Appendix F

Answers to Selected Exercises

1 · Functions and Their Graphs

1.1 · Linear Models

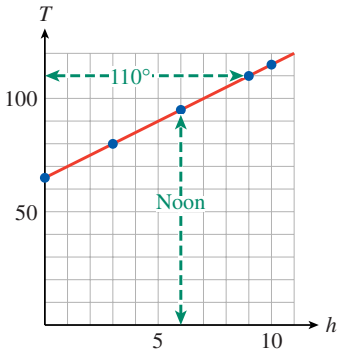
1.1.7 · Linear Models (Homework 1.1)

1.1.7.1.
Answer.

h	0	3	6	9	10
T	65	80	95	110	115

a $T = 65 + 5h$

b



c $95°$

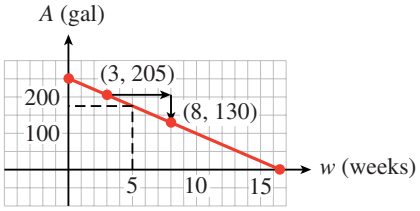
d 3 p.m.

1.1.7.3.
Answer.

w	0	4	8	12	16
A	250	190	130	70	10

a $A = 250 - 15w$

b



c 75 gallons

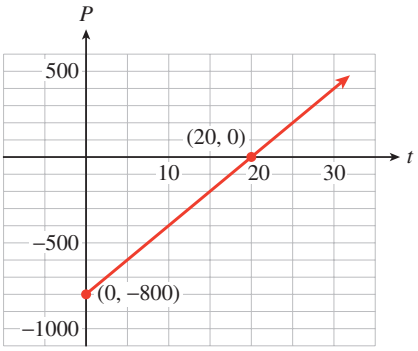
d Until the fifth week

1.1.7.5.

Answer.

a $P = -800 + 40t$

b $(0, -800)$, $(20, 0)$



c The P-intercept, -800, is the initial ($t = 0$) value of the profit. Phil and Ernie start out \$800 in debt. The t-intercept, 20, is the number of hours required for Phil and Ernie to break even.

1.1.7.7.

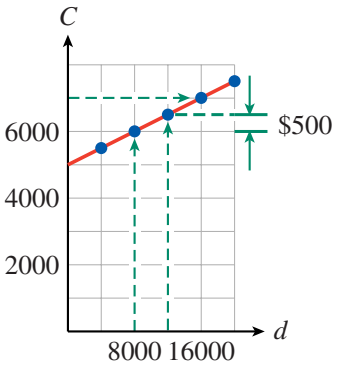
Answer.

a $C = 5000 + 0.125d$

b Complete the table of values.

Miles Driven	4000	8000	12,000	16,000	20,000
Cost (\$)	5500	6000	6500	7000	7500

c

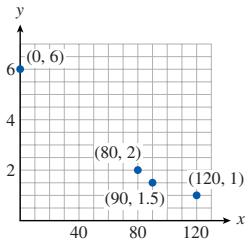


d \$500

e More than 16,000 miles

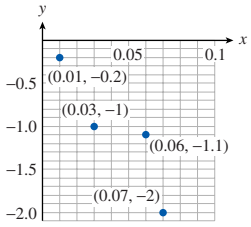
1.1.7.9.

Answer.



1.1.7.11.

Answer.

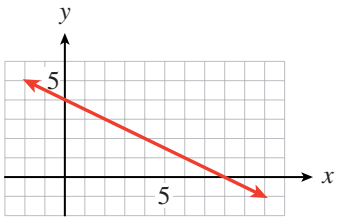


1.1.7.13.

Answer.

a $(8, 0), (0, 4)$

b

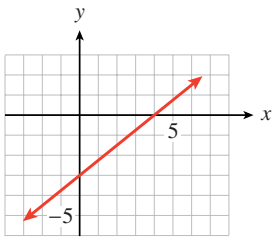


1.1.7.15.

Answer.

a $(4, 0), (0, -3)$

b

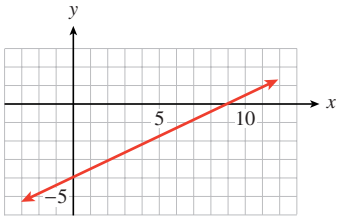


1.1.7.17.

Answer.

a $(9, 0), (0, -4)$

b

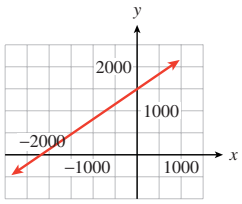


1.1.7.19.

Answer.

a $(-2250, 0), (0, 1500)$

b

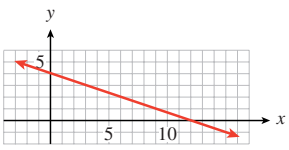


1.1.7.21.

Answer.

a $(12, 0), (0, 4)$

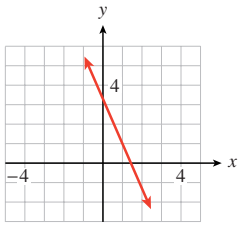
b



1.1.7.23.

Answer.

a $\left(\frac{3}{2}, 0\right), \left(0, \frac{11}{3}\right)$

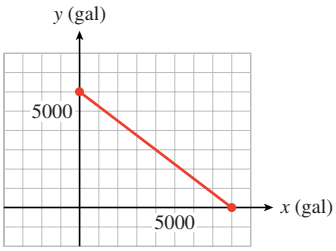
b 

1.1.7.25.

Answer.

a $\$2.40x$, $\$3.20y$

b $2.40x + 3.20y = 19,200$

c 

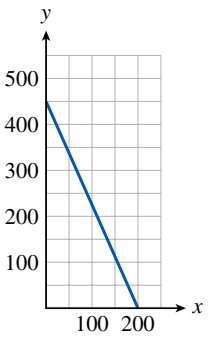
d The y-intercept, 6000 gallons, is the amount of premium that the gas station owner can buy if he buys no regular. The x-intercept, 8000 gallons, is the amount of regular he can buy if he buys no premium.

1.1.7.27.

Answer.

a $9x$ mg, $4y$ mg

b $9x + 4y = 1800$

c 

d The x-intercept, 200 grams, tells how much fig Delbert should eat if he has no bananas, and the y-intercept, 450 grams, tells how much banana he should eat if he has no figs.

1.1.7.29.

Answer.

a $(3, 0), (0, 5)$

b $\left(\frac{1}{2}, 0\right), \left(0, \frac{-1}{4}\right)$

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

d $(p, 0), (0, q)$

e The value of a is the x-intercept, and the value of b is the y-intercept.

1.1.7.31.

Answer.

a $(0, b)$

b $\left(\frac{-b}{m}, 0\right)$, if $m \neq 0$

1.1.7.33.

Answer. $-2x + 3y = 2400$

1.1.7.35.

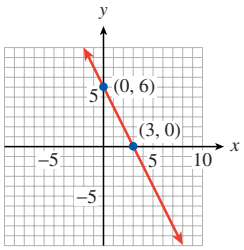
Answer. $3x + 400y = 240$

1.1.7.37.

Answer.

a $y = 6 - 2x$

b

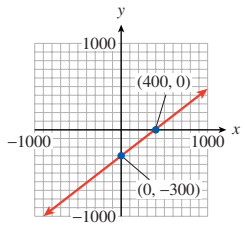


1.1.7.39.

Answer.

a $y = \frac{3}{4}x - 300$

b

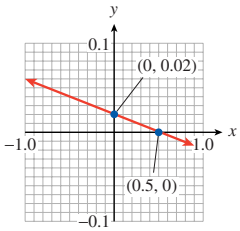


1.1.7.41.

Answer.

a $y = 0.02 - 0.04x$

b

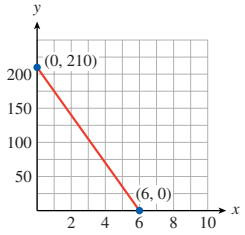


1.1.7.43.

Answer.

a $y = 210 - 35x$

b



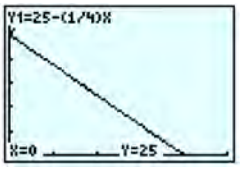
1.1.7.45.

Answer.

a $(100, 0), (0, 25)$

b $y = 25 - \frac{1}{4}x$

c



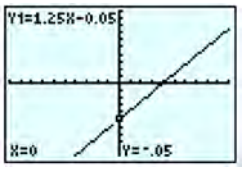
1.1.7.47.

Answer.

a $(0.04, 0), (0, -0.05)$

b $y = 1.25x - 0.05$

c

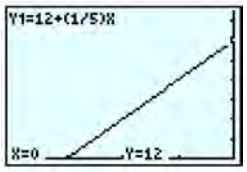


1.1.7.49.

Answer.

a $(-60, 0), (0, 12)$

b $y = 12 + \frac{1}{5}x$

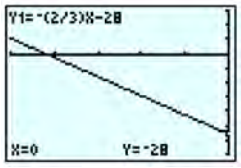
c 

1.1.7.51.

Answer.

a $(-42, 0), (0, -28)$

b $y = \frac{-2}{3}x - 28$

c 

1.2 · Functions

1.2.10 · Functions (Homework 1.2)

1.2.10.1.

Answer. Function; the tax is determined by the price of the item.

1.2.10.3.

Answer. Not a function; incomes may differ for same number of years of education.

1.2.10.5.

Answer. Function; weight is determined by volume.

1.2.10.7.

Answer. Input: items purchased; output: price of item. Yes, a function because each item has only one price.

1.2.10.9.

Answer. Input: topics; output: page or pages on which topic occurs. No, not a function because the same topic may appear in more than one page.

1.2.10.11.

Answer. Input: students' names; output: students' scores on quizzes, tests, etc. No, not a function because the same student can have different grades on different tests.

1.2.10.13.

Answer. Input: person stepping on scales; output: person's weight. Yes, a function because a person cannot have two different weights at the same time.

1.2.10.15.

Answer. No

1.2.10.17.

Answer. Yes

1.2.10.19.

Answer. Yes

1.2.10.21.

Answer. Yes

1.2.10.23.

Answer. No

1.2.10.25.

Answer. Yes

1.2.10.27.

Answer.

a 60

b 37.5

c 30

1.2.10.29.

Answer.

a 15%

b 14%

c $7010–$9169

1.2.10.31.

Answer.

a 67.7: In 1985, 67.7% of 20–24 year old women had not yet had children.

b 1987: Approximately 68% of 20–24 year old women had not yet had children in 1987.

c $f(1997) = 64.9$

1.2.10.33.

Answer.

a No

b 60; no

c Decreasing

1.2.10.35.

Answer.

a 1991

b 1 yr

c 1 yr

d About 7300

1.2.10.37.

Answer.

a Approximately $1920

b $5 or $15

c $7.50 < d < 12.50$

1.2.10.39.

Answer.

a 1968, about $8.70

b 1989, about $5.10

c 1967, approximately 1970

1.2.10.41.

Answer.

a 0

b 10

c -19.4

d $\frac{14}{3}$

1.2.10.43.

Answer.

a 1

b 6

c $\frac{3}{8}$

d 96.48

1.2.10.45.

Answer.

a $\frac{5}{6}$

b 9

c $\frac{-1}{10}$

d $\frac{12}{13} \approx 0.923$

1.2.10.47.

Answer.

a $\sqrt{12}$

b 0

c $\sqrt{3}$

d $\sqrt{0.2} \approx 0.447$

1.2.10.49.

Answer.

a $V(12) = 1120$: After 12 years, the SUV is worth \$1120.

b $t = 12.5$: The SUV has zero value after $12\frac{1}{2}$ years.

c The value 2 years later

1.2.10.51.

