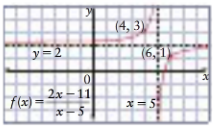
24. a) $\frac{1}{12}$ **b)** 80 **c)** 21

25. a)



b) Answers may vary: $f(x) = \frac{2x-11}{x-5}$. **26.** $x = 4$

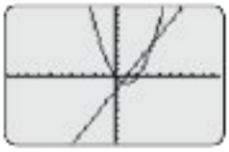
27. $x = \pm\frac{1}{2}$, $x = 7$, $x = -\frac{5}{3}$, and $x = \frac{1}{3}$ **28.** $x = 30°$

1.5 Introduction to Derivatives, pages 58–62

1. a) C **b)** A **c)** B **2. a)** $f'(x) = 3x^2$ **b) i)** 108 **ii)** 0.75 **iii)** $\frac{4}{3}$ **iv)** 12 **c) i)** $y = 108x + 432$ **ii)** $y = 0.75x + 0.25$ **iii)** $y = \frac{4}{3}x - \frac{16}{27}$ **iv)** $y = 12x - 16$ **3.** Answers will vary **4. a)** $f'(x) = 1$ **b) i)** 1 **ii)** 1 **iii)** 1 **iv)** 1 **5. a)** $f(x) = 3x$ **b)** $f(x) = x^2$ **c)** $f(x) = 4x^3$ **d)** $f(x) = -6x^3$ **e)** $f(x) = \frac{5}{x}$ **f)** $f(x) = \sqrt{x}$ **6. a)** $f'(x) = -\frac{1}{x^2}$ **b) i)** $-\frac{1}{36}$ **ii)** -4 **iii)** $-\frac{9}{4}$ **iv)** $-\frac{1}{4}$ **c) i)** $y = -\frac{1}{36}x - \frac{1}{3}$ **ii)** $y = -4x - 4$ **iii)** $y = -\frac{9}{4}x + 3$ **iv)** $y = -\frac{1}{4}x + 1$

7. Answers will vary. **a)** $x \in (-\infty, -1)$ or $(-1, \infty)$ **b)** $x \in (-\infty, \infty)$ **c)** $x \in (3, \infty)$ **d)** $x \in (-\infty, -1)$ or $(-1, \infty)$ **8.** Answers will vary. **a)** linear **b)** cubic **c)** constant **d)** quadratic **9. a)** $\frac{dy}{dx} = 2x$ **b)** $x \in \mathbb{R}$; $x \in \mathbb{R}$ **c)** Answers will vary **10. a) i)** $\frac{dy}{dx} = -6x$ **ii)** $\frac{dy}{dx} = 8x$ **b)** Answers will vary **c) i)** $\frac{dy}{dx} = -4x$ **ii)** $\frac{dy}{dx} = 10x$ **d) i)** $\frac{dy}{dx} = -4x$ **ii)** $\frac{dy}{dx} = 10x$ **11. a)** $\frac{dy}{dx} = 0$ **b)** Answers may vary: Yes. The slope of a horizontal line is 0. **c)** $\frac{dy}{dx} = 0$ **12. a)** $x^3 + 3hx^2 + 3h^2x + h^3$ **b) i)** $\frac{dy}{dx} = 6x^2$ **ii)** $\frac{dy}{dx} = -3x^2$ **13. a)** Answers will vary **b) i)** $\frac{dy}{dx} = -12x^2$ **ii)** $\frac{dy}{dx} = \frac{3}{2}x^2$ **c) i)** $\frac{dy}{dx} = -12x^2$ **ii)** $\frac{dy}{dx} = \frac{3}{2}x^2$ **14. a)** $\frac{dy}{dx} = 8$ **b)** $\frac{dy}{dx} = 6x - 2$ **c)** $\frac{dy}{dx} = -2x$ **d)** $\frac{dy}{dx} = 8x + 5$ **e)** $\frac{dy}{dx} = 8x - 4$ **15. a)** $x^4 + 4hx^3 + 6h^2x^2 + 4h^3x + h^4$ **b) i)** $\frac{dy}{dx} = 4x^3$ **ii)** $\frac{dy}{dx} = 8x^3$ **iii)** $\frac{dy}{dx} = 12x^3$ **c)** Answers will vary **d) i)** $\frac{dy}{dx} = -4x^3$ **ii)** $\frac{dy}{dx} = 2x^3$ **e) i)** $\frac{dy}{dx} = -4x^3$ **ii)** $\frac{dy}{dx} = 2x^3$ **16. a)** $H'(t) = -9.8t + 3.5$ **b)** -1.4 m/s **c)** 0.357 s; 1.625 m **17. a)** $\frac{dy}{dx} = 2x - 2$

b)



