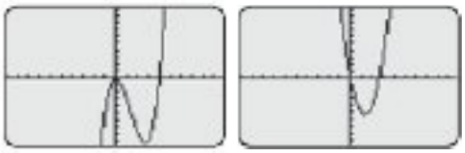
Chapter 1 Practice Test, pages 66–67

1. C **2.** C; there is a cusp at $x = 2$. **3. a)** 35 **b)** 141 **c)** 7 **d)** $-\frac{9}{5}$ **e)** 14 **f)** 0 **4.** C

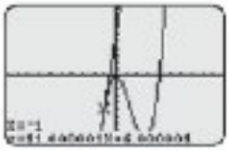
5. a) $\frac{dy}{dx} = 3x^2 - 8x$

b)



c) $y = 11x + 6$

d)



6. a) -3 **b)** 1 **c)** -2 **d)** -2 **e)** 1 **f)** ∞ **7. a)** domain: $\{x \mid x \in \mathbb{R}, x \neq 4\}$; range: $\{y \mid y \in \mathbb{R}, y \neq 3\}$ **b) i)** 3 from above **ii)** 3 from below **iii)** $+\infty$ **iv)** $-\infty$ **v)** 9 **vi)** 1
c) The graph is not continuous. Answers may vary: As x approaches 4 from the left, the graph becomes large and negative. As x approaches 4 from the right, the graph becomes large and positive. Therefore, there is an infinite discontinuity at $x = 4$.

8. a) $V(x) = 4x - \frac{1}{4}x^3$ **b)** 0.0625 m^3/m **c)** -2.75 m^3/m

9. a) i) 0.2 m **ii)** 0.6 m **iii)** 1 m **b)** $\frac{dA}{dr} = 2\pi r$ m^2/m
c) i) 1.3 m^2/m **ii)** 3.8 m^2/m **iii)** 6.3 m^2/m **10. a)** C **b)** A **c)** D **d)** B

CHAPTER 2 DERIVATIVES

Prerequisite Skills, pages 70–71

1. a) polynomial **b)** sinusoidal **c)** polynomial **d)** root **e)** exponential **f)** rational **g)** logarithmic **h)** polynomial
2. a) $-\frac{1}{2}$ **b)** $\frac{1}{5}$ **c)** $-\frac{3}{2}$ **d)** undefined **e)** -1 **f)** 0 **3. a)** $x^{\frac{1}{2}}$ **b)** $x^{\frac{1}{3}}$ **c)** $x^{\frac{3}{4}}$ **d)** $x^{\frac{2}{5}}$ **4. a)** x^{-1} **b)** $-2x^{-4}$ **c)** $x^{-\frac{1}{2}}$ **d)** $x^{-\frac{2}{3}}$
5. a) $(x^3 - 1)(5x + 2)^{-1}$ **b)** $(3x^4)(5x + 6)^{-\frac{1}{2}}$ **c)** $(9 - x^2)^3(2x + 1)^{-4}$ **d)** $(x + 3)^2(1 - 7x^2)^{-\frac{1}{3}}$
6. a) $\frac{1}{x^6}$ **b)** $2 - \frac{1}{x} + \frac{3}{x^2}$ **c)** $\frac{1}{x^3}$ **d)** $x^{\frac{1}{2}} - \frac{1}{x^{\frac{1}{2}}}$ **e)** c^9 **f)** $\frac{(4x - 3)^2}{(x^2 + 3)^{\frac{3}{2}}}$ **7. a) i)** increasing: $(-\infty, -1)$, $(2.5, \infty)$; decreasing: $(-1, 2.5)$ **ii)** positive: $(-3, 2)$, $(3, \infty)$; negative: $(-\infty, -3)$, $(2, 3)$ **iii)** zero slope: $x = -1$, $x = 2.5$; positive slope: $(-\infty, -1)$, $(2.5, \infty)$; negative slope: $(-1, 2.5)$ **b) i)** decreasing: $(-\infty, -2.5)$, $(1.5, 4.5)$; increasing: $(-2.5, 1.5)$, $(4.5, \infty)$ **ii)** positive: $(-\infty, -4)$, $(-0.5, 4)$, $(5, \infty)$; negative: $(-4, -0.5)$, $(4, 5)$ **iii)** zero slope: $x = -2.5$, $x = 1.5$, $x = 4.5$; positive slope: $(-2.5, 1.5)$, $(4.5, \infty)$; negative slope: $(-\infty, -2.5)$, $(1.5, 4.5)$
8. a) 2, 6 **b)** -3, 7 **c)** $\frac{4}{5}$, 2 **d)** $-\frac{2}{3}, \frac{3}{2}$ **e)** $\frac{-5 \pm \sqrt{41}}{2}$ **f)** $\frac{-13 \pm \sqrt{217}}{4}$ **g)** $\frac{9 \pm \sqrt{33}}{8}$ **h)** $\frac{7 \pm 3\sqrt{5}}{2}$
9. a) $-4, -1, 2$ **b)** $-1, -0.5, 2$ **c)** $-4, -\frac{1}{3}, 3$ **d)** $-3, -\frac{1}{5}, 1$ **e)** $-2, \frac{1}{3}, 1$ **f)** $-3, -1, 2, 4$
10. a) $15x^2 - 14x + 20$ **b)** $-175x^4 - 30x^2 + 126x$
c) $42x^6 + 75x^4 - 48x^3 - 60x$
11. a) $(x^3 - 1)^4(2x + 7)^3(38x^3 + 105x^2 - 8)$
b) $(x^3 + 4)^{-2}(-12x^3 + 15x^2 + 24)$
c) $2\sqrt{x}(x - 1)(x^2 + x + 1)$ **d)** $\frac{(x + 1)^2}{x^2}$ **12. a)** 23 **b)** -5 **c)** 3
13. a) $f \circ g(x) \left(\frac{1}{x - 2}\right)^3 + 1$ **b)** $g \circ f(x) \frac{1}{\sqrt{1 - x^2} - 2}$
c) $h[f(x)] \sqrt{-x^6 - 2x^3}$ **d)** $g[f(x)] \frac{1}{x^3 - 1}$
14. a) $h(x) = f[g(x)]$ if $f(x) = x^2$ and $g(x) = 2x - 3$
b) $h(x) = f[g(x)]$ if $f(x) = \sqrt{x}$ and $g(x) = 2 + 4x$
c) $h(x) = f[g(x)]$ if $f(x) = \frac{1}{x}$ and $g(x) = 3x^2 - 7x$
d) $h(x) = f[g(x)]$ if $f(x) = \frac{1}{x^2}$ and $g(x) = x^3 - 4$