Answer.

a $N(6000) = 2000$: 2000 cars will be sold at a price of \$6000.

b $N(p)$ decreases with increasing p because fewer cars will be sold when the price increases.

c $2N(D)$ represents twice the number of cars that can be sold at the current price.

1.2.10.53.

Answer.

a $v(250) = 54.8$ is the speed of a car that left 250-foot skid marks.

b $833\frac{1}{3}$ feet

c $v\left(833\frac{1}{3}\right) = 100$

1.2.10.55.

Answer.

a June 21–24, June 29–July 3, July 8–14

b June 17–21, June 25–29, July 4–7

c June 22–24, June 27, June 29–July 4, July 8–14

d Avalanches occur when temperatures rise above freezing immediately after snowfall.

1.2.10.57.

Answer.

a No

b Yes

c Moving downwards on the graph corresponds to moving downwards in the ocean.

1.2.10.59.

Answer.

a $27a^2 - 18a$

b $3a^2 + 6a$

c $3a^2 - 6a + 2$

d $3a^2 + 6a$

1.2.10.61.

Answer.

a 8

b 8

c 8

d 8

1.2.10.63.

Answer.

a $8x^3 - 1$

b $2x^3 - 2$

c $x^6 - 1$

d $x^6 - 2x^3 + 1$

1.2.10.65.

Answer.

a a^6

b a^{12}

c a^3b^3

d $a^3 + 3a^2b + 3ab^2 + b^3$

1.2.10.67.

Answer.

a $96a^5$

b $6a^5$

c $3a^{10}$

d $9a^{10}$

1.2.10.69.

Answer.

a 11

b 13

c $3a + 3b -$

4

d $3a + 3b - 2$

This function does NOT satisfy $f(a+b) = f(a) + f(b)$.

1.2.10.71.

Answer.

a 19

b 28

c $a^2 + b^2 +$

6

d $a^2 + 2ab + b^2 + 3$

This function does NOT satisfy $f(a+b) = f(a) + f(b)$.

1.2.10.73.

Answer.

a $\sqrt{3} + 2$

b $\sqrt{6}$

c $\sqrt{a+1} + \sqrt{b+1}$

d $\sqrt{a+b+1}$

This function does NOT satisfy $f(a+b) = f(a) + f(b)$.

1.2.10.75.

Answer.

a $\frac{-5}{3}$ $\frac{-2}{b}$

b $\frac{-2}{5}$

c $\frac{-2}{a} -$

d $\frac{-2}{a+b}$

This function does NOT satisfy $f(a+b) = f(a) + f(b)$.

1.2.10.77.

Answer.

a

x	0	10	20	30	40	50	60	70	80	90
$f(x)$	800	840	840	800	720	600	440	240	0	-280
-600										

$a = 50$ and $b = 60$

b

x	50	51	52	53	54	55	56	57	58
$f(x)$	600	585.8	571.2	556.2	540.8	525	508.8	492.2	475.2

$c = 56$ and $d = 57$

c

x	56	56.1	56.2	56.3	56.4	56.5	56.6
$f(x)$	508.8	507.158	505.512	503.862	502.208	500.55	498.888

$p = 56.5$ and $q = 56.6$

d $s = 56.55$

e $f(56.55) = 499.7195$

1.2.10.79.

Answer. 94.85

1.3 · Graphs of Functions

1.3.6 · Graphs of Functions (Homework 1.3)

1.3.6.1.

Answer.

a $-2, 0, 5$

b 2

c $h(-2) = 0,\ h(1) = 0,\ h(0) = -2$

d 5

e 3

f Increasing: $(-3, 0)$ and $(1, 3)$; decreasing: $(0, 1)$ and $(3, 5)$

1.3.6.3.

Answer.

a $-1, 2$

b $3, -1.3$

c $R(-2) = 0,\ R(2) = 0,\ R(4) = 0,\ R(0) = 4$

d Max: 4; min: -5

e Max at $p = 0$; min at $p = 5$

f Increasing: $(-3, 0)$ and $(1, 3)$; decreasing: $(0, 1)$ and $(3, 5)$

1.3.6.5.

Answer.

a $0, \frac{1}{2}, 0$

b 0.9

c $\frac{-5}{6}, \frac{-1}{6}, \frac{7}{6}, \frac{11}{6}$

d Max: 1; min: -1

e Max at $x = -1.5, 0.5$; min at $x = -0.5, 1.5$

1.3.6.7.

Answer.

a $2, 2, 1$

b $-6 \le s < -4$ or $0 \le s < 2$

c Max: 2; min: -1

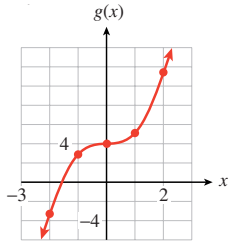
d Max for $-3 \le s < -1$ or $3 \le s < 5$; min for $-6 \le s < -4$ or $0 \le s < 2$

1.3.6.9.

Answer. (a) and (d)

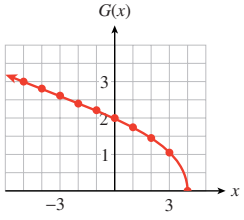
1.3.6.11.

Answer.



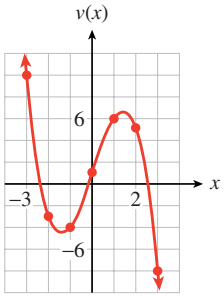
1.3.6.13.

Answer.



1.3.6.15.

Answer.



1.3.6.17.

Answer.

a $f(1000) = 1495$: The speed of sound at a depth of 1000 meters is approximately 1495 meters per second.

b $d = 570$ or $d = 1070$: The speed of sound is 1500 meters per second at both a depth of 570 meters and a depth of 1070 meters.

c The slowest speed occurs at a depth of about 810 meters and the speed is about 1487 meters per second, so $f(810) = 1487$.

d f increases from about 1533 to 1541 in the first 110 meters of depth, then drops to about 1487 at 810 meters, then rises again, passing 1553 at a depth of about 1600 meters.

1.3.6.19.

Answer.

a $f(1985) = 41$: The federal debt in 1985 was about 41% of the gross domestic product.

b $t = 1942$ or $t = 1955$: The federal debt was 70% of the gross domestic product in 1942 and 1955.

c In about 1997, the debt was about 67% of the gross domestic product, so $f(1997) \approx 67.3$.

d The percentage basically dropped from 1946 to 1973, but there were small rises around 1950, 1954, 1958, and 1968, so the longest time interval was from 1958 to 1967.

1.3.6.21.

Answer.

a i $x = -3$
ii $x < -3$
iii $x > -3$

b I $x = -3$
II $x < -3$
III $x > -3$

c On the graph of $y = -2x + 6$, a value of y is the same as a value of $-2x + 6$, so parts (a) and (b) are asking for the same x's.

1.3.6.23.

Answer.

a $x = 0.6$

b $x = -0.4$

c $x > 0.6$

d $x < -0.4$

1.3.6.25.

Answer.

a $x = -1$ or $x = 1$

b Approximately $-3 \leq x \leq -2$ or $2 \leq x \leq 3$

1.3.6.27.

Answer.

a 3.5

b $-2.2, -1.2, 3.4$

c $p < -3.1$ or $0.3 < p < 2.8$

d $0.5 < B < 5.5$

e $p < -1.7$ or $p > 1.7$

1.3.6.29.

Answer.

a i $-2, 2$

ii $-2.8, 0, 2.8$

iii $-2.5 < q < -1.25$ or $1.25 < q < 2.5$

b $-2 < q < 0$ or $q > 2$

1.3.6.31.

Answer.

a He has an error: $f(-3)$ cannot have both the value 5 and also the value -2, and $f(-1)$ cannot have both values 2 and -4.

b Her readings are possible for a function: each input has only one output.

1.3.6.33.

Answer.

a

x	-4	-2	3	5
$g(x)$	4.5	5.7	5.2	3.3

b $-4.8, 4.8$

1.3.6.35.

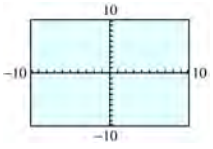
Answer.

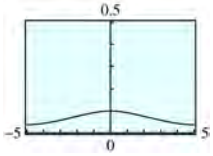
a $(-1.6, 4.352), (1.6, -4.352)$

b $F(-1.6) = 4.352$; $F(1.6) = -4.352$

1.3.6.37.

Answer.

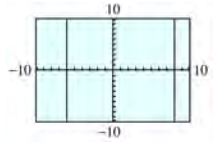
a 

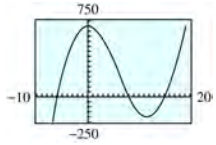
b 

The curve cannot be distinguished from the x-axis in the standard window because the values of y are closer to zero than the resolution of the calculator can display. The second window provides sufficient resolution to see the curve.

1.3.6.39.

Answer.

a 

b 

The curve looks like two vertical lines in the standard window because that window covers too small a region of the plane. The second window allows us to see the turning points of the curve.

1.3.6.41.

Answer.

a $x = 4$ b $x = -5$ c $x > 1$ d $x < 14$

1.3.6.43.

Answer.

a $x = 11$ b $x = -10$ c $x \geq -5$ d $x \leq 8$

1.3.6.45.

Answer.

a $x = 4$ b $x < 22$

1.3.6.47.

Answer.

a $x = 20$ b $x \leq 7$

1.3.6.49.

Answer.

a $-15, 5, 20$ b $-13, 2, 22$

1.4 · Slope and Rate of Change

1.4.9 · Slope and Rate of Change (Homework 1.4)

1.4.9.1.

Answer. Anthony

1.4.9.3.

Answer. Bob's driveway

1.4.9.5.

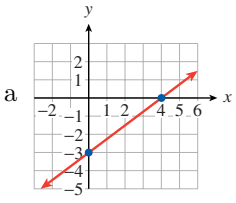
Answer. -1

1.4.9.7.

Answer. $\dfrac{-2}{3}$

1.4.9.9.

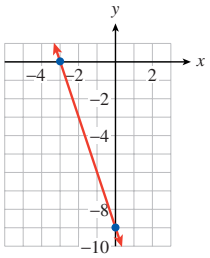
Answer.

a 

b $\dfrac{3}{4}$

1.4.9.11.

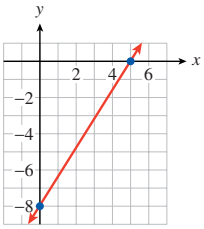
Answer.

a 

b -3

1.4.9.13.

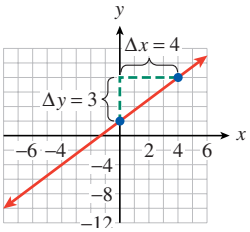
Answer.

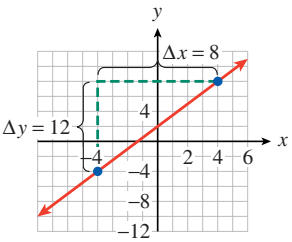
a 

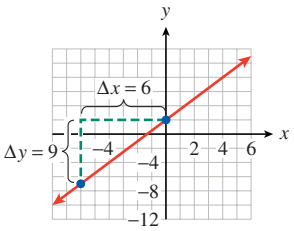
b $\frac{8}{5}$

1.4.9.15.

Answer.

a 

b 

c 

1.4.9.17.

Answer.

a i -3 ii 6 iii $\frac{-3}{2}$ iv $\frac{9}{2}$

b i -4 ii 8 iii $\frac{8}{3}$ iv $\frac{4}{3}$

1.4.9.19.

Answer. $\frac{100}{7}$ ft ≈ 14.286 ft ≈ 14 ft 3.4 in

1.4.9.21.

