -3$, a minimum, at $x = -1$. It is bounded.



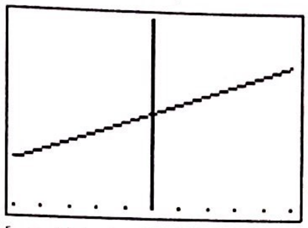
$[-10, 10]$ by $[-5, 5]$

31. $e^x \geq 0$ for all x, so $-e^x \leq 0$ and $5 - e^x \leq 5$ for all x. $h(x)$ is bounded above.



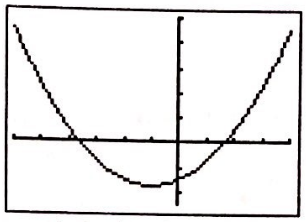
$[-5, 5]$ by $[-10, 10]$

32. The function is linear with slope $\frac{1}{1000}$ and y-intercept 1000. Thus $k(x)$ is not bounded.



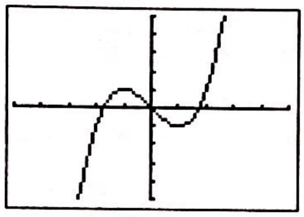
$[-5, 5]$ by $[-999.99, 1000.01]$

33. **(a)** None **(b)** -7, at $x = -1$



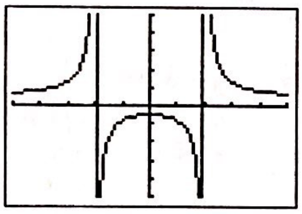
$[-6, 4]$ by $[-10, 20]$

34. **(a)** 2, at $x = -1$ **(b)** -2, at $x = 1$



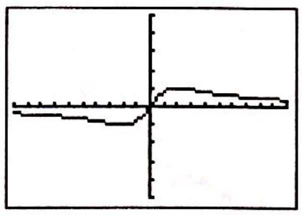
$[-5, 5]$ by $[-10, 10]$

35. **(a)** -1, at $x = 0$ **(b)** None



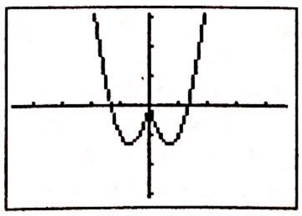
$[-5, 5]$ by $[-10, 10]$

36. **(a)** 1, at $x = 2$ **(b)** -1, at $x = -2$



$[-10, 10]$ by $[-5, 5]$

37. The function is even since it is symmetrical about the y-axis.



$[-4.7, 4.7]$ by $[-3.1, 3.1]$

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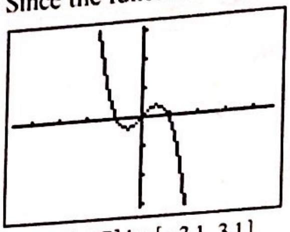
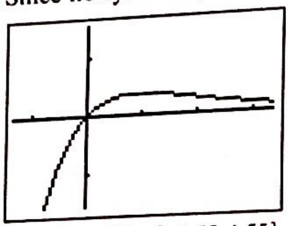
38. Since the function is symmetrical about the origin, it is odd.



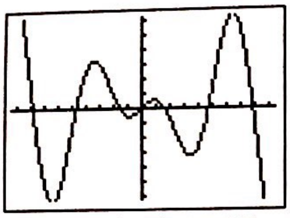
$[-4.7, 4.7]$ by $[-3.1, 3.1]$

39. Since no symmetry is exhibited, the function is neither.



$[-1.35, 3.35]$ by $[-1.55, 1.55]$

40. Since the function is symmetrical about the origin, it is odd.



$[-9.4, 9.4]$ by $[-6.2, 6.2]$

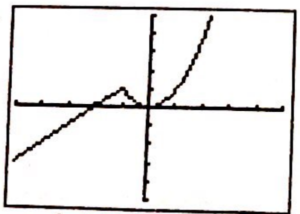
41. $x = 2y + 3, 2y = x - 3, y = \frac{x-3}{2}$, so
$f^{-1}(x) = \frac{x-3}{2}$.