2.1 Derivative of a Polynomial Function, pages 83–86

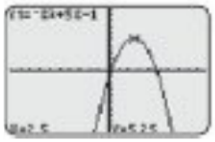
1. A, B, E, G, and H **2. a)** $\frac{dy}{dx} = 1$ **b)** $\frac{dy}{dx} = \frac{1}{2}x$ **c)** $\frac{dy}{dx} = 5x^4$ **d)** $\frac{dy}{dx} = -12x^3$ **e)** $\frac{dy}{dx} = 4.5x^2$ **f)** $\frac{dy}{dx} = \frac{3}{5\sqrt[5]{x^2}}$ **g)** $\frac{dy}{dx} = \frac{-5}{x^2}$ **h)** $\frac{dy}{dx} = -\frac{2}{\sqrt{x^3}}$ **3. a)** 0 **b)** 90 **c)** $\frac{3}{16}$ **d)** -34.3 **e)** $\frac{3\pi}{2}$ **f)** $\frac{1}{12}$ **4. a)** $f'(x) = 4x + 3x^2$; sum rule, power rule, constant multiple rule **b)** $\frac{dy}{dx} = 4x^4 - 3$; difference rule, power rule, constant multiple rule **c)** $h'(t) = -4.4t^3$; sum rule, power rule, constant rule, constant multiple rule
d) $V'(r) = 4\pi r^2$; power rule, constant multiple rule
e) $p'(a) = \frac{1}{3}a^4 - \frac{1}{\sqrt{a}}$; difference rule, power rule, constant multiple rule **f)** $k'(s) = \frac{2}{s^3} + 28s^3$; sum rule, power rule, constant multiple rule

5. a) i) (0.25, 3.625) **ii)** (2.5, 5.25) **iii)** $\left(-\frac{4}{3}, \frac{5}{3}\right) = (1.\dot{3}, 1.\dot{6})$

b) i)

local minimum point

ii)



local maximum point

iii)

local minimum point

6. a) $f(x) = 5x^2 - 3x$; $f'(x) = 10x - 3$

b) $g(x) = 6x^2 + 5x - 4$; $g'(x) = 12x + 5$

c) $p(x) = \frac{1}{4}x^5 - x^3 + \frac{1}{2}$; $p'(x) = \frac{5}{4}x^4 - 3x^2$

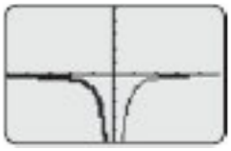
d) $f(x) = 25x^2 + 20x + 4$; $f'(x) = 50x + 20$

7. Answers may vary. **a)** Use a graphing calculator to graph the curve, and then draw the tangent to the curve and determine the equation of the tangent to the curve at the given x-value. **b)** The derivative is equal to the slope of the tangent at the given point. The equation formed can then be solved to find the x-value of the tangent point. The x-value is then substituted into the equation of the function to find the y-value of the tangent point.

8. a) Answers may vary: The rules in this chapter require expansion and solving by the sum, power, and constant multiple rules. This question needs to be in a more expanded form to solve via these methods.

b) $f(x)$ would need to be expanded and simplified to make solving simpler. **c)** $f(x) = 4x^3 + 8x^2 - 11x + 3$; $f'(x) = 12x^2 + 16x - 11$

9. Answers may vary: The function could be plotted on a graphing calculator and the slope of a tangent line found. The slope of the tangent line will match the derivative of the function at a given point. Simple derivative rules can be used to prove this algebraically, while numerical evidence can be taken from the graphing procedure.

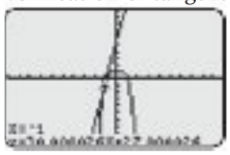


10. $f'(t)$ is the rate of water entering the first barrel, $g'(t)$ is the rate of water entering the second barrel, $f'(t) + g'(t)$ is the sum of the rates of water entering the two barrels, and, according to the sum and difference rule, $(f + g)'(t)$ is also the sum of the rates of the water entering the two barrels. **11.** −49 m/s **b)** 17.5 s **c)** 171.5 m/s

12. Earth = −39.2 m/s; Venus = −35.6 m/s; Mars = −14.8 m/s; Saturn = − 42.0 m/s; Neptune = − 44.8 m/s

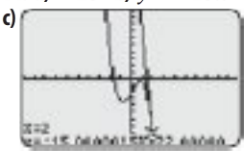
13. a) $\frac{dy}{dx} = -24x^3 + 6x^2 = 30$ **b)** $y = 30x + 27$

c) Answers may vary; plotting both curves would allow verification of tangent and intercept.

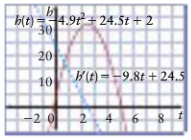


14. a) −15 **b)** $y = -15x + 22$

c)

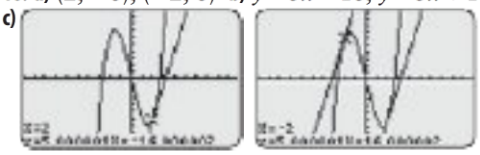


15. a) 31.4 m **b)** 14.7 m/s; 4.9 m/s; −14.7 m/s; −24.5 m/s **c)** The arrow is at the initial launch height of 2 m off the ground. **d)** $t = 5.08$ s **e)** −25.28 m/s **f)** Answers may vary; plot the $h(t)$ and $h'(t)$ functions from 0 to about 5.08 s and read the values off the plots.



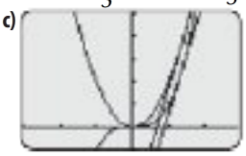
16. a) (2, −6), (−2, 6) **b)** $y = 5x - 16$; $y = 5x + 16$

c)



17. a) $x = \frac{4}{3}, 0$ **b)** $y = \frac{16}{3}x - \frac{32}{9}$; $y = \frac{16}{3}x - \frac{128}{27}$; $y = 0$

c)



19. a) $4850; $3250

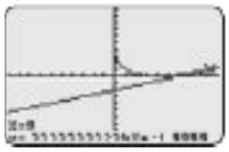
b) $C'(1000) = 1.3$; $C'(3000) = 0.9$; provides marginal cost of production per unit **c)** never; $C'(x) = 1.5 - 0.0002x$; lowest value of $C'(x) = 1.0$ within range of x

d) $R'(x) = 3.25$ is the rate of change of revenue per yogourt bar produced. **e)** $P(x) = 0.0001x^2 + 1.75x - 3450$

f) Positive: $x \geq 1789$; negative: $x \leq 1788$; this provides the break-even point. **20. a)** −5 **b)** $y = 0.2x + 4.6$

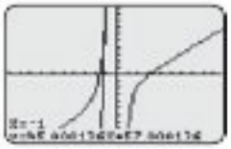
21. a) $-\frac{29}{2}$ **b)** $y = \frac{2}{29}x - \frac{60}{29}$ **22. a)** $y = \frac{1}{3}x - 2$

b)



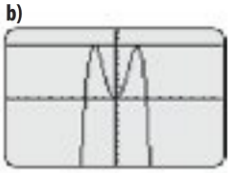
23. a) $y = 45x + 57$

b)



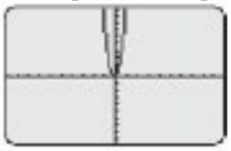
24. a) $y = 0$; $y = 16$

b)



25. a) Setting the derivative equal to -5 results in an equation that has no solution: $-5 = 18x^2 + 4x$

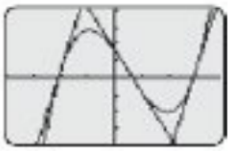
b) Answers may vary; plot the first derivative to see that the slope is never equal to -5.