Answer.

a IV b III c II d I

1.4.9.23.

Answer. $\frac{3}{4}$

1.4.9.25.

Answer. -4000

1.4.9.27.

Answer.

a $\frac{5}{2}$

b

x	y
3	$\frac{7}{2}$
6	11

1.4.9.29.

Answer.

a -3

b

x	y
-1	**30**
5	12

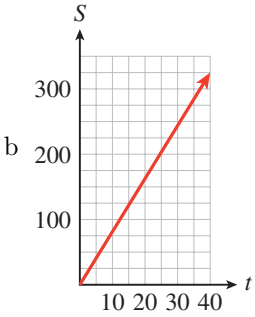
1.4.9.31.

Answer.

a

t	4	8	20	40
S	32	64	160	320

b



c 8 dollars/hour

d The typist is paid \$8 per hour.

1.4.9.33.

Answer.

a 1250 barrels/day

b The slope indicates that oil is pumped at a rate of 1250 barrels per day.

1.4.9.35.

Answer.

a -6 liters/day

b The slope indicates that the water is diminishing at a rate of 6 liters per day.

1.4.9.37.

Answer.

a 12 inches/foot

b The slope gives the conversion rate of 12 inches per foot.

1.4.9.39.

Answer.

a 4 dollars/kilogram

b The slope gives the unit price of \$4 per kilogram

1.4.9.41.

Answer. (a)

1.4.9.43.

Answer.

a Yes, the slope between any two points is $\frac{1}{2}$.

b 0.5 grams of salt per degree Celsius

1.4.9.45.

Answer.

a Yes

b 2π

1.4.9.47.

Answer.

a $\dfrac{1500 \text{ meters}}{1 \text{ second}}$

b 3375 meters

1.4.9.49.

Answer.

a The distances are known.

b 5.7 km per second

1.4.9.51.

Answer.

a About 18°C

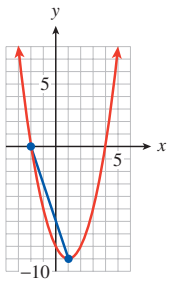
b 0.3 km to 0.4 km

c About -28°C per kilometer

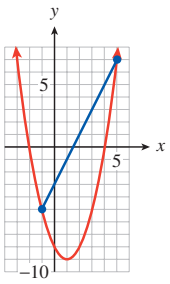
1.4.9.53.

Answer.

a -3



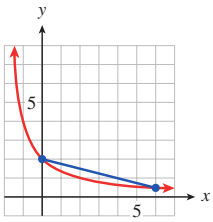
b 2



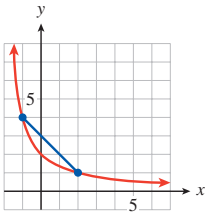
1.4.9.55.

Answer.

a $\dfrac{-1}{4}$



b -1



1.4.9.57.

Answer.

a $(1, F(1)), (4, F(4)); \quad F(4) - F(1)$

b $(r, f(r)), (s, f(s)); \quad f(s) - f(r)$

1.4.9.59.

Answer.

a $(2, H(2)), (3, H(3)); \quad H(3) - H(2)$

b $(a, g(a)), (b, g(b)); \quad g(b) - g(a)$

1.4.9.61.

Answer.

a $(c, s(c)), (d, s(d)); \quad s(c)(d - c)$

b $(x_1, q(x_1)), (x_2, q(x_2)); \quad q(x_2)(x_2 - x_1)$

1.4.9.63.

Answer.

a $(1, f(1)), (5, f(5)); \quad \dfrac{f(5) - f(1)}{4}$

b $(-1, f(-1)), (2, f(2)); \quad \dfrac{f(2) - f(-1)}{3}$

1.4.9.65.

Answer.

a $(a, f(a)), (b, f(b)); \quad \dfrac{f(b) - f(a)}{b - a}$

b $(a, f(a)), (a + \Delta x, f(a + \Delta x)); \quad \dfrac{f(a + \Delta x) - f(a)}{\Delta x}$

1.5 · Linear Functions

1.5.6 · Linear Functions (Homework 1.5)

1.5.6.1.

Answer.

a $y = \dfrac{1}{2} - \dfrac{3}{2}x$

b Slope $\dfrac{-3}{2}$, y-intercept $\dfrac{1}{2}$

1.5.6.3.

Answer.

a $y = \dfrac{1}{9} - \dfrac{1}{6}x$

b Slope $\dfrac{-1}{6}$, y-intercept $\dfrac{1}{9}$

1.5.6.5.

Answer.

a $y = -22 + 14x$

b Slope 14, y-intercept -22

1.5.6.7.

Answer.

a $y = -29$

b Slope 0, y-intercept -29

1.5.6.9.

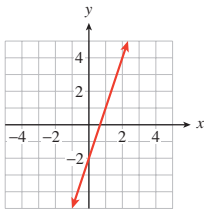
Answer.

a $y = \dfrac{49}{3} - \dfrac{5}{3}x$

b Slope $\dfrac{-5}{3}$, y-intercept $\dfrac{49}{3}$

1.5.6.11.

Answer.

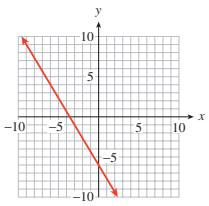
a 

b $y = -2 + 3x$

c $\dfrac{2}{3}$

1.5.6.13.

Answer.

a 

b $y = -6 + \dfrac{5}{3}x$

c $\dfrac{-18}{5}$

1.5.6.15.

Answer. 5

1.5.6.17.

Answer. $\dfrac{-1}{4}$

1.5.6.19.

Answer. $m = \dfrac{-A}{B}$, x-intercept $\left(\dfrac{C}{A}, 0\right)$, y-intercept $\left(0, \dfrac{C}{B}\right)$

1.5.6.21.

Answer.

a $a = 100 + 150t$

b The slope tells us that the skier's altitude is increasing at a rate of 150 feet per minute, the vertical intercept that the skier began at an altitude of 200 feet.

1.5.6.23.

Answer.

a $G = 25 + 12.5t$

b The slope tells us that the garbage is increasing at a rate of 12.5 tons per year, the vertical intercept that the dump already had 25 tons (when the new regulations went into effect).

1.5.6.25.

Answer.

a $M = 7000 - 400w$

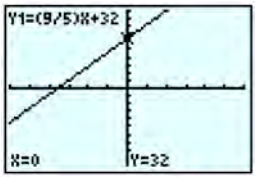
b The slope tells us that Tammy's bank account is diminishing at a rate of \$400 per week, the vertical intercept that she had \$7000 (when she lost all sources of income).

1.5.6.27.

Answer.

a $50°$F

b $-20°$C

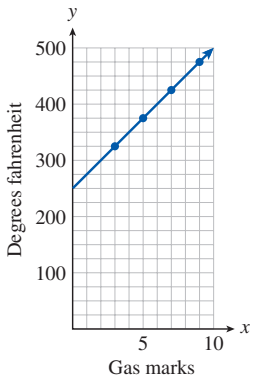
c 

d The slope, $\frac{9}{5} = 1.8$, tells us that Fahrenheit temperatures increase by $1.8°$ for each increase of $1°$ Celsius.

e C-intercept $\left(-17\frac{7}{9}, 0\right)$: $-17\frac{7}{9}{}^{\circ}$ C is the same as $0°$F; F-intercept $(0, 32)$: $0°$C is the same as $32°$F.

1.5.6.29.

Answer.

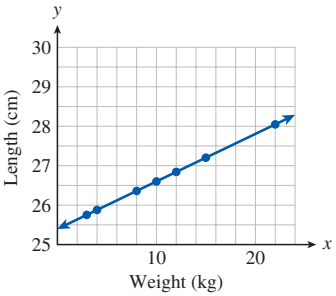
a 

b $m = 25,\ b = 250$

c $y = 250 + 25x$

1.5.6.31.

Answer.

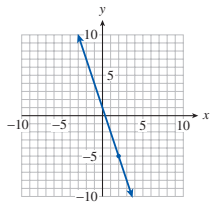
a 

b $y = 0.12x + 25.4$

c 18 kg

1.5.6.33.

Answer.

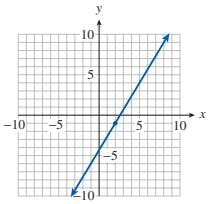
a 

b $y + 5 = -3(x - 2)$

c $y = 1 - 3x$

1.5.6.35.

Answer.

a 

b $y + 1 = \frac{5}{3}(x - 2)$

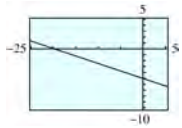
c $y = \frac{-13}{3} + \frac{5}{3}x$

1.5.6.37.

Answer.

a $y + 3.5 = -0.25(x + 6.4)$

b $y = -5.1 - 0.25x$

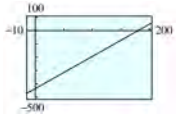
c 

1.5.6.39.

Answer.

a $y + 250 = 2.4(x - 80)$

b $y = -442 + 2.4x$

c 

1.5.6.41.

Answer.

a $m = \frac{2}{3}$

b $y = \frac{-1}{3} + \frac{2}{3}x$

1.5.6.43.

Answer.

a $(-4, 4)$: neither; $(0, 3)$: $y = px + q$; $(3, 2)$: both; $(2, 1)$: neither; $(1, -2)$: $y = tx + v$

b $p = \frac{-1}{3}$, $q = 3$, $t = 2$, $v = -4$

1.5.6.45.

Answer.

a $m = 4,\ b = 40$

b $y = 40 + 4x$

1.5.6.47.

Answer.

a $m = -80,\ b = -2000$

b $P = -2000 - 80t$

1.5.6.49.

Answer.

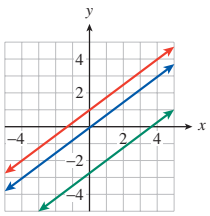
a $m = \frac{1}{4},\ b = 0$

b $V = \frac{1}{4}d$

1.5.6.51.

Answer.

a $y = \frac{3}{4}x,\ y = 1 + \frac{3}{4}x,\ y = -2.7 + \frac{3}{4}x$

b 

The lines are parallel.

1.5.6.53.

Answer.

a II b III c I d IV

1.5.6.55.

Answer.

a III b IV c II d I

1.5.6.57.

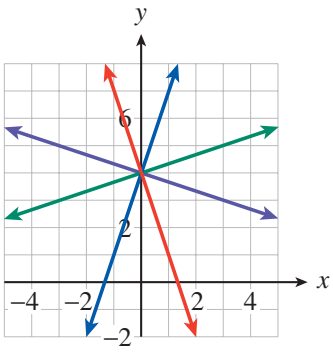
Answer. $m = 2;\ (6, -1)$

1.5.6.59.

Answer. $m = \frac{-4}{3};\ (-5, 3)$

1.5.6.61.

Answer.

a 

b The lines with slope 3 and $\frac{-1}{3}$ are perpendicular to each other, and the lines with slope -3 and $\frac{1}{3}$ are perpendicular to each other.

1.5.6.63.

Answer. $m = -0.0018$ degree/foot, so the boiling point drops with altitude at a rate of 0.0018 degree per foot. $b = 212$, so the boiling point is 212° at sea level (where the elevation $h = 0$).

1.6 · Chapter Summary and Review

1.6.2 · Chapter 1 Review Problems

1.6.2.1.

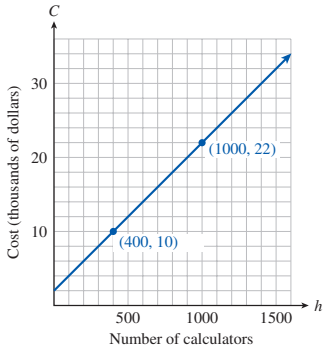
Answer.

a

n	100	500	800	1200	1500
C	4000	12,000	18,000	26,000	32,000

b $C = 20n + 2000$

c



d $\$22,000$

e 400

1.6.2.3.