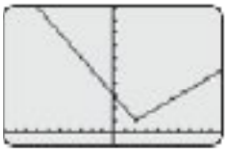
d)

c) $y = -8x - 9$

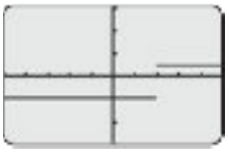
18. a) i) $\frac{dy}{dx} = -\frac{2}{x^2}$ **ii)** $\frac{dy}{dx} = \frac{1}{x^2}$ **iii)** $\frac{dy}{dx} = -\frac{3}{x^2}$ **iv)** $\frac{dy}{dx} = \frac{4}{3x^2}$ **b)** Answers will vary

c) i) $\{x \mid x \in \mathbb{R}, x \neq 0\}$; $\{x \mid x \in \mathbb{R}, x \neq 0\}$
ii) $\{x \mid x \in \mathbb{R}, x \neq 0\}$; $\{x \mid x \in \mathbb{R}, x \neq 0\}$
iii) $\{x \mid x \in \mathbb{R}, x \neq 0\}$; $\{x \mid x \in \mathbb{R}, x \neq 0\}$
iv) $\{x \mid x \in \mathbb{R}, x \neq 0\}$; $\{x \mid x \in \mathbb{R}, x \neq 0\}$

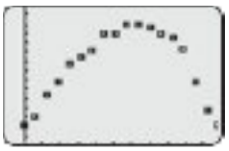
19. a) i) $\frac{dy}{dx} = -\frac{5}{x^2}$ **ii)** $\frac{dy}{dx} = \frac{3}{5x^2}$ **b) i)** $\frac{dy}{dx} = -\frac{5}{x^2}$ **ii)** $\frac{dy}{dx} = \frac{3}{5x^2}$ **20.** Answers may vary **a)** piecewise function: $y = -x + 3$ if $x \leq 2$ and $y = 0.5x$ if $x > 2$



b)



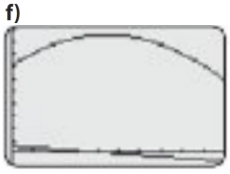
21. a) Answers will vary



b) $y = -1499x^2 + 26\,808x + 356\,532$

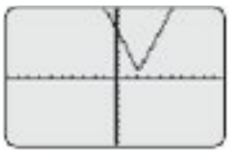
c) $\frac{dy}{dx} = -2998x + 26\,808$ **d) i)** 17 814 births/year **ii)** 5822 births/year **iii)** -3172 births/year **iv)** $-12\,166$ births/year **v)** $-21\,160$ births/year **e)** Answers will vary

f)



g) Answers will vary **23. a) i)** $\frac{dy}{dx} = 2x + 3$ **ii)** $\frac{dy}{dx} = 1 - 6x^2$ **iii)** $\frac{dy}{dx} = 8x^3 - 1$ **b) i)** $\frac{dy}{dx} = 2x + 3$ **ii)** $\frac{dy}{dx} = 1 - 6x^2$ **iii)** $\frac{dy}{dx} = 8x^3 - 1$ **24. a) i)** $\frac{dy}{dx} = -\frac{2}{x^3}$ **ii)** $\frac{dy}{dx} = -\frac{3}{x^4}$ **iii)** $\frac{dy}{dx} = -\frac{4}{x^5}$ **b) i)** $\{x \mid x \in \mathbb{R}, x \neq 0\}$; $\{x \mid x \in \mathbb{R}, x \neq 0\}$ **ii)** $\{x \mid x \in \mathbb{R}, x \neq 0\}$; $\{x \mid x \in \mathbb{R}, x \neq 0\}$ **iii)** $\{x \mid x \in \mathbb{R}, x \neq 0\}$; $\{x \mid x \in \mathbb{R}, x \neq 0\}$ **c)** Answers will vary

25. a) $x = 2$



b) Answers will vary **26. a) i)** $\frac{dy}{dx} = 0$ **ii)** $\frac{dy}{dx} = 1$ **iii)** $\frac{dy}{dx} = 2x$ **iv)** $\frac{dy}{dx} = 3x^2$ **v)** $\frac{dy}{dx} = 4x^3$

b) Answers will vary **c) i)** $\frac{dy}{dx} = 5x^4$ **ii)** $\frac{dy}{dx} = 6x^5$ **d) i)** $\frac{dy}{dx} = 5x^4$ **ii)** $\frac{dy}{dx} = 6x^5$ **e)** $\frac{dy}{dx} = nx^{n-1}$, $n \in \mathbb{N}$ **f)** Answers will vary