27. a) $a = 2$; $b = -\frac{5}{2}$ **28.** $y = 6x - 11$; $y = -2x - 3$

29. a) $y = 25x + 52$; $y = -12.5x + 8.25$; $y = 25x - 73$

b)



31. D **32.** E

2.2 The Product Rule, pages 93–96

1. a) $f'(x) = 4x + 7$ **b)** $h'(x) = -20x + 11$ **c)** $h'(x) = -6x - 5$
d) $g'(x) = -12x + 11$ **2. a)** $f'(x) = 80x - 14$
b) $h'(t) = -4t + 7$ **c)** $p'(x) = -4x + 21$
d) $g'(x) = 12x^2 - 10x + 8$ **e)** $f'(x) = -3x^2 + 2x + 5$
f) $h'(t) = 4t(3t^2 + 1)$ **3. a)** $M'(u) = -12u^2 - 16u + 1$
b) $g'(x) = -2x + 13$ **c)** $p'(n) = -15n^2 - 2n + 15$
d) $A'(r) = 12r^2 + 4r - 12$ **e)** $b'(k) = 0.4k - 4.4$
4. a) $f(x) = 5x^2 + 7$; $g(x) = 21 - 3x$
b) $f(x) = -4x^3 + 8x$; $g(x) = 2x^2 - 4x$
c) $f(x) = 2x^3 - x$; $g(x) = 0.5x^2 + x$
d) $f(x) = -\frac{3}{4}x^4 + 6x$; $g(x) = 7x - \frac{2}{3}x^2$ **5. a)** 54 **b)** 60
c) -11 **d)** 215 **e)** -116 **f)** -274 **6. a)** $y = -240x - 739$
b) $y = -36x + 65$ **c)** $y = -4x - 24$
d) $y = -1491x + 3648$ **7. a)** $\left(-\frac{9}{8}, \frac{225}{16}\right)$
b) $(1.57, -87.021)$ **c)** $(1.53, -3.42)$; $(-1.20, 8.70)$
d) $(0.43, -3.38)$; $(-0.77, 0.76)$

8. a) $Y(t) = (10t + 120)(280 + 15t)$ **b)** 5200; rate of change of apple production at $t = 2$ years
c) $Y'(6) = 6400$; represents the rate of change of apple production at $t = 6$ years.

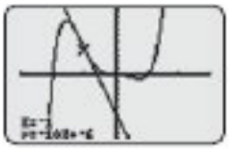
9. a) $\frac{dy}{dx} = 15x^2 + 18x - 1$ **b)** $\frac{dy}{dx} = \frac{3}{x^4} - 6x^2 - \frac{1}{x^2} + 2x$

c) $\frac{dy}{dx} = -24x^5 - 32x^3 - 30x^2 + 5x^4 + 6x$

d) $\frac{dy}{dx} = 16x^3 - 10x^{\frac{3}{2}} + 1$ **e)** $\frac{dy}{dx} = 36x^3 - 18x^2 - 10x + 2$

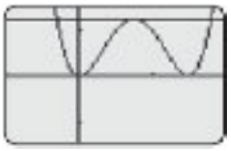
10. a) Expand and differentiate; use the product rule. $R'(n) = 14.50 - 4n$ **b)** -1.5; tells the manager that he is losing revenue at a price of \$8.50 **c)** $n = 3.625$; determines the price for maximum revenue: \$8.31.
d) Maximum revenue is \$552.78. Notice that revenue deteriorates after $n = 3.625$. **e)** When the derivative is zero, the revenue is maximized. This occurs at $n = 3.625$.
11. a) $R(x) = (30 + 2.5x)(550 - 5x)$ **b)** $R'(x) = 1225 - 25x$
c) 1150; represents the rate of change of revenue at a \$7.50 increase **d)** $x = 49$ **e)** The owner could increase the price from \$30 to \$152.50 per haircut to maximize revenue. **12. a)** $y = -10x - 6$

b)



13. a) $\left(\frac{3}{2}, 0\right)$; $(0, 0)$; $\left(\frac{3}{4}, \frac{81}{64}\right)$

b)



14. a) 90 L of gas **b)** 3.33 L/h **c)** -6.66 L/h
15. a) 3600 **b)** 1575 fish per year **c)** 1071.7 fish per year
d) 3.45 years; 1813.6 fish per year.
16. a) $R(n) = (1.75 + 0.25n)(150 - 10n)$
b) $R'(0.25) = 18.75$; $R'(1) = 15$; $R'(3) = 5$; $R'(4) = 0$; $R'(5) = -5$; $R'(6) = -10$ **c)** $n = 4$; at this point the revenue is not changing, so profit is maximized.
d) $P'(1) = 22.50$; $P'(3) = 12.50$; $P'(4) = 7.50$; $P'(5) = 2.50$; $P'(6) = -2.50$ **e)** \$3.13 **f)** The profit numbers have a rate of change that is 7.5 greater than that of the revenue numbers.

17. a) i) $\frac{dy}{dx} = (2x - 3)(x^2 - 3x) + (2x - 3)(x^2 - 3x)$

ii) $\frac{dy}{dx} = (6x^2 + 1)(2x^3 + x) + (6x^2 + 1)(2x^3 + x)$

iii) $\frac{dy}{dx} = (-4x^3 + 10x)(-x^4 + 5x^2) + (-4x^3 + 10x)(-x^4 + 5x^2)$

b) $\frac{d}{dx}[f(x)]^2 = 2f(x)\frac{d}{dx}[f(x)]$ **c)–d)** Answers may vary

18. a) $f'gh + fg'h + fgh'$

b) $f'(x) = 2x(3x^4 - 2)(5x + 1) + (x^2 + 4)(12x^2)(5x + 1) + (x^2 + 4)(x^2 - 2)(5)$ **c)** Expand and differentiate. $f'(A) = 105x^6 + 18x^5 + 300x^4 + 48x^3 - 30x^2 - 4x - 40$

19. a) $\frac{d}{dx}[f(x)]^3 = 3f(x)^2\frac{d}{dx}([f(x)])$

c) i) $\frac{dy}{dx} = 384x^5 - 240x^4 + 48x^3 - 3x^2$

ii) $\frac{dy}{dx} = 9x^8 + 21x^6 + 15x^4 + 3x^2$

iii) $\frac{dy}{dx} = -96x^{11} + 120x^9 - 48x^7 + 6x^5$

20. a) $h'(x) = 3x^2f(x) + x^3f'(x)$

b) $p'(x) = g(x)(4x^3 - 6x) + (x^4 - 3x^2)g'(x)$

c) $q'(x) = (-12x^3 - 16x + 5)f(x) + (-3x^4 - 8x^2 + 5x + 6)f'(x)$

d) $r'(x) = f'(x)(2x^3 + 5x^2)^2 + 4f(x)(2x^3 + 5x^2)(3x^2 + 5x)$

21. a) $\frac{d}{dx}[f(x)]^n = n[f(x)]^{n-1}\left(\frac{d}{dx}[f(x)]\right)$

b) $\frac{dy}{dx} = 4(2x^3 + x^2)^3(6x^2 + 2x)$;