Answer.

a $R = 2100 - 28t$

b $(75, 0)$, $(0, 2100)$

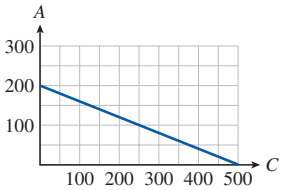
c t-intercept: The oil reserves will be gone in 2080; R-intercept: There were 2100 billion barrels of oil reserves in 2005.

1.6.2.5.

Answer.

a $2C + 5A = 1000$

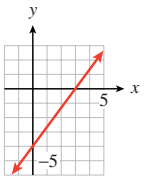
b $(500, 0)$, $(0, 200)$



c C-intercept: If no adult tickets are sold, he must sell 500 children's tickets; A-intercept: If no children's tickets are sold, he must sell 200 adult tickets.

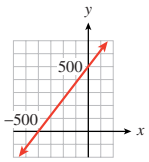
1.6.2.7.

Answer.



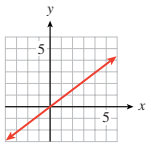
1.6.2.9.

Answer.



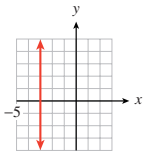
1.6.2.11.

Answer.



1.6.2.13.

Answer.



1.6.2.15.

Answer. A function: Each x has exactly one associated y-value.

1.6.2.17.

Answer. Not a function: The IQ of 98 has two possible SAT scores.

1.6.2.19.

Answer. $N(10) = 7000$: Ten days after the new well is opened, the company has pumped a total of 7000 barrels of oil.

1.6.2.21.

Answer. Function

1.6.2.23.

Answer. Not a function

1.6.2.25.

Answer. $F(0) = 1, \quad F(-3) = \sqrt{37}$

1.6.2.27.

Answer. $h(8) = -6, \quad h(-8) = -14$

1.6.2.29.

Answer.

a $f(-2) = 3, \quad f(2) = 5$

b $t = 1, \quad t = 3$

c t-intercepts $(-3, 0), (4, 0)$; $f(t)$-intercept: $(0, 2)$

d Maximum value of 5 occurs at $t = 2$

1.6.2.31.

Answer.

a $x = \dfrac{1}{2} = 0.5$

b $x = \dfrac{27}{8} \approx 3.4$

c $x > 4.9$

d $x \leq 2.0$

1.6.2.33.

Answer.

a $x \approx \pm 5.8$

b $x = \pm 0.4$

c $-2.5 < x < 0$ or $0 < x < 2.5$

d $x \leq -0.5$ or $x \geq 0.5$

1.6.2.35.

Answer. $H(2a) = 4a^2 + 4a, \quad H(a+1) = a^2 + 4a + 3$

1.6.2.37.

Answer. $f(a) + f(b) = 2a^2 + 2b^2 - 8, \quad f(a+b) = 2a^2 + 4ab + 2b^2 - 4$

1.6.2.39.

Answer. The volleyball

1.6.2.41.

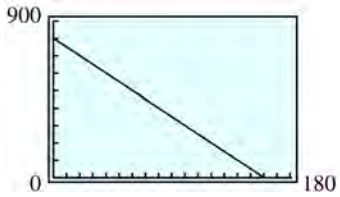
Answer. Highway 33

1.6.2.43.

Answer.

a $B = 800 - 5t$

b



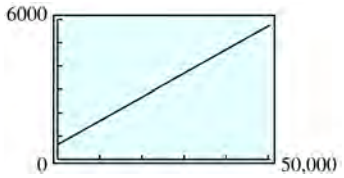
c $m = -5$ thousand barrels/minute: The amount of oil in the tanker is decreasing by 5000 barrels per minute.

1.6.2.45.

Answer.

a $F = 500 + 0.10C$

b



c $m = 0.10$: The fee increases by \$0.10 for each dollar increase in the remodeling job.

1.6.2.47.

Answer. $\dfrac{-3}{2}$

1.6.2.49.

Answer. $\dfrac{-34}{83} \approx -0.4$

1.6.2.51.

Answer. 80 ft

1.6.2.53.

Answer.

a $h(x_2) - h(x_1)$

b $\dfrac{h(x_2) - h(x_1)}{x_2 - x_1}$

1.6.2.55.

Answer. Neither

1.6.2.57.

Answer.

d	V
-5	-4.8
-2	-3
	-1.2
6	1.8
10	4.2

1.6.2.59.

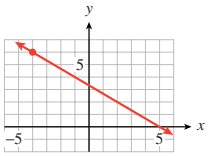
Answer. $m = \frac{1}{2},\ b = \frac{-5}{4}$

1.6.2.61.

Answer. $m = -4,\ b = 3$

1.6.2.63.

Answer.

a 

b $y = \frac{10}{3} - \frac{2}{3}x$

1.6.2.65.

Answer.

a $m = -2,\ b = 3$

b $y = 3 - 2x$

1.6.2.67.

Answer. $\frac{3}{5}$

1.6.2.69.

Answer.

a $\frac{3}{2}$ b $(4, 2)$, no c $(6, 5)$

1.6.2.71.

Answer. $(3, -14),\ (-7, 2)$

1.6.2.73.

Answer.

a $T = 62 - 0.0036h$ b $-46°\text{F}$; $108°\text{F}$ c $-71°\text{F}$

1.6.2.75.

Answer. $y = \frac{2}{5} - \frac{9}{5}x$

1.6.2.77.

Answer.

a

t	0	15
P	4800	6780

b $P = 4800 + 132t$

c $m = 132$ people/year: the population grew at a rate of 132 people per year.

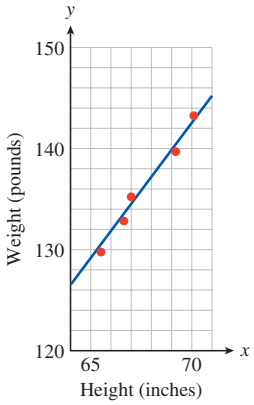
1.6.2.79.

Answer. 6

1.6.2.81.

Answer.

a



b 129 lb, 145 lb

c $y = 2.\overline{6}x - 44.\overline{3}$

d 137 lb

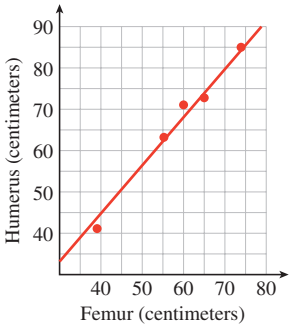
e $y = 2.84x - 55.74$

f 137.33 lb

1.6.2.83.

Answer.

a



b 45 cm

c 87 cm

d $y = 1.2x - 3$

e 69 cm

f $y = 1.197x - 3.660$; 68.16 cm

2 · Modeling with Functions

2.1 · Nonlinear Models

2.1.7 · Nonlinear Models (Homework 2.1)

2.1.7.1.

Answer. $\pm\frac{5}{3}$

2.1.7.3.

Answer. $\pm\sqrt{6}$

2.1.7.5.

Answer. $\pm\sqrt{6}$

2.1.7.7.

Answer. ± 2.65

2.1.7.9.

Answer. ± 5.72

2.1.7.11.

Answer. ± 5.73

2.1.7.13.

Answer. $\pm\sqrt{\frac{Fr}{m}}$

2.1.7.15.

Answer. $\pm\sqrt{\frac{2s}{g}}$

2.1.7.17.

Answer.

a $V = 2.8\pi r^2 \approx 8.8r^2$

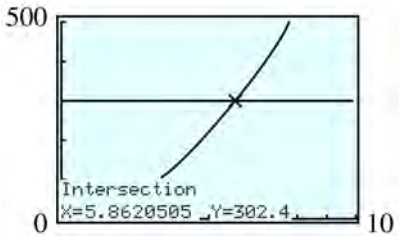
b

r	1	2	3	4	5	6	7	8
V	8.8	35.2	79.2	140.7	219.9	316.7	431.0	563.0

The volume increases by a factor of 4.

c 5.86 cm

d



2.1.7.19.

Answer. 21 in.

2.1.7.21.

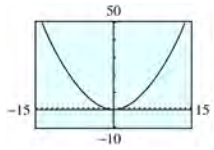
Answer. $\sqrt{1800} \approx 42.4$ m

2.1.7.23.

Answer. $\sqrt{128}$ in. by $\sqrt{128}$ in. ≈ 11.3 in. $\times 11.3$ in.

2.1.7.25.

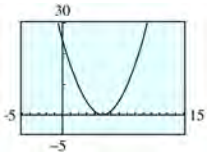
Answer.

a 

b $x = \pm 12$

2.1.7.27.

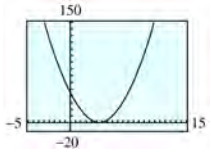
Answer.

a 

b $x = 1$ or $x = 9$

2.1.7.29.

Answer.

a 

b $x = 10$ or $x = -2$

2.1.7.31.

Answer. $5, -1$

2.1.7.33.

Answer. $\frac{5}{2}, \frac{-3}{2}$

2.1.7.35.

Answer. $-2 \pm \sqrt{3}$

2.1.7.37.

Answer. $\frac{1}{2} \pm \frac{\sqrt{3}}{2}$

2.1.7.39.

Answer. $\frac{-2}{9}, \frac{-4}{9}$

2.1.7.41.

Answer. $\frac{7}{8} \pm \frac{\sqrt{8}}{8}$

2.1.7.43.

Answer. 6

2.1.7.45.

Answer. 64

2.1.7.47.

Answer. $\frac{13}{6}$

2.1.7.49.

Answer. 8

2.1.7.51.

Answer. 9

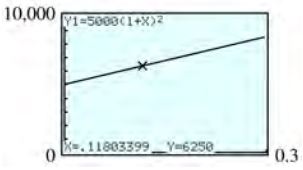
2.1.7.53.

Answer. $\frac{33}{64}$

2.1.7.55.

Answer.

a $B = 5000(1 + r)^2$

c 

b 11.8%

2.1.7.57.

Answer. 8%

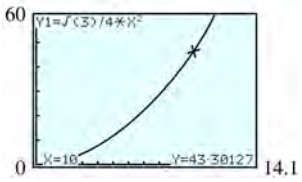
2.1.7.59.

Answer. 7.98 mm

2.1.7.61.

Answer.

a $\sqrt{3} \approx 1.73$ sq cm, $4\sqrt{3} \approx 6.93$ sq cm, $25\sqrt{3} \approx 43.3$ sq cm

b 

c An equilateral triangle with side 5.1 cm has area 11.263 cm^2.

d side ≈ 6.8 cm

e $\frac{\sqrt{3}}{4}s^2 = 20$; $s \approx 6.8$

f ≈ 20 cm

2.1.7.63.

Answer. $\pm\sqrt{\frac{bc}{a}}$

2.1.7.65.

Answer. $a \pm 4$

2.1.7.67.

Answer. $\frac{-b \pm 3}{a}$

2.1.7.69.