42. $x = \sqrt[3]{y-8}, x^3 = y - 8, y = x^3 + 8$, so
$f^{-1}(x) = x^3 + 8$.

43. $x = \frac{2}{y}, xy = 2, y = \frac{2}{x}$, so $f^{-1}(x) = \frac{2}{x}$.

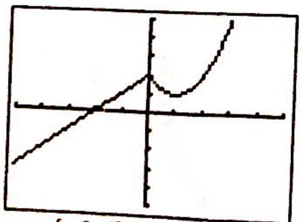
44. $x = \frac{6}{y+4}, (y+4)x = 6, xy + 4x = 6, xy = 6 - 4x,$
$y = \frac{6-4x}{x}$, so $f^{-1}(x) = \frac{6}{x} - 4$.

45.



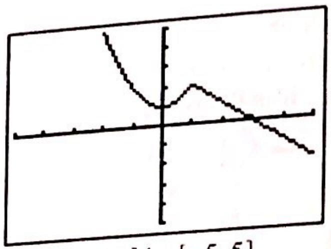
$[-5, 5]$ by $[-5, 5]$

46.



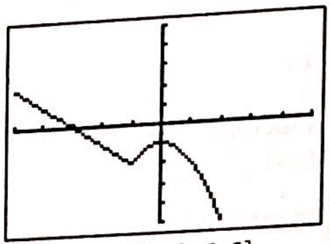
$[-5, 5]$ by $[-5, 5]$

47.



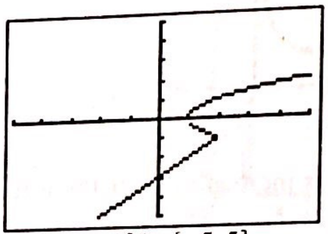
$[-5, 5]$ by $[-5, 5]$

48.



$[-5, 5]$ by $[-5, 5]$

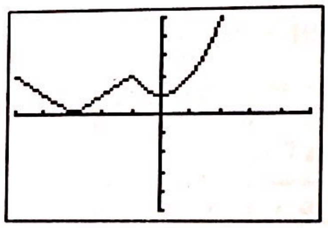
49.



$[-5, 5]$ by $[-5, 5]$

50. No

51.



$[-5, 5]$ by $[-5, 5]$

52. $f(x) = \begin{cases} x + 3 \text{ if } x \le -1 \\ x^2 + 1 \text{ if } x \ge -1 \end{cases}$

53. $(f \circ g)(x) = f(g(x)) = f(x^2 - 4) = \sqrt{x^2 - 4}$.
Since $x^2 - 4 \ge 0, x^2 \ge 4, x \le -2$ or $x \ge 2$.
The domain is $(-\infty, -2] \cup [2, \infty)$.

54. $(g \circ f)(x) = g(f(x)) = g(\sqrt{x}) = (\sqrt{x})^2 - 4 =$
$x - 4$. Since $\sqrt{x} \ge 0, x \ge 0$. The domain is $[0, \infty)$.

55. $(f \cdot g)(x) = f(x) \cdot g(x) = \sqrt{x} \cdot (x^2 - 4)$.
Since $\sqrt{x} \ge 0$, the domain is $[0, \infty)$.

56. $\left(\frac{f}{g}\right)(x) = \frac{f(x)}{g(x)} = \frac{\sqrt{x}}{x^2 - 4}$ Since $x^2 - 4 \ne 0$,
$(x+2)(x-2) \ne 0, x \ne -2, x \ne 2$. Also since
$\sqrt{x} \ge 0, x \ge 0$. The domain is $[0, 2) \cup (2, \infty)$.

57. $\lim_{x \to \infty} \sqrt{x} = \infty$. (Large negative values are not in the domain.)

58. $\lim_{x \to \pm\infty} \sqrt{x^2 - 4} = \infty$. (The graph resembles the line $y = x$.)

59. $r = \left(\frac{s}{2}\right) + \left(\frac{s}{2}\right) = \frac{2s^2}{4}, r = \sqrt{\frac{2s^2}{4}} = \frac{s\sqrt{2}}{2}$.

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