$\frac{dy}{dx} = 5(2x^3 + x^2)^4(6x^2 + 2x)$; $\frac{dy}{dx} = 6(2x^3 + x^2)^5(6x^2 + 2x)$

22. C **23.** E

2.3 Velocity, Acceleration, and Second Derivatives, pages 106–110

1. a) $\frac{d^2y}{dx^2} = 12x$ **b)** $s''(t) = -12t^2 + 30t - 4$

c) $h''(x) = 5x^4 - 4x^3$ **d)** $f''(x) = \frac{3}{2}x - 4$

e) $g''(x) = 20x^3 + 36x^2 - 12x$ **f)** $h''(t) = -9.8$

2. a) 174 **b)** 72 **c)** −234 **d)** −48 **e)** 98 **f)** 2100

3. a) $s'(t) = 7 - 24t^2$; $s''(t) = -48t$

b) $s'(t) = -7 - 20t$; $s''(t) = -20$

c) $s'(t) = -9t^2 - 10t - 3$; $s''(t) = -18t - 10$

d) $s'(t) = -t - \frac{1}{4}$; $s''(t) = -1$

4. a) 1 m/s; 6 m/s^2 **b)** −4.6 m/s; −9.8 m/s^2

c) −95 m/s; −86 m/s^2 **d)** 32 m/s; 48 m/s^2

5. a) ①: $v(t)$; ②: $s(t)$; ③: $a(t)$ **b)** ①: $v(t)$; ②: $a(t)$; ③: $s(t)$

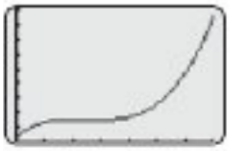
6. a)

Interval	$v(t)$	$a(t)$	$v(t) \times a(t)$	Motion of Object	Description of Slope of $s(t)$
[0, 3)	+	−	−	forward slowing	+ decreasing
(3, 6]	−	−	+	reverse accelerating	− decreasing

b)

Interval	$v(t)$	$a(t)$	$v(t) \times a(t)$	Motion of Object	Description of Slope of $s(t)$
[0, 1)	−	+	−	reverse slowing	− increasing
(1, 2)	+	+	+	forward accelerating	+ increasing
(2, 3)	+	−	−	forward slowing	+ decreasing
(3, ∞)	−	−	+	reverse accelerating	− decreasing

7. Answers may vary **8. a) i)** increasing **ii)** +
b) i) increasing **ii)** + **c) i)** decreasing **ii)** − **d) i)** decreasing **ii)** − **e) i)** constant **ii)** zero **9. a)** zero **b)** zero; zero **c)** A **d)** $v(t)=0$; $a(t)=0$ **e)** A speeding up; B slowing down; D speeding up **f)** bus returns to origin; slows to a stop
10. a) + **b)** − **c)** + **d)** − **e)** + **11. a) i)** + **ii)** − **iii)** + **iv)** 0 **v)** + **vi)** 0 **b) i)** all positive acceleration **ii)** all negative acceleration **iii)** opposite accelerations
12. a) −19.6 m/s **b)** −29.4 m/s **c)** 4.04 s **d)** −39.6 m/s
13. a) 5.1 m/s; −9.8 m/s^2 **b)** $t = 3.5$ s **c)** 63.9 m
d) 7.13 s **e)** −35.4 m/s **14. a)** + **b)** decreasing **c)** −
15. a) $s(t) = 48t$ **b)** $v(t) = 48$; $a(t) = 0$ **c)** $s(t) = 50 - 4.9t^2$
d) $v(t) = -9.8t$; $a(t) = -9.8$ **e)** −31.3 m/s **f)** 1.36 s
g) $v_{tot}(t) = \sqrt{2304 + 96.04t^2}$ **h)** $a_{tot}(t) = -9.8$
i) −9.8 m/s^2 **16. a)** $v(1) = 12$; $a(1) = -18$; $v(4) = 12$; $a(4) = 18$ **b)** $t = 2$; $t = 3$; $s(2) = 38$; $s(3) = 37$
c) positive: $(\infty, 2)(3, \infty)$; negative: (2, 3) **d)** 205 m
e)



17. a) $v(t) = gt + v_0$; $a(t) = g$
b) $h(t) = -4.9t^2 + 17.5t + 4$; $v(t) = -9.8t + 17.5$; $a(t) = -9.8$ **c)** $h(t) = -4.9t^2 + 30t + 2$; $v(t) = -9.8t + 30$; $a(t) = -9.8$ **18. a)** $s(t) = -6t^2 + 24t$; $v(t) = -12t + 24$; $a(t) = -12$ **b)** 2 s **19.** E **20.** D

2.4 The Chain Rule, pages 117–119

1. a) $f'(x) = 24x^2$ **b)** $g'(x) = 64x^3$ **c)** $p'(x) = \frac{3x}{\sqrt{x^2}}$

d) $f'(x) = 12x^{\frac{1}{2}}$ **e)** $q'(x) = \frac{8}{3x^{\frac{1}{3}}}$

2.

$f(x) = g[h(x)]$	$g(x)$	$h(x)$	$h'(x)$	$g'[h(x)]$	$f'(x) = g'[h(x)]h'(x)$
a) $(6x-1)^2$	x^2	$6x-1$	6	$2h(x)$	$12(6x-1)$
b) $(x^2+3)^3$	x^3	x^2+3	$2x$	$3[h(x)]^2$	$6x(x^2+3)^2$
c) $(2-x^3)^4$	x^4	$2-x^3$	$3x^2$	$4[h(x)]^3$	$12x^2(x^3-2)^3$
d) $(-3x+4)^{-1}$	x^{-1}	$-3x+4$	-3	$-[h(x)]^{-2}$	$\frac{3}{(-3x+4)^2}$
e) $(7+x^2)^{-2}$	x^{-2}	$7+x^2$	$2x$	$-2[h(x)]^{-3}$	$\frac{-4x}{(x^2+7)^3}$
f) $\sqrt{x^4-3x^2}$	$x^{\frac{1}{2}}$	x^4-3x^2	$4x^3-6x$	$\frac{1}{2}[h(x)]^{-\frac{1}{2}}$	$\frac{2x^2-3}{\sqrt{x^2-3}}$

3. a) $y' = 8(4x + 1)$ **b)** $y' = 18x(3x^2 - 2)^2$

c) $y' = \dfrac{-3(3x^2 - 1)}{(x^3 - x)^4}$ **d)** $y' = \dfrac{-2(8x + 3)}{(4x^2 + 3x)^3}$