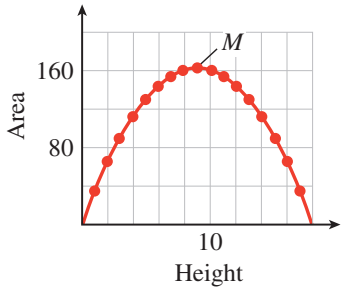
Answer.

a

Height	Base	Area
1	34	34
2	32	64
3	30	90
4	28	112
5	26	130
6	24	144
7	22	154
8	20	160
9	18	162

Height	Base	Area
10	16	160
11	14	154
12	12	144
13	10	130
14	8	112
15	6	90
16	4	64
17	2	34
18	0	0

b



c 162 sq ft, with base 18 ft, height 9 ft

d Base: $36 - 2x$; area: $x(36 - 2x)$

e See (a)

f 6.5 ft or 11.5 ft

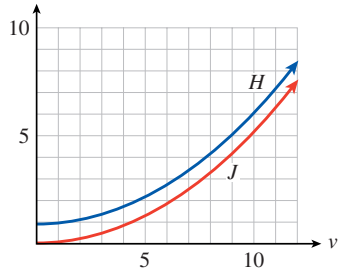
2.1.7.71.

Answer.

a

v	0	1	2	3	4	5	6	7	8	9	10	11
J	0	0.05	0.2	0.46	0.82	1.28	1.84	2.5	3.27	4.13	5.1	6.17

b



c

v	0	1	2	3	4	5	6	7	8	9	10	11
H	0.9	0.95	1.1	1.36	1.72	2.18	2.74	3.4	4.17	5.03	6.0	7.07

d 5.5 meters

e 10.15 meters per second

2.2 · Some Basic Functions

2.2.7 · Some Basic Functions (Homework 2.2)

2.2.7.1.

Answer.

a -9 b 9

2.2.7.3.

Answer.

a -4 b 20

2.2.7.5.

Answer. -50

2.2.7.7.

Answer. 144

2.2.7.9.

Answer. 1

2.2.7.11.

Answer.

a 2.7 b -2.7 c 1.8 d 2.9

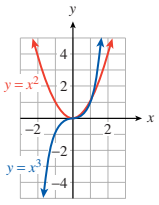
2.2.7.13.

Answer.

a 0.3 b -0.4 c 0.2

2.2.7.15.

Answer.

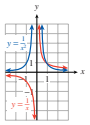
a 

b $x = 0,\ x = 1$

c $(-\infty, 0)$ and $(0, 1)$

2.2.7.17.

Answer.

a 

b $x = 1$

c $(1, +\infty)$

2.2.7.19.

Answer. Graph (b) is the basic graph shifted 2 units down; graph (c) is the basic graph shifted 1 unit up.

2.2.7.21.

Answer. Graph (b) is the basic graph shifted 1.5 units left; graph (c) is the basic graph shifted 1 unit right.

2.2.7.23.

Answer. Graph (b) is the basic graph reflected about the x-axis; graph (c) is the basic graph reflected about the y-axis.

2.2.7.25.

Answer.

a $\sqrt{x}$ c $|x|$ e x^3

b $\sqrt[3]{x}$ d $\dfrac{1}{x}$ f $\dfrac{1}{x^2}$

2.2.7.27.

Answer.

a $x \approx 12$ b $x \approx 18$ c $x < 9$ d $x > 3$

2.2.7.29.

Answer.

a $t \approx -3.1$ b $t \approx 1.5$ c $t < 0.8$ d $-2.4 < t < 0.4$

2.2.7.31.

Answer.

a $x = 41$ b $29 < x < 61$

2.2.7.33.

Answer.

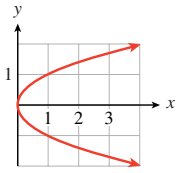
a $x = -5$ or $x = 17$ b $-1 < x < 13$

2.2.7.35.

Answer.

a

x	4	1	$\frac{1}{4}$	0	$\frac{1}{4}$	1	4
y	-2	-1	$-\frac{1}{2}$	0	$\frac{1}{2}$	1	2



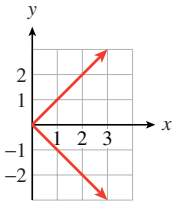
b no

2.2.7.37.

Answer.

a

x	2	1	$\frac{1}{2}$	0	$\frac{1}{2}$	1	2
y	-2	-1	$-\frac{1}{2}$	0	$\frac{1}{2}$	1	2



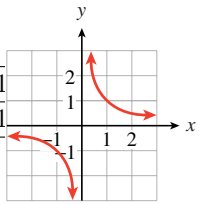
b no

2.2.7.39.

Answer.

a

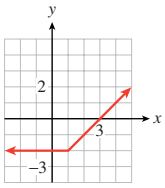
x	$-\frac{1}{2}$	-1	-2	undefined	2	1
y	-2	-1	$-\frac{1}{2}$	0	$\frac{1}{2}$	1



b yes

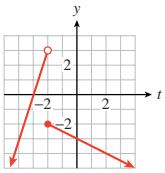
2.2.7.41.

Answer.



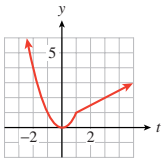
2.2.7.43.

Answer.



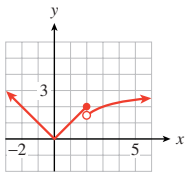
2.2.7.45.

Answer.



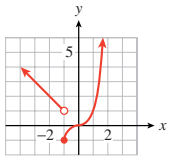
2.2.7.47.

Answer.



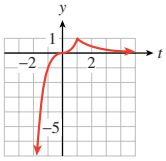
2.2.7.49.

Answer.



2.2.7.51.

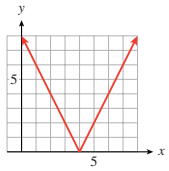
Answer.



2.2.7.53.

Answer.

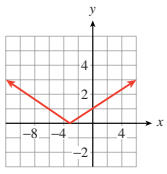
$$f(x) = \begin{cases} 8 - 2x & x < 4 \\ 2x - 8 & x \geq 4 \end{cases}$$



2.2.7.55.

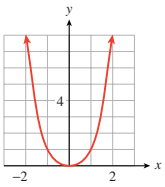
Answer.

$$g(t) = \begin{cases} -1 - \dfrac{t}{3} & t < -3 \\ 1 + \dfrac{t}{3} & t \geq -3 \end{cases}$$



2.2.7.57.

Answer. $F(x) = \begin{cases} -x^3 & x < 0 \\ x^3 & x \geq 0 \end{cases}$



2.2.7.59.

Answer.

a Not always true: $f(1+2) \neq f(1) + f(2)$ because $9 \neq 5$.

b True: $(ab)^2 = a^2b^2$

2.2.7.61.

Answer.

a Not always true: $f(1+2) \neq f(1) + f(2)$ because $\frac{1}{3} \neq \frac{3}{2}$.

b True: $\frac{1}{ab} = \frac{1}{a} \cdot \frac{1}{b}$

2.2.7.63.

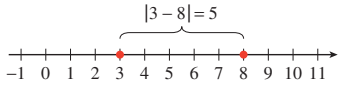
Answer.

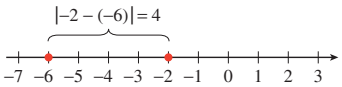
a Not always true (unless $b = 0$): $f(1+2) \neq f(1) + f(2)$ because $3m + b \neq 3m + 2b$.

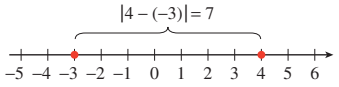
b Not always true: $f(1 \cdot 2) \neq f(1) \cdot f(2)$ because $2m + b \neq 2m^2 + 3mb + b^2$.

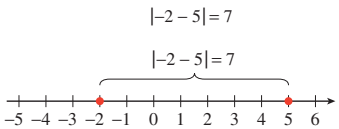
2.2.7.65.

Answer.

a


b


c


d


2.2.7.67.

Answer. The distributive law shows a relationship between multiplication and addition that always holds. The equation $f(a+b) = f(a) + f(b)$ is not about multiplication and may or may not be true.

2.3 · Transformations of Graphs

2.3.5 · Transformations of Graphs (Homework 2.3)

2.3.5.1.

Answer. $y = \sqrt{x+2}$

2.3.5.3.

Answer. $y = x^3 - 1$

2.3.5.5.

Answer. $y = \dfrac{1}{x-4}$

2.3.5.7.

Answer.

a Translate $y = |x|$ by 2 units down.

b 

2.3.5.9.

Answer.

a Translate $y = \sqrt[3]{s}$ by 4 units right.

b 

2.3.5.11.

Answer.

a Translate $y = \dfrac{1}{t^2}$ by 1 unit up.

b 

2.3.5.13.

Answer.

a Translate $y = r^3$ by 2 units left.

b 

2.3.5.15.

Answer.

a Translate $y = \sqrt{d}$ by 3 units down.

b 

2.3.5.17.

Answer.

a Translate $y = \dfrac{1}{v}$ by 6 units left.

b 

2.3.5.19.

Answer. A vertical stretch by a factor of 3: $y = \dfrac{3}{x}$

2.3.5.21.

Answer. A vertical compression, the scale factor is $\dfrac{1}{2}$: $y = \dfrac{1}{2}x^3$

2.3.5.23.

Answer.

a Scale factor $\frac{1}{3}$; $y = |x|$ is compressed vertically by the scale factor.

b 

2.3.5.25.

Answer.

a Scale factor -2; $y = \frac{1}{z^2}$ is reflected over the z-axis and stretched vertically by a factor of 2.

b 

2.3.5.27.

Answer.

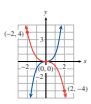
a Scale factor -3; $y = \sqrt{v}$ is reflected over the v-axis and stretched vertically by a factor of 3.

b 

2.3.5.29.

Answer.

a Scale factor $\frac{-1}{2}$; $y = s^3$ is reflected over the s-axis and compressed vertically by a factor of $\frac{1}{2}$.

b 

2.3.5.31.

Answer.

a Scale factor $\frac{1}{3}$; $y = \frac{1}{x}$ is compressed vertically by the scale factor.

b 

2.3.5.33.

Answer.

a vi

b ii

c iv

d i

e v

f iii

2.3.5.35.

Answer.

a Vertical stretch by a factor of 3: $y = 3f(x)$

b Reflection about the x-axis: $y = -f(x)$

c Translation 1 unit right: $y = f(x - 1)$

d Translation 4 units up: $y = f(x) + 4$

2.3.5.37.

Answer.

a Reflection about the v-axis and vertical stretch by a factor of 2: $T = -2h(v)$

b Vertical stretch by a factor of 3: $T = 3h(v)$

c Translation 3 units up: $T = h(v) + 3$

d Translation 3 units left: $T = h(v + 3)$

2.3.5.39.

Answer.

a Translation 2 units up: $y = f(x) + 2$

b Translation 4 units down: $y = f(x) - 4$

c Vertical compression by a factor of $\frac{1}{2}$: $y = \frac{1}{2}f(x)$

d Translation 1 unit right: $y = f(x - 1)$

2.3.5.41.

Answer.

a Translation 1 unit right: $y = f(x - 1)$

b Part (a) is translated 30 units up: $y = f(x - 1) + 30$

c f is reflected about the x-axis and stretched vertically by a factor of 2: $y = -2f(x)$

d Part (c) is translated 10 units down: $y = -2f(x) - 10$

2.3.5.43.

Answer.
$y = \frac{1}{2} \cdot \frac{1}{x^2}$ is a vertical compression with factor $dfrac12$ of $y = \frac{1}{x^2}$.

2.3.5.45.

Answer.
$y = 2\sqrt[3]{x}$ is a vertical stretch with factor 2 of $y = \sqrt[3]{x}$.

2.3.5.47.

Answer.
$y = 3\,|x|$ is a vertical stretch with factor 3 of $y = |x|$.

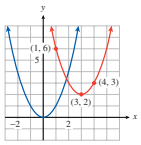
2.3.5.49.

Answer.
$y = \frac{1}{8}x^3$ is a vertical compression with factor $\frac{1}{8}$ of $y = x^3$.