27. a) $\frac{dy}{dx} = 2x$; Difference of squares **b) i)** $\frac{dy}{dx} = 3x^2$ **ii)** $\frac{dy}{dx} = 4x^3$ **iii)** $\frac{dy}{dx} = 5x^4$ **c)** Answers may vary. Factoring is easier than expanding

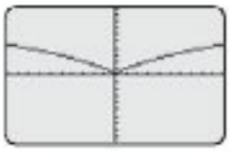
28. a) $f'(x) = \frac{3}{(x-1)^2}$, $\{x \mid x \in \mathbb{R}, x \neq 1\}$

b) $f'(x) = \frac{13}{(x+4)^2}$, $\{x \mid x \in \mathbb{R}, x \neq -4\}$

29. a) $f'(x) = \frac{1}{2\sqrt{x+1}}$, $\{x \mid x \in \mathbb{R}, x \geq -1\}$; $\{x \mid x \in \mathbb{R}, x > -1\}$

b) $f'(x) = \frac{1}{\sqrt{2x-1}}$, $\{x \mid x \in \mathbb{R}, x \geq 0.5\}$; $\{x \mid x \in \mathbb{R}, x > 0.5\}$

30.



(0, 0); Answers will vary **b)** Answers will vary

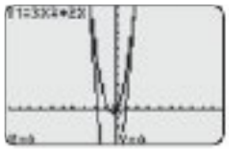
31. (1, 1, 1), (1, 2, 2) **32.** $x = \sqrt{2}$ **33.** 2009

Chapter 1 Review, pages 64–65

1. a) Answers will vary **b) i)** −900 L/h **ii)** −120 L/h **c) i)** −900 L/h **ii)** −600 L/h **iii)** −150 L/h **d) i)** Answers may vary: The graph would be steeper. **ii)** Answers may vary: The graph will shift up. **e)** Answers will vary

2. Answers will vary: **a)** the volume of gas remaining in a gas tank as a car is driven **b)** the volume of water in a beaker as the beaker is filled with water **c)** the velocity of an airplane as it travels down a runway at takeoff **d)** the speed of a car when the brakes are applied in order to stop the car at a red light **3. a)** 5.6 m/s **b)** −14 m/s **c)** Answers will vary **4. a) i)** 14 **ii)** −16 **b) i)** $y = 14x - 12$ **ii)** $y = -16x - 27$

c)



5. a) $t_1 = \frac{4}{3}$; $t_2 = \frac{1}{6}$; $t_3 = -\frac{4}{9}$; $t_4 = -\frac{11}{12}$; $t_5 = -\frac{4}{3}$

b) No. Answers may vary: The sequence does not have a limit as $n \to \infty$. The sequence is divergent.

6. a) $t_1 = \frac{35}{8}$; $t_2 = \frac{245}{64}$; $t_3 = \frac{1715}{512}$; $t_4 = -\frac{12\,005}{4096}$; $t_5 = \frac{84\,035}{32\,768}$ **b)** 0 **c)** 13 bounces

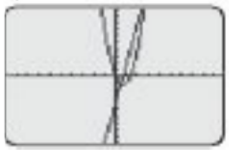
7. a) Function is continuous at $x = 3$. Answers will vary

b) Yes. The function is discontinuous for $x = -3$, where there is a vertical asymptote.

8. a) $x \in (-\infty, 0)$ or $(0, \infty)$; $y \in (-\infty, 2]$ **b) i)** −2 **ii)** −2 **iii)** $-\infty$ **iv)** $-\infty$ **c)** Answers may vary. The graph is discontinuous at $x = 0$. **9. a)** −4 **b)** $\frac{15}{7}$ **c)** $\frac{1}{8}$ **d)** $\frac{7}{6}$ **e)** 14 **10.** Answers may vary: As x approaches −6 from the left, the graph of $y = h(x)$ approaches $y = 3$. As x approaches −6 from the right, the graph of $y = h(x)$ approaches $y = 3$. There is a hole in the graph of $y = g(x)$ at (6, 3). Since $h(-6) \neq 3$, the function is discontinuous at $x = -6$.

11. a) $\frac{dy}{dx} = 4$ **b)** $h'(x) = 22x + 2$ **c)** $s'(t) = t^2 - 10t$ **d)** $f'(x) = 2x + 2$ **12. a)** $\frac{dy}{dx} = 6x - 4$

b)



c) $y = -16x - 12$