4. a) $y = (2x - 3x^5)^{\frac{1}{2}}; \dfrac{dy}{dx} = \dfrac{2 - 15x^4}{2\sqrt{2x - 3x^5}}$

b) $y = (-x^3 + 9)^{\frac{1}{2}}; \dfrac{dy}{dx} = \dfrac{-3x^2}{2\sqrt{-x^3 + 9}}$

c) $y = (x - x^4)^{\frac{1}{3}}; \dfrac{dy}{dx} = \dfrac{1 - 4x^3}{3(x - x^4)^{\frac{2}{3}}}$

d) $y = \sqrt[5]{2 + 3x^2 - x^3}, \dfrac{dy}{dx} = \dfrac{6x - 3x^2}{5(2 + 3x^2 - x^3)^{\frac{4}{5}}}$

5. a) $y = (-x^3 + 1)^{-2}; \dfrac{dy}{dx} = \dfrac{6x^2}{(-x^3 + 1)^3}$

b) $y = (3x^2 - 2)^{-1}; \dfrac{dy}{dx} = -\dfrac{6x}{(3x^2 - 2)^2}$

c) $y = (x^2 + 4x)^{-\frac{1}{2}}; \dfrac{dy}{dx} = -\dfrac{x + 2}{(x^2 + 4x)^{\frac{3}{2}}}$

d) $y = (x - 7x^2)^{-\frac{1}{3}}; \dfrac{dy}{dx} = -\dfrac{1 - 14x}{3(x - 7x^2)^{\frac{4}{3}}}$

6. a) $f'(x) = 10x$ **b)** Answers may vary. **c)** No.

7. a) 56 **b)** $-\dfrac{2}{27}$ **c)** $\dfrac{4}{5}\sqrt{5}$ **d)** 0 **8. a)** $\dfrac{7}{4}$

b) $-\dfrac{9}{26}\sqrt{13}$ **c)** $-\dfrac{7}{4}$ **d)** $-\dfrac{5}{16}$ **9.** $y = 729x - 2916$

10. $y = -\dfrac{13}{80}x + \dfrac{33}{40}$ **11.** $\dfrac{7}{3}$

12. $(-1, 0), \left(-\dfrac{1}{\sqrt{2}}, \dfrac{1}{16}\right), (0, 0), \left(\dfrac{1}{\sqrt{2}}, \dfrac{1}{16}\right), (1, 0)$

13. a) $N'(t) = \dfrac{1800t}{(16 + 3t^2)^{\frac{3}{2}}}$ represents the rate at which the customers are being served **b)** $N(4) = 75$; $N'(4) \doteq 14.06$; after 4 h, 75 customers are served at an instantaneous rate of change of $\dfrac{225}{16}$ customers per hour **c)** $t \doteq 7$ h represents the time when 103 customers are served

d) $N'(7) = \dfrac{12600}{26569}\sqrt{163} \doteq 6.05$; the customers are being served at a slower rate at 7 h.

14. $P'(2) = -12.01$; $P'(4) = -11.56$; $P'(7) = -10.92$

15. $V'(3) = 1617$; this represents the rate of change of the volume of the cube with respect to x.

16. $y = (4x - x^3)(3x^2 + 2)^{-2}; \dfrac{dy}{dx} = \dfrac{-42x^2 + 8 + 3x^4}{(3x^2 + 2)^3}$

18. $y = \dfrac{35}{3}x - \dfrac{26}{3}; y = \dfrac{35}{3}x + \dfrac{26}{3}$ **19.** -12

20. $\dfrac{d^2y}{dx^2} = -\dfrac{1}{(2x + 1)^{\frac{3}{2}}}$ **21.** Answers may vary.

a) $f(x) = x^2$; $g(x) = 2x$ **b)** $f(x) = g(x) = x^2$

22. a) $\dfrac{dy}{dx} = -\dfrac{2(x + 1)}{x^2(x + 2)^2}$ **b)** $\dfrac{dy}{dx} = -\dfrac{2(x + 1)}{x^2(x + 2)^2}$

c) $\dfrac{dy}{dx} = -\dfrac{2(x^2 + 1)}{x(x^2 + 2)\sqrt{x^2(x^2 + 2)}}$ **d)** $\dfrac{dy}{dx} = -\dfrac{2(x^2 + 1)}{x^3\sqrt{2x^2 + 1}}$

23. $\dfrac{dy}{dx} = f'(g[h(x)])(g'[h(x)])[h'(x)]$ **24.** D **25.** E

2.5 Derivatives of Quotients, pages 124–126

1. a) $q(x) = (3x + 5)^{-1}$; $x \neq -\dfrac{5}{3}$ **b)** $f(x) = -2(x - 4)^{-1}$; $x \neq 4$

c) $g(x) = 6(7x^2 + 1)^{-1}$; no restrictions

d) $r(x) = -2(x^3 - 27)^{-1}$; $x \neq 3$

2. a) $q'(x) = -(3x + 5)^{-2}(3)$ **b)** $f'(x) = 2(x - 4)^{-2}(1)$

c) $g'(x) = -6(7x^2 + 1)^{-2}(14x)$ **d)** $r'(x) = 2(x^3 - 27)^{-2}(3x^2)$

3. a) $q(x) = 3x(x + 1)^{-1}$; $x \neq -1$

b) $f(x) = -x(2x + 3)^{-1}$; $x \neq -\dfrac{3}{2}$

c) $g(x) = x^2(5x - 4)^{-1}$; $x \neq \dfrac{4}{5}$ **d)** $r(x) = 8x^2(x^2 - 9)^{-1}$; $x \neq \pm 3$

4. a) $q'(x) = 3(x + 1)^{-1} + 3x(-1)(x + 1)^{-2}(1)$

b) $f'(x) = -1(2x + 3)^{-1} + (-x)(-1)(2x + 3)^{-2}(2)$

c) $g'(x) = 2x(5x - 4)^{-1} + x^2(-1)(5x - 4)^{-2}(5)$

d) $r'(x) = 16x(x^2 - 9)^{-1} + 8x^2(-1)(x^2 - 9)^{-2}(2x)$

5. a) $\dfrac{dy}{dx} = \dfrac{2x^2 - 12x - 5}{(2x^2 + 5)^2}$ **b)** $\dfrac{dy}{dx} = -\dfrac{8x^3 + 3x^2 + 8}{(x^3 - 2)^2}$

c) $\dfrac{dy}{dx} = 3$ **d)** $\dfrac{dy}{dx} = \dfrac{x^3(2x^2 - 3x + 4)}{(x^2 - x + 1)^2}$

6. a) $\dfrac{4}{25}$ **b)** $-\dfrac{5}{4}$ **c)** $-\dfrac{17}{32}$ **d)** 0 **e)** $\dfrac{7}{5}$

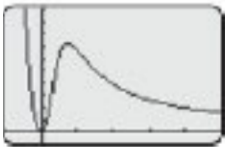
7. a) Express as a product and Product Rule or Simplify and Sum Rule: $q'(x) = -\dfrac{5x^2 - 4x + 18}{x^4}$

b) Answers may vary

8. a) $(-1, 1), (-3, -9)$ **9.** $y = -20x - 16$

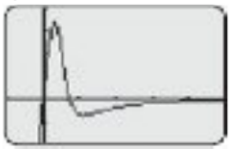
10. a) $\dfrac{3}{5}$ m/s **b)** 2 s **11. a)** $C'(1) \doteq 7.9$; $C'(3) \doteq 17.4$; $C'(5) \doteq 10.4$; $C'(8) \doteq -1.4$; C' is the number of new clients in the fund per week.

b)



The slope of the line indicates if $C'(w)$ is positive, zero, or negative

c)



e) Answers may vary.