2.3.5.51.

Answer.

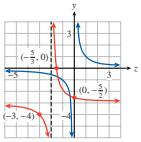
a Translation by 2 units up and 3 units right

b 

2.3.5.53.

Answer.

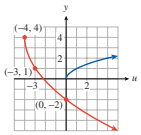
a Translation by 2 units left and 3 units down.

b 

2.3.5.55.

Answer.

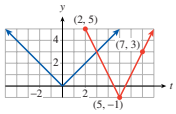
a Reflection across the u-axis, vertical stretch by a factor of 3, translation by 4 units left and 4 units up

b 

2.3.5.57.

Answer.

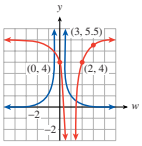
a Vertical stretch by a factor of 2, translation by 5 units right and 1 down

b 

2.3.5.59.

Answer.

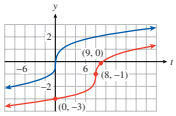
a Reflection across the w-axis, vertical stretch by a factor of 2, translation by 6 units up and 1 unit right

b 

2.3.5.61.

Answer.

a Translation by 8 units right and 1 unit down

b 

2.3.5.63.

Answer.

a Translation by 4 units up and 1 unit right: $y = f(x-1)+4$

b Vertical stretch by a factor of 2 and a translation by 4 units up: $y = 2f(x)+4$

2.3.5.65.

Answer.

a $y = |x|$ translated by 1 unit left and 2 units down

b $y = |x+1|-2$

2.3.5.67.

Answer.

a $y = \sqrt{x}$ reflected about the x-axis and shifted 3 units up

b $y = -\sqrt{x}+3$

2.3.5.69.

Answer.

a $y = x^3$ translated by 3 units right and 1 unit up

b $y = (x-3)^3 + 1$

2.3.5.71.

Answer.

a $y = f(x-20)$: Students scored 20 points higher than Professor Hilbert's class.

b $y = 1.5f(x)$: The class is about 50% larger than Hilbert's, but the classes scored the same.

2.3.5.73.

Answer.

a $y = f(x-5000)$: Taxpayers earn \$5000 more than Californians in each tax rate

b $y = f(x) - 0.2$: Taxpayers pay 0.2% less tax than Californians on the same income.

2.3.5.75.

Answer.

a $y = g(t+2)$: This population has its maximum and minimum two months before the marmots.

b $y = g(t) - 20$: This population remains 20 fewer than that of the marmots.

2.4 · Functions as Mathematical Models

2.4.5 · Functions as Mathematical Models (Homework 2.4)

2.4.5.1.

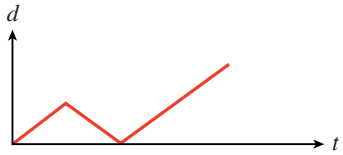
Answer. (b)

2.4.5.3.

Answer. (a)

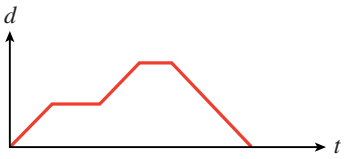
2.4.5.5.

Answer.



2.4.5.7.

Answer.



2.4.5.9.

Answer. (b)

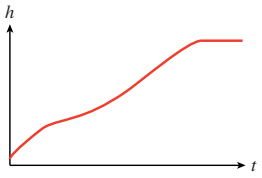
2.4.5.11.

Answer.

a II b IV c I d III

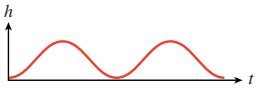
2.4.5.13.

Answer.



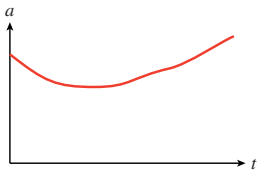
2.4.5.15.

Answer.



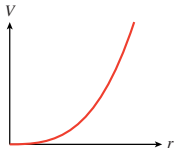
2.4.5.17.

Answer.



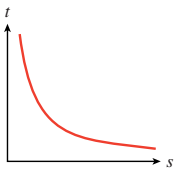
2.4.5.19.

Answer. $y = x^3$ stretched or compressed vertically



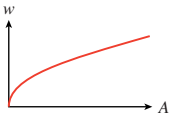
2.4.5.21.

Answer. $y = \dfrac{1}{x}$ stretched or compressed vertically



2.4.5.23.

Answer. $y = \sqrt{x}$



2.4.5.25.

Answer.

a Increasing

b Concave up

2.4.5.27.

Answer.

a Increasing

b Concave down

2.4.5.29.

Answer.

a Increasing, linear (neither concave up nor down)

b C

2.4.5.31.

Answer.

a Increasing, concave down

b F

2.4.5.33.

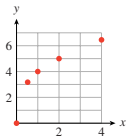
Answer.

a Decreasing, linear (neither concave up nor down)

b D

2.4.5.35.

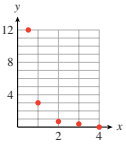
Answer.



$y = 4\sqrt[3]{x}$

2.4.5.37.

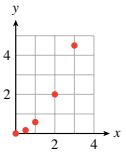
Answer.



$y = 3 \cdot \dfrac{1}{x^2}$

2.4.5.39.

Answer.



$y = 0.5x^2$

2.4.5.41.

Answer.

a Table (4), Graph (C)

b Table (3), Graph (B)

c Table (1), Graph (D)

d Table (2), Graph (A)

2.4.5.43.

Answer.

a III

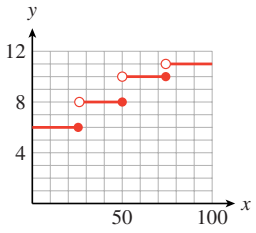
b 3

2.4.5.45.

Answer.

a $S(x) = \begin{cases} 5.95 & x \leq 25 \\ 7.95 & 25 < x \leq 50 \\ 9.95 & 50 < x \leq 75 \\ 10.95 & 75 < x \leq 100 \end{cases}$

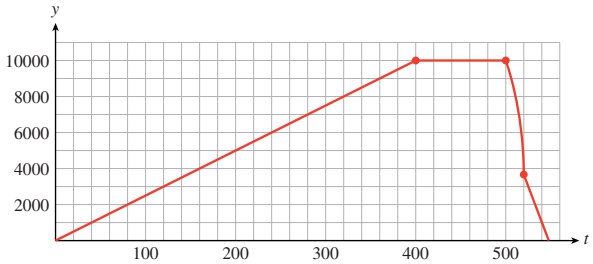
b



2.4.5.47.

Answer.

a



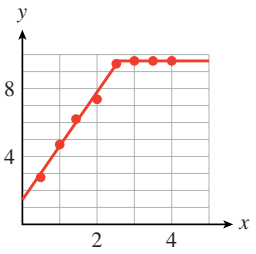
During the first 400 seconds Bob's altitude is climbing with the aircraft; then the aircraft maintains a constant altitude of 10,000 feet for the next 100 seconds; after jumping from the plane, Bob falls for 20 seconds before opening the parachute; he falls at a constant rate after the chute opens.

b 240 seconds (4 minutes) and $500 + \sqrt{250} \approx 515.8$

2.4.5.49.

Answer.

a



b $m \approx 3.2$ mm/cc: The height of precipitate increases by 1 mm for each additional cc of lead nitrate

c $f(x) = \begin{cases} 1.34 + 3.2x & x < 2.6 \\ 9.6 & x \geq 2.6 \end{cases}$

d The increasing portion of the graph corresponds to the period when the reaction was occurring, and the horizontal section corresponds to when the potassium iodide is used up.

2.4.5.51.

Answer.

a II b IV c I d III

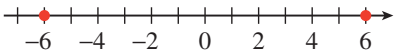
2.5 · The Absolute Value Function

2.5.7 · The Absolute Value Function (Homework 2.5)

2.5.7.1.

Answer.

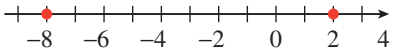
a $|x| = 6$

b 

2.5.7.3.

Answer.

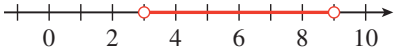
a $|p + 3| = 5$

b 

2.5.7.5.

Answer.

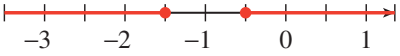
a $|t - 6| < 3$

b 

2.5.7.7.

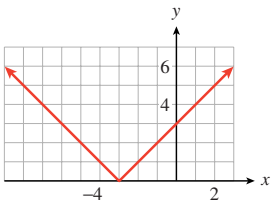
Answer.

a $|b + 1| \geq 0.5$

b 

2.5.7.9.

Answer.



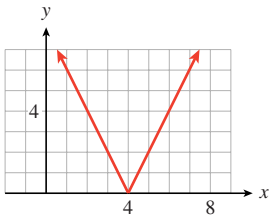
a $x = -5$ or $x = -1$

b $-7 \leq x \leq 1$

c $x < -8$ or $x > 2$

2.5.7.11.

Answer.



a $x = 4$

b No solution

c No solution

2.5.7.13.

Answer. $x = \frac{-3}{2}$ or $x = \frac{5}{2}$

2.5.7.15.

Answer. $q = \frac{-7}{3}$

2.5.7.17.

Answer. $b = -14$ or $b = 10$

2.5.7.19.

Answer. $w = \frac{13}{2}$ or $w = \frac{15}{2}$

2.5.7.21.

Answer. No solution

2.5.7.23.

Answer. No solution

2.5.7.25.

Answer. $\frac{-9}{2} < x < \frac{-3}{2}$

2.5.7.27.

Answer. $d \leq -2$ or $d \geq 5$

2.5.7.29.

Answer. All real numbers

2.5.7.31.

Answer. $1.4 < t < 1.6$

2.5.7.33.

Answer. $T \leq 3.2$ or $T \geq 3.3$

2.5.7.35.

Answer. No solution

2.5.7.37.

Answer. $4.299 < l < 4.301$

2.5.7.39.

Answer. $250 \leq t \leq 350$

2.5.7.41.

Answer. $|T - 5| < 0.3$

2.5.7.43.

Answer. $|D - 100| \leq 5$

2.5.7.45.

Answer. $|g - 0.25| \leq 0.001$

2.5.7.47.

Answer.

a $|t - 200| < 50$, $150 \leq t < 250$

b $|t - 200| < 0.5$, $199.5 \leq t < 200.5$

c $|t - 200| < 0.05$, $199.95 \leq t < 200.05$

2.5.7.49.

Answer.

a $|3x-6| = \begin{cases} -(3x-6) & \text{if } x < 2 \\ 3x-6 & \text{if } x \geq 2 \end{cases}$

b $-(3x-6) \leq 9, \;\; 3x-6 < 9$

c $-1 < x < 5$

d The solutions are the same.

2.5.7.51.

Answer.

a $|2x+5| = \begin{cases} -(2x+5) & \text{if } x < \dfrac{-5}{2} \\ 2x+5 & \text{if } x \geq \dfrac{-5}{2} \end{cases}$

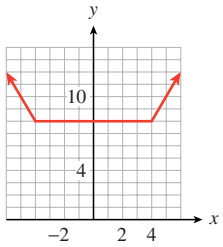
b $-(2x+5) > 7, \;\; 2x+5 > 7$

c $x < -6$ or $x > 1$

d The solutions are the same.

2.5.7.53.

Answer.



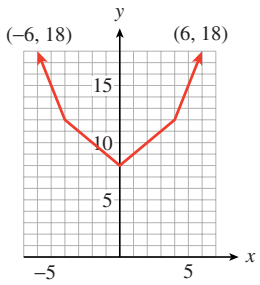
a $f(x) = \begin{cases} -2x, & x < -4 \\ 8, & -4 \leq x \leq 4 \\ 2x, & x > 4 \end{cases}$

b The graphs looks like like a trough. The middle horizontal section is $y = p + q$ for $-p \leq x \leq q$, the left side, $x < -p$, has slope -2 and the right side, $x > q$, has slope 2.

c $g(x) = \begin{cases} -2x + q - p, & x < -p \\ p + q, & -p \leq x \leq q \\ 2x + p - q, & x > q \end{cases}$

2.5.7.55.

Answer.



a $f(x) = \begin{cases} -3x, & x < -4 \\ -x + 8, & -4 \leq x \leq 0 \\ x + 8, & 0 < x < 4 \\ 3x, & x \geq 4 \end{cases}$

b 8

c $p + q$

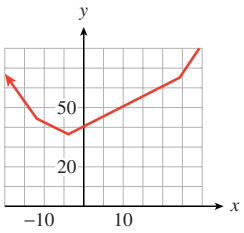
2.5.7.57.

Answer.

a $|x + 12|$, $|x + 4|$, $|x - 24|$

b $f(x) = |x + 12| + |x + 4| + |x - 24|$

c



At x-coordinate -4

2.5.7.59.

Answer. 2 miles east of the river

2.6 · Domain and Range

2.6.6 · Domain and Range (Homework 2.6)

2.6.6.1.

Answer. Domain: $[-5, 3]$; Range: $[-3, 7]$

2.6.6.3.

Answer. Domain: $[-4, 5]$; Range: $[-1, 1) \cup [3, 6]$

2.6.6.5.

Answer. Domain: $[-2, 2]$; Range: $[-1, 1]$

2.6.6.7.

Answer. Domain: $(-5, 5]$; Range: $\{-1, 0, 2, 3\}$

2.6.6.9.

Answer.

a Domain: all real numbers; Range: all real numbers

b Domain: all real numbers; Range: $[0, \infty)$

2.6.6.11.

Answer.

a Domain: all real numbers except zero; Range: $(0, \infty)$

b Domain: all real numbers except zero; Range: all real numbers except zero

2.6.6.13.

Answer. Domain: $[0, 26.2]$; Range: $[90, 300]$

2.6.6.15.

Answer. Domain: $[0, 600]$; Range: $[-90, 700]$

2.6.6.17.

Answer.

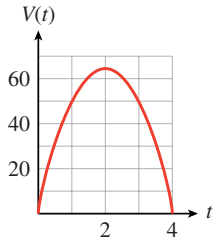
a $V(t) = 6000 - 550t$

b Domain: $[0, 10]$; Range: $[500, 6000]$

2.6.6.19.

Answer.

a

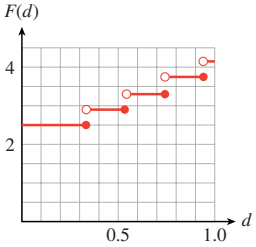


b Domain: $[0, 4]$; Range: $[0, 64]$. The ball reaches a height of 64 feet and hits the ground 4 seconds after being hit.

2.6.6.21.

Answer.

a



b Range: $\{2.50, 2.90, 3.30, 3.70, 4.10\}$

c \$13.30

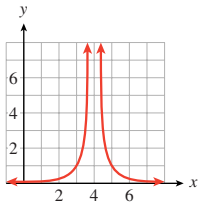
2.6.6.23.

Answer. Domain: nonnegative integers; The range includes all whole number multiples of 2.50 up to $20 \times 2.50 = 50$, all integer multiples of 2.25 from $21 \times 2.25 = 47.25$ to $50 \times 2.25 = 112.50$ and all integer multiples of 2.10 from $51 \times 2.10 = 107.10$ onwards: $0, 2.50, 5.00, 7.50, \ldots, 50, 47.25, 49.50, 51.75, \ldots, 112.50, 107.10, 109.20, 111.30, \ldots$

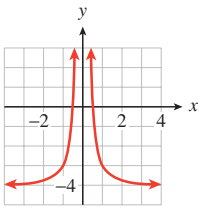
2.6.6.25.

Answer.

a $f(x)$ domain: $x \neq 4$; Range: $(0, \infty)$



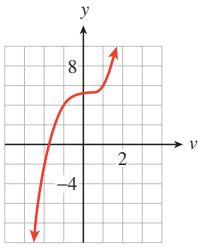
b $h(x)$ domain: $x \neq 0$; Range: $(-4, \infty)$



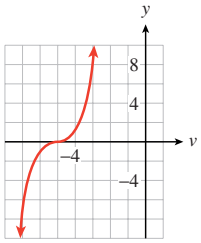
2.6.6.27.

Answer.

a $G(v)$ domain: all real numbers; Range: all real numbers



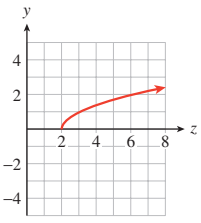
b $H(v)$ domain: all real numbers; Range: all real numbers



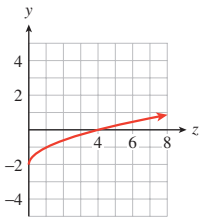
2.6.6.29.

Answer.

a $G(v)$ domain: $[2, \infty)$; Range: $[0, \infty)$



b $H(v)$ domain: $[0, \infty)$; Range: $[-2, \infty)$



2.6.6.31.

Answer.

a Not in range

b $x = -6$ or $x = 2$

2.6.6.33.

Answer.

a $t = -64$

b $t = -8$

2.6.6.35.

Answer.

a $w = \dfrac{1}{2}$

b Not in range

2.6.6.37.

Answer.

a Not in range

b $h = 4$

2.6.6.39.

Answer. Domain: $[-2, 5]$; Range: $[-4, 12]$

2.6.6.41.

Answer. Domain: $[-5, 3]$; Range: $[-15, 1]$

2.6.6.43.

Answer. Domain: $[-2, 2]$; Range: $[-9, 7]$

2.6.6.45.

Answer. Domain: $[-1, 8]$; Range: $[0, 3]$

2.6.6.47.

Answer. Domain: $[-1.25, 2.75]$; Range: $\left[\dfrac{4}{17}, 4\right]$

2.6.6.49.

Answer. Domain: $(3, 6]$; Range: $\left[-\infty, \dfrac{-1}{3}\right]$

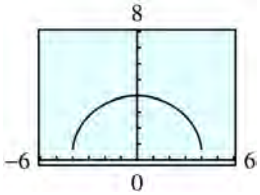
2.6.6.51.

Answer.

a Squaring both sides of the equation gives the equation of the circle centered on the origin with radius 4, but the points in the third and fourth quadrants are extraneous solutions introduced by squaring. (The original equation allowed only $y \geq 0$.)

b Domain: $[-4, 4]$; Range: $[0, 4]$

c



The calculator does not show the graph extending down to the x-axis.

2.6.6.53.

Answer.

a Domain: $x \neq 2$; Range: $(0, \infty)$

b Domain: $x \neq 0$; Range: $(-2, \infty)$

c Domain: $x \neq 3$; Range: $(-5, \infty)$

2.6.6.55.

Answer.

a Domain: all real numbers; Range: $(-\infty, 0)$

b Domain: all real numbers; Range: $(-\infty, 6]$

c Domain: all real numbers; Range: $(-\infty, 6]$

2.6.6.57.

Answer.

a Domain: $[3, 13]$; Range: $[-2, 2]$

b Domain: $[0, 10]$; Range: $[-6, 6]$

c Domain: $[5, 15]$; Range: $[-4, 4]$

2.6.6.59.

Answer.

a Domain: $(0, \infty)$; Range: $(0, 5)$

b Domain: $(-2, \infty)$; Range: $(0, 3)$

c Domain: $(3, \infty)$; Range: $(2, 4)$

2.6.6.61.

Answer.

a $f(x)$

b $g(x)$

2.6.6.63.

Answer.

a $g(x)$

b $f(x)$

2.6.6.65.

Answer. Domain: $[0°, 90°]$; Range: $[12, 24]$

2.7 · Chapter Summary and Review

2.7.2 · Chapter 2 Review Problems

2.7.2.1.

Answer. $x = 1$ or $x = 4$

2.7.2.3.

Answer. $w = -2$ or $w = 4$

2.7.2.5.

Answer. $r = -1 \pm \sqrt{\dfrac{A}{P}}$

2.7.2.7.

Answer. 11%

2.7.2.9.

Answer. $P = 1.001$

2.7.2.11.

Answer. $m = 29$

2.7.2.13.

Answer. $r = 3$

2.7.2.15.

Answer. $\sqrt{12,132} \approx 110$ cm

2.7.2.17.

Answer. -2

2.7.2.19.

Answer. 24

2.7.2.21.

Answer.

a $x = -2$ or $x = 6$

b $(-2, 6)$

c $(-\infty, -2] \cup [6, +\infty)$

2.7.2.23.

Answer.

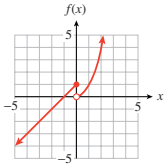
a $x = 0$ or $x = 3$

b $(-\infty, 0) \cup (3, \infty)$

c $(0, 3)$

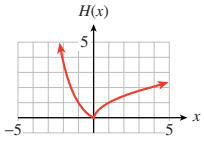
2.7.2.25.

Answer.



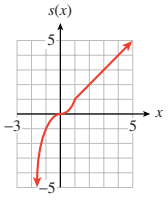
2.7.2.27.

Answer.



2.7.2.29.

Answer.

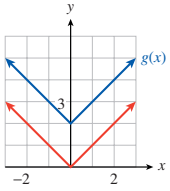


2.7.2.31.

Answer.

a $y = |x|$ shifted up 2 units

b

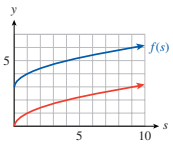


2.7.2.33.

Answer.

a $y = \sqrt{x}$ shifted up 3 units

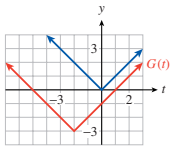
b



2.7.2.35.

Answer.

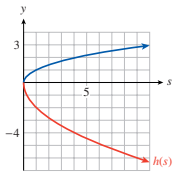
a $y = |x|$ shifted left 2 units and down 3 units

b 

2.7.2.37.

Answer.

a $y = \sqrt{x}$ reflected across the horizontal axis and stretched vertically by a factor of 2

b 

2.7.2.39.

Answer.

a $y = \dfrac{-3}{2} f(t)$

b $y = \dfrac{-3}{2} f(t) + 3$

c $y = \dfrac{-3}{2} f(t+2) + 3$

2.7.2.41.

Answer.

a $y = f(t-1)$

b $y = -f(t-1)$

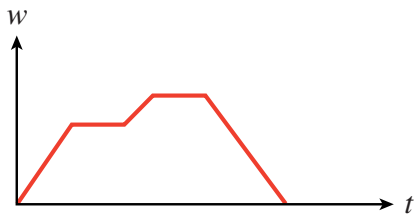
c $y = -f(t-1) + 300$

2.7.2.43.

Answer. $y = (x-2)^2 - 4$

2.7.2.45.

Answer.

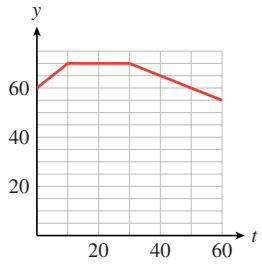


2.7.2.47.

Answer. I (c), II (b), III (a)

2.7.2.49.

Answer. $g(t) = \begin{cases} 60 + t, & 0 \le t < 10 \\ 70, & 10 \le t < 30 \\ 70 - \frac{1}{2}(t - 30), & 30 \le t \le 60 \end{cases}$



2.7.2.51.