12. a) 1805.3 **b)** 206.55 **c)** $N'(1) \doteq 69.5$; $N'(6) \doteq 328.3$ **d)** Never. The number of customers will continue to increase. **13. a)** \$1767.77

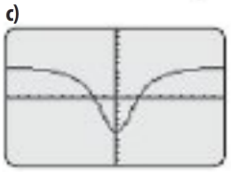
b) $V'(t) = \dfrac{0.4(3t^2 + 12517t + 87508)}{(2t+8)^{\frac{3}{2}}}$ **c)** always increasing

d) $V'(2) = 1083.05$; $V'(22) = 388.65$; these values represent the rate of increase in value of the painting. It gains value more quickly 2 years after purchase than 22 years after purchase.

14. a) $f^{(n)}(x) = \dfrac{(-1)^n n!\, a^n}{(ax+b)^{n+1}}$, $x \neq -\dfrac{b}{a}$ **b)** $f^{(4)}(x) = \dfrac{384}{(2x-3)^5}$

15. a) $(0, -1)$ **b)** $\left(-\dfrac{2}{\sqrt{3}}, -\dfrac{1}{2}\right); \left(\dfrac{2}{\sqrt{3}}, -\dfrac{1}{2}\right)$

c)



local minimum and points of inflection

d)

local extrema

16. a) $\dfrac{dy}{dx} = \dfrac{x^4 - 2x^3 + 2x - 1}{2x^2(x^2 - x + 1)\sqrt{\dfrac{x^2 - x + 1}{x}}}$, $x \neq 0$

b) $\dfrac{dy}{dx} = \dfrac{x^3 - 3x^2 + 3x - 2}{2x^2(x-1)^{\frac{3}{2}}}$ $x \neq 0, 1$ **17.** D **18.** D

Extension: The Quotient Rule, page 129

1–3. See Section 2.5, Q4, Q5 and Q6 answers

4. a) i), ii) $\dfrac{dy}{dx} = -\dfrac{5(2x+3)}{(x^2+3x)^6}$ **b)** The power of a function rule is more efficient because the numerator is one.

c) Answers may vary **5.** $-\dfrac{28}{25}$ **6.** $(0, 0)$; $(-5, -5)$ **7.** No.

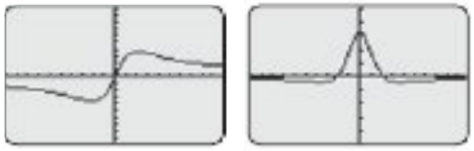
8. a) $n'(1) = 150$; $n'(5) = \dfrac{750}{169}$ **b)** No **9.** $-\dfrac{92}{961}$; the rate of change of antibiotic concentration at 3 h

10. a) $c'(1) = \dfrac{42}{121}$; $c'(4) = -\dfrac{138}{1681}$; $c'(7) = -\dfrac{534}{11449}$

b) zero: $t = \dfrac{3}{\sqrt{2}}$; positive $t \in \left(0, \dfrac{3}{\sqrt{2}}\right)$;

negative: $t \in \left(\dfrac{3}{\sqrt{2}}, \infty\right)$

c)



d) The concentration increases to a peak value at $t = \dfrac{3}{\sqrt{2}}$. After this point, the concentration begins to decrease

e) $\dfrac{480}{68\,921}$ represents the rate of dissipation of the cleaner at 4 days

2.6 Rate of Change Problems, pages 137–141

1. a) $R(x) = \dfrac{575x}{\sqrt{x}} - 3x$ **b)** $R'(x) = \dfrac{575}{2\sqrt{x}} - 3$ **c)** \$17.33

2. a) $P(x) = 0.002x^2 - 153x - 575\sqrt{x} - 2000$

b) $P'(x) = 0.004x - 153 + \dfrac{575}{2\sqrt{x}}$ **c)** $-\$138.14$

3. a) $R(x) = 17.5x$ **b)** $R'(x) = 17.5$
c) $P(x) = 0.001x^3 - 0.025x^2 + 13.5x$
d) $P'(x) = 0.003x^2 - 0.05x + 13.5$
e) $R'(300) = \$17.50$, $P'(300) = \$268.50$

4. a) 0.41 g/m **b)** $f'(5) = \dfrac{1}{3}$ g/m; $f'(8) = \dfrac{1}{\sqrt{15}}$ g/m; the density of the wire decreases as the distance increases.

5. a) $p(x) = 86 - 0.2x$ **b)** $R(x) = 86x - 0.2x^2$
c) $R'(x) = 86 - 0.4x$ **d)** $x = 215$; revenue is maximized at this point **e)** $p(215) = \$43.00$ **6. a)** 12.75 kg/m **b)** 11.75 kg/m **7. a) i)** Increasing; The slope of the graph is positive **ii)** The rate of growth is positive during this period; the slope of the graph is positive. **b)** i, ii, vi, iii, iv; the intervals are ordered from the least steep to the interval with the steepest slope. **c)** The rate of inflation is higher after 1975. You can conclude the economy was doing well **d)** Decreasing; the slope of the graph decreases slightly. **8. a)** \$2.80 **b)** \$1.70 **c)** \$4.50; the gross income, or revenue, will be the number of containers sold times the price. Thus, the price is the revenue divided by the number of containers sold. **9. a)** $C'(5) = 45$; $[C(5.001) - C(5)] = 0.045$ **b)** \$1.64 **c)** -0.32; the change in cost of producing an additional unit
10. a) 12 500 **b)** $P'(3) = 313.25$; $P'(8) = 272$
c) in 14 years and in 26.66 years **d)** in 10 years
e) Increasing until year 20.66; At this point the population begins decreasing **11. a)** \$1920; rate of change of total cost with respect to x **b)** \$1918.98 **c)** The cost of the 751st hot tub is less than the marginal cost at 750
d) $R(x) = 9200x$ **e)** \$7280 **12.** $-\dfrac{10}{27}$ A/Ω **13.** 7.2°F/min

14. Negative. The pupil becomes smaller as it is exposed to more light. **15. a)** $-\$15$ per item; $-\$0.60$ per item
b) Rate of change of revenue decreases with sales of commodity **c)** $x = 3$ **d)** \$1500

16. a) $-8.9375c$ **b)** $r = 0$; The rate of change of airflow is zero; $c = 1$. **17. a)** $p(x) = 5.75 - 0.002x$ **b)** \$1767.50; \$4.35 **c)** \$3.15 **d)** \$3.1495 **e)** \$203.75; \$1.20 **f)** \$5.03; \$0.60; the profit is much lower than revenue due to the cost of producing the mocha lattes. **18. a)** 0.206 g/s

b) No; the function is $M'(t) = \dfrac{13.86}{(t + 2.2)^2}$, which is always positive. **19. a)** $R(x) = \dfrac{650x}{\sqrt{x}} - 4.5x$ **b)** \$10.03

c) $P(x) = \dfrac{650x}{\sqrt{x}} - 129.5x$ **d)** $-\$114.97$ **20.** $\dfrac{15(2c - 45b)}{abc}$

21. a) Answers will vary. **b) i)** $\dfrac{du}{dM} = \dfrac{1181.25}{(M + 150)^2}$

ii) 0.000 82 m/s^2 **22.** D **23.** C

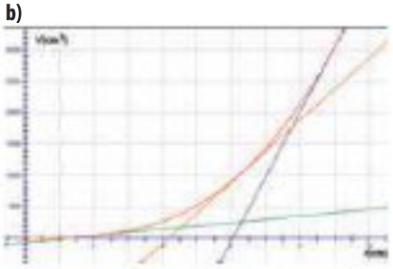
Chapter 2 Review, pages 142–143

1. Rules used may vary. **a)** $h'(t) = 3t^2 - 4t - \dfrac{2}{t^3}$

b) $p'(n) = -5n^4 + 15n^2 + \dfrac{2}{3\sqrt[3]{n}}$ **c)** $p'(r) = 6r^5 + \dfrac{1}{5\sqrt{r^3}} + 1$

2. a) $V'(1.5) = 9\pi$; $V'(6) = 144\pi$; $V'(9) = 324\pi$

b)

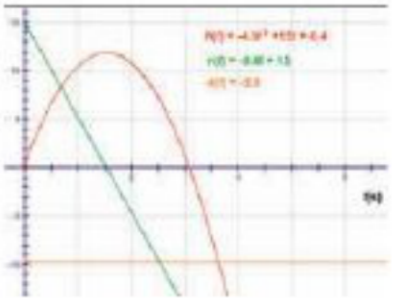


c) $y_{1.5} = 28.27x - 28.27$; $y_6 = 452.39x - 1809.56$; $y_9 = 1017.88x - 6107.26$

3. a) $f'(x) = 20x - 49$ **b)** $h'(t) = \dfrac{72x^{\frac{8}{3}} - 60x^{\frac{5}{3}} + 16x - 5}{3x^{\frac{2}{3}}}$

c) $g'(x) = -27x^5 + 84x^6 - 8$ **d)** $p'(n) = 99n^2 + 12n - 55$

4. a) $y = 3$ **b)** $y = 21x - 40$ **5.** 34 **6. a)** 10.8 m **b)** 5.2 m/s; -24.2 m/s **c)** 3.088 s **d)** -15.26 m/s **e) i)** 1.53 s **ii)** 11.88 m **iii)** 0 m/s; at $t = 1.53$, the velocity function passes through zero.



7. a) 3.67 bushes per year **b)** 10.85 years **c)** 3.68 bushes per year

8. a) $\dfrac{7}{4}$ **b)** $-\dfrac{1}{3\sqrt{2}}$ **c)** $-\dfrac{1}{4}$ **9. a)** $\dfrac{16}{9}$ **b)** $-\dfrac{31}{50}$ **c)** 1 **d)** $\dfrac{18}{25}$

10. a) $q'(x) = \dfrac{140x^2 + 21 - 48x}{(4x^2 - 3)^4}$

b) $\dfrac{dy}{dx} = \dfrac{12x^2(5x - 4)}{(3x - 2)^{\frac{3}{2}}}$ **c)** $m'(x) = -\dfrac{2(x - 2)(-23 + 5x)}{(3 + 5x)^5}$

d) $\dfrac{dy}{dx} = \dfrac{2(x^2 - 3)(7x^2 + 10x + 3)}{(4x + 5)^{\frac{3}{2}}}$

e) $\dfrac{dy}{dx} = -\dfrac{3(2\sqrt{x} + 7)^2(13x^3 - 25x^2 - 1 + 49x^{\frac{5}{2}} - 98x^{\frac{3}{2}})}{(x^3 - 3x^2 + 1)^8\sqrt{x}}$

11. $y = -216x - 459$ **12. a)** $p(x) = 42 - 0.15x$ **b)** \$3.00 **c)** \$3.30 **d)** $-\$6.30$

13. a) $V(t) = (4.85 - 0.01t^2)(15 + 0.11t)$ **b)** $V'(t) = -0.3t - 0.0033t^2 + 0.5335$ The rate of change in voltage over time **c)** -0.0797 V/s **d)** -0.04 A/s **e)** 0.11 Ω/s **f)** No. The product rule dictates that $V'(2) = I(2)R'(2) + I'(2)R(2)$

Chapter 2 Practice Test, pages 144–145

1. B; **2.** C; **3.** A and B are incorrect.

4. 2178 **5.** Methods may vary. **a)** $\dfrac{dy}{dx} = 2 - 3^{\frac{1}{3}}x$

b) $\dfrac{dy}{dx} = 6x^2 + 2x - 8$ **6. a)** $\dfrac{dy}{dx} = \dfrac{-5(3x^8 + 4)}{x^6}$

b) $g(x) = 3x^2(8x - 3)^2(16x - 3)$

c) $m'(x) = -\dfrac{5x^6 - 10x - 18x^5 + 54}{\sqrt{9 - 2x}(x^4)}$

d) $f'(x) = \dfrac{3 - 2x}{(1 - x^2)^{\frac{3}{2}}}$

7. a) -18.4 m/s; -9.8 m/s^2 **b)** The arrow moves upward until 1.12 s and then stops and moves downward. **c)** at $t = 1.12$ s **d)** 8.17 m; at this point the arrow has zero velocity and is at its maximum height **e)** 2.41 s; -12.62 m/s **8.** $y = -8x - 9$ **9.** (4, 3) **10. a)** Faster at A and H **b)** 0 **c)** The vehicle is stopped **d)** Slowing down **e)** Vehicle returns to starting position; **f) i)** − **ii)** − **iii)** + **iv)** 0 **v)** − **11. a)** $p(x) = 49.5 - 0.025x$ **b)** $-\$40.50$ **c)** \$5.70 **d)** \$5.70 **e)** $-\$3980$; $-\$46.20$ **12. a)** $-\$1917.53$; $-\$1775.54$; $-\$1590.40$ **b)** \$100 000.00 **c)** Used; The new boat depreciates in value rapidly after purchase and less so at later times **13. a)** \$47 **b)** \$47.01 **c)** The cost of producing the 251st player only slightly exceeds the marginal cost of production at the 250 production level.

d) $R(x) = 130x - 0.4x^2$; $P(x) = -0.41x^2 + 88x - 300$
e) −$70; −$117 **f)** The production level is too high; profit is not being maximized.

14. a) $5500 **b)** $V'(t) = \dfrac{1000(3t^3 + 2250t - 1375)t}{(5t^2 + 2500)^{\frac{3}{2}}}$

c) Increasing; $V'(t)$ is always positive.
d) $5611.72; $10 498.45 **e)** $127.49; $1468.20; the dining set is gaining value at a faster rate with time.
f) 10.0 years; $1468.20 per year

CHAPTER 3 CURVE SKETCHING

Prerequisite Skills, pages 148–149

1. a) $(x+1)(x^2+x+1)$ **b)** $(z+2)(z^2-2z-2)$
c) $(t+5)(t+4)(t-3)$ **d)** $(b+4)(b+3)(b+1)$
e) $(n+1)(n-1)(3n-1)$ **f)** $(2p-1)(p-1)(p-3)$
g) $(k+1)(4k+3)(k-1)$ **h)** $(3w+5)(w-3)(2w-1)$

2. a) $x = 3$; $x = 4$ **b)** $x = -\dfrac{3}{2}$; $x = \dfrac{3}{2}$ **c)** $v = 0$; $v = 2$

d) $a = -7$; $a = 5$ **e)** $t = \dfrac{98 \pm 3\sqrt{931}}{49}$

f) $x = -5$; $x = -2$; $x = 1$ **g)** $x = -2$; $x = 7$
3. a) $x > 5$ **b)** $-5 < x < 0$ **c)** $x > 4$ **d)** $-7 < x < 2$
e) $-2 < x < 1$ or $x > 3$ **f)** $-1 < x < 0$ or $x > 1$; $x \neq \pm 1$
4. a) $x = 3$ **b)** $x = -4$, $x = 7$ **c)** $x = -3$, $x = -2$, $x = -1$
d) $x = \pm 3$ **5. a)** $\mathbb{R}$; $\mathbb{R}$ **b)** $\mathbb{R}$; $\{y \mid y \in \mathbb{R}, y \geq -9\}$ **c)** $\mathbb{R}$; $\mathbb{R}$
d) $\{x \mid x \in \mathbb{R}, x \neq -1\}$; $\{y \mid y \in \mathbb{R}, y \neq 0\}$
e) $\{y \in \mathbb{R} \mid y \neq 4\}$; $\mathbb{R}$ **f)** $\{y \in \mathbb{R}, y < -\dfrac{1}{3}$ $uy > 0\}$;
$\left\{y \middle| y \in \mathbb{R}, -\dfrac{1}{3} < y \leq 0\right\}$ **g)** $\{x \in \mathbb{R} \mid y \in \mathbb{R} \mid -0.5 \leq y \leq 0.5\}$;
$\{y \mid y \in \mathbb{R}, y > 0\}$
6. a) none **b)** none **c)** none **d)** $x = -1$, $y = 0$
e) no asymptotes **f)** $x = -3$, $x = 3$, $y = 0$ **g)** $y = 0$
7. a) increasing: $-\infty < x < 0$, $2 < x < \infty$;
decreasing: $0 < x < 2$ **b)** increasing: $-2 < x < 0$,
$2 < x < \infty$; decreasing: $-\infty < x < -2$, $0 < x < 2$

8. a) $f'(x) = 10x - 7$ **b)** $\dfrac{dy}{dx} = 3x^2 - 4x + 4$

c) $f'(x) = -\dfrac{1}{x^2}$ **d)** $\dfrac{dy}{dx} = \dfrac{20x}{(x^2+1)^2}$

9. $V(x) = 4x^3 - 200x^2 + 2400x$, $0 < x < 20$

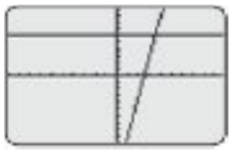
10. $SA(r) = 2\pi r^2 + \dfrac{2000}{r}$ **11. a)** odd **b)** even **c)** even
d) neither **12. a)** odd **b)** neither **c)** even **d)** neither
e) odd **f)** even

3.1 Increasing and Decreasing Functions, pages 156–158

1. a) $x = 3$ **b)** $x = 1$, $x = -9$ **c)** $x = -2$, $x = 2$
d) $x = 6$, $x = 0$ **e)** $x = -1 \pm \sqrt{5}$ **f)** $x = -4$, $x = 2$, $x = 5$
g) $x = -3$, $x = -2$, $x = 2$ **h)** $x = -1$, $x = 0$, $x = 1$
2. a) increasing: $x < 3$; decreasing: $x > 3$
b) increasing: $x > 1$ and $x < -9$; decreasing: $-9 < x < 1$
c) increasing: $x < -2$ and $x > 2$; decreasing: $-2 < x < 2$
d) increasing: $x > 6$; decreasing: $x < 0$, $0 < x < 6$
e) increasing: $x < -1 - \sqrt{5}$, $x > -1 + \sqrt{5}$;
decreasing: $-1 - \sqrt{5} < x < -1 + \sqrt{5}$
f) increasing: $-4 < x < 2$, $x > 5$; decreasing: $x < -4$,
$2 < x < 5$ **g)** increasing: $-3 < x < -2$, $x > 2$;
decreasing: $x < -3$, $-2 < x < 2$ **h)** increasing: $x < -1$,
$0 < x < 1$, $x > 1$ decreasing: $-1 < x < 0$
3. a) i) $f'(x) = 6$

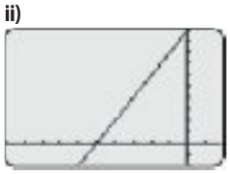
ii)

iv)

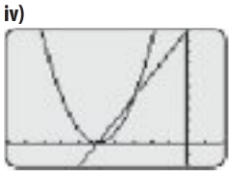


iii) always increasing
b) i) $f'(x) = 2x + 10$

ii)



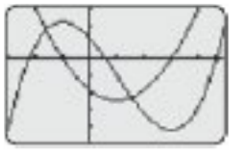
iv)



iii) increasing: $x > -5$; decreasing: $x < -5$
c) i) $f'(x) = 3x^2 - 6x - 9$

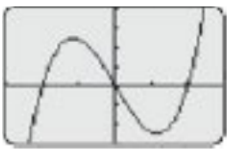
ii)

iv)

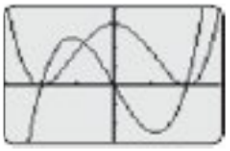


iii) increasing: $x < -1$, $x > 3$; decreasing: $-1 < x < 3$
d) i) $f'(x) = 4x^3 - 16x$

ii)



iv)



iii) increasing: $-2 < x < 0$, $x > 2$; decreasing: $x < -2$,
$0 < x < 2$ **e) i)** $f'(x) = 2 - 2x$

ii)

iv)

iii) increasing: $x < 1$; decreasing: $x > 1$
f) i) $f'(x) = 3x^2 + 2x - 1$

ii)

iv)