Answer. $|x| = 4$

2.7.2.53.

Answer. $|p - 7| < 4$

2.7.2.55.

Answer. $t = \dfrac{6}{5}$ or $t = \dfrac{12}{5}$

2.7.2.57.

Answer. No solutions

2.7.2.59.

Answer. $p = 1$ or $p = 6$

2.7.2.61.

Answer. $\left(\dfrac{-2}{3}, 2\right)$

2.7.2.63.

Answer. $(-\infty, -0.9] \cup [0.1, \infty)$

2.7.2.65.

Answer. $|H - 65.5| < 9.5$

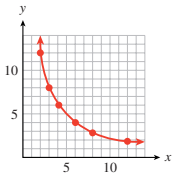
2.7.2.67.

Answer. $[2.05, 2.15]$

2.7.2.69.

Answer.

a



b $g(x) = \dfrac{24}{x}$

2.7.2.71.

Answer.

a

x	0	4	8	14	16	22
y	24	20	16	10	8	2

b $y = 24 - x$

2.7.2.73.

Answer.

a

x	0	1	4	9	16	25
y	0	1	2	3	4	5

b $y = \sqrt{x}$

2.7.2.75.

Answer.

a

x	-3	-2	-1	0	1	2
y	5	0	-3	-4	-3	0

b $y = x^2 - 4$

2.7.2.77.

Answer. Domain: $[-2, 4]$; Range: $[-10, -4]$

2.7.2.79.

Answer. Domain: $(-2, 4]$; Range: $\left[\frac{1}{6}, \infty\right)$

3 · Power Functions

3.1 · Variation

3.1.9 · Variation (Homework 3.1)

3.1.9.1.

Answer.

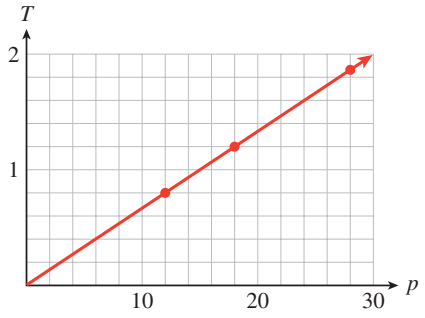
a

Price of item	18	28	12
Tax	1.17	1.82	0.78
Tax/Price	**0.065**	**0.065**	**0.065**

Yes; 6.5%

b $T = 0.065p$

c



3.1.9.3.

Answer.

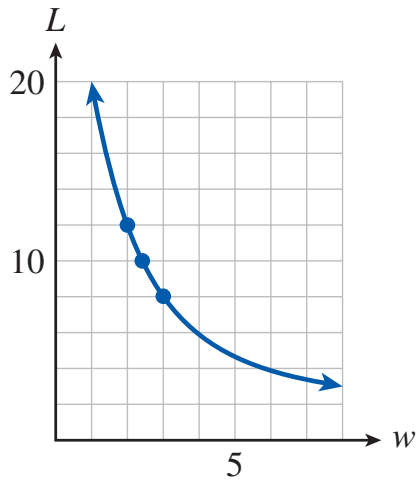
a

Width (feet)	2	2.5	3
Length (feet)	12	9.6	8
Length × width	**24**	**24**	**24**

24 square feet

b $L = \dfrac{24}{w}$

c



3.1.9.5.

Answer.

a The ratio $\frac{y}{x}$ is a constant.

b The product xy is a constant.

3.1.9.7.

Answer.

a

Length	Width	Perimeter	Area
10	8	**36**	**80**
12	8	**40**	**96**
15	8	**46**	**120**
20	8	**56**	**160**

b No

c $P = 16 + 2l$

d Yes

e $A = 8l$

3.1.9.9.

Answer. (b)

3.1.9.11.

Answer. (c)

3.1.9.13.

Answer.

a $m = 0.165w$

w	50	100	200	400
m	**8.25**	**16.5**	**33**	**66**

b 19.8 lb

c 303.03 lb

d It will double.

3.1.9.15.

Answer.

a $L = 0.8125T^2$

T	1	5	10	20
L	**0.8125**	**20.3**	**81.25**	**325**

b 234.8125 ft

c 0.96 sec

d It must be four times as long.

3.1.9.17.

Answer.

a $B = \dfrac{88}{d}$

d	1	2	12	24
B	**88**	**44**	**7.3**	**3.7**

b 8.8 milligauss

c More than 20.47 in

d It is one half as strong.

3.1.9.19.

Answer.

a $P = \dfrac{1825}{8192}w^3 \approx 0.2228w^3$

w	10	20	40	80
P	**223**	**1782**	**14,259**	**114,074**

b 752 kilowatts

c 33.54 mph

d It is multiplied by 8.

3.1.9.21.

Answer.

a $y = 0.3x$

b

x	y
2	**0.6**
5	1.5
8	2.4
12	**3.6**
15	4.5

c y doubles.

3.1.9.23.

Answer.

a $y = \dfrac{2}{3}x^2$

b

x	y
3	**6**
6	24
9	
12	**96**
15	150

c y is quadrupled.

3.1.9.25.

Answer.

a $y = \dfrac{120}{x}$

b

4	**30**
8	15
20	6
30	**4**
40	3

c y is halved.

3.1.9.27.

Answer. (b) $y = 0.5x^2$

3.1.9.29.

Answer. (c) $\dfrac{y}{x^p}$ is not constant for any exponent p.

3.1.9.31.

Answer. (b) $y = \dfrac{72}{x^2}$

3.1.9.33.

Answer. (c) $x^p y$ is not constant for any exponent p.

3.1.9.35.

Answer.

a $d = 0.005v^2$ b 50 m

3.1.9.37.

Answer.

a $m = \dfrac{8}{p}$ b 0.8 ton

3.1.9.39.

Answer.

a $T = \dfrac{6}{d}$ b 1°C

3.1.9.41.

Answer.

a $W = 600d^2$ b 864 newtons

3.1.9.43.

Answer.

a Wind resistance quadruples.

b It is one-ninth as great.

c It is decreased by 19% because it is 81% of the original.

3.1.9.45.

Answer.

a It is one-fourth the original illumination.

b It is one-ninth the illumination.

c It is 64% of the illumination.

3.1.9.49.

Answer.

a $L = (1.25 \times 10{-}27)m^3$

b 2×10^{12} kg

3.1.9.51.

Answer. $y = kx$ implies that $k(cx) = c(kx) = cy$.

3.1.9.53.

Answer. If $y = kx^2$, then dividing both sides of the equation by x^2 gives $\frac{y}{x^2} = k$.

3.1.9.55.

Answer. Yes

3.2 · Integer Exponents

3.2.6 · Integer Exponents (Homework 3.2)

3.2.6.1.

Answer.

n	-5	-4	-3	-2	-1	0	1	2	3	4	5
3^n	$\frac{1}{243}$	$\frac{1}{81}$	$\frac{1}{27}$	$\frac{1}{9}$	$\frac{1}{3}$	1	3	9	27	81	243

Each time n increases by 1, we multiply the power in the bottom row by 3.

3.2.6.3.

Answer.

a 8 b -8 c $\frac{1}{8}$ d $\frac{-1}{8}$

3.2.6.5.

Answer.

a $\frac{1}{8}$ b $\frac{-1}{8}$ c 8 d -8

3.2.6.7.

Answer.

a $\frac{1}{2^1} = \frac{1}{2}$ b $\frac{1}{(-5)^2} = \frac{1}{25}$ c $3^3 = 27$ d $(-2)^4 = 16$

3.2.6.9.

Answer.

a $5 \cdot 4^3 = 320$

b $\frac{1}{(2q)^5} = \frac{1}{32q^5}$

c $\frac{-4}{x^2}$ d $8b^3$

3.2.6.11.

Answer.

a $\dfrac{1}{(m-n)^2}$

b $\dfrac{1}{y^2}+\dfrac{1}{y^3}$

c $\dfrac{2p}{q^4}$

d $\dfrac{-5x^5}{y^2}$

3.2.6.13.

Answer.

(a)

x	1	2	4	8	16
x^{-2}	1	0.25	0.06	0.02	0.00

(b) The values of $f(x)$ decrease, because x^{-2} is the reciprocal of x^2.

(c)

x	1	0.5	0.25	0.125	0.0625
x^{-2}	1	4	16	64	256

(d) The values of $f(x)$ increase toward infinity, because x^{-2} is the reciprocal of x^2.

3.2.6.15.

Answer. b. (ii), (iii), and (iv) have the same graph, because they represent the same function.

3.2.6.17.

Answer.

(a) $F(r)=3r^{-4}$ (b) $G(w)=\dfrac{2}{5}w^{-3}$ (c) $H(z)=\dfrac{1}{9}z^{-2}$

3.2.6.19.

Answer. $x=-1.25$ or $x=1.25$

3.2.6.21.

Answer. $t=\dfrac{1}{16}$

3.2.6.23.

Answer. $v=\dfrac{1}{5}$ or $v=\dfrac{-1}{5}$

3.2.6.25.

Answer.

(a) $P=0.355v^3$ (b) $v\approx 52.03$ mph (c) 3.375

3.2.6.27.

Answer.

(a) $D=\dfrac{70}{i}$ (b) It decreases by about 2.3 years.

3.2.6.29.

Answer.

(a) $L=\left(4\pi sR^2\right)T^4\approx 7.2\times 10^{-7}R^2T^4$

(b) 4840 K

3.2.6.31.

Answer.

(a) 500 picowatts

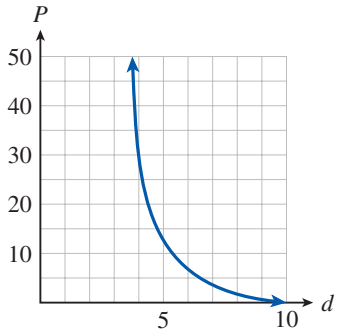
(b) $P = 8000d^{-4}$

(c)

d (nautical miles)	P (picowatts)
4	31.3
5	12.8
7	3.3
10	0.8

(d) 16.8 nautical miles

(e)



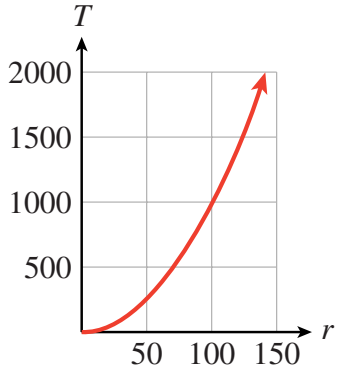
3.2.6.33.

Answer.

(a) $T = 16kr^2$

(b) $T = 0.1r^2$

(c)



3.2.6.35.

Answer.

(a) a^5

(b) $\frac{1}{5^7}$

(c) $\frac{1}{p^3}$

(d) $\frac{1}{7^{10}}$

3.2.6.37.

Answer.

(a) $\dfrac{20}{x^3}$ (b) $\dfrac{1}{3u^{12}}$ (c) $5^8 t$

3.2.6.39.

Answer.

(a) $\dfrac{x^4}{9y^6}$ (b) $\dfrac{a^6b^4}{36}$ (c) $\dfrac{5}{6h^6}$

3.2.6.41.

Answer.

(a) $\dfrac{1}{3}x + 3x^{-1}$ (b) $\dfrac{1}{4}x^{-2} - \dfrac{3}{2}x^{-1}$

3.2.6.43.

Answer.

(a) $\dfrac{1}{2}x^{-2} + x^{-3} - \dfrac{1}{2}x^{-4}$ (b) $\dfrac{2}{3}x^{-2} - \dfrac{1}{9} + \dfrac{1}{6}x^2$

3.2.6.45.

Answer. $x - 3 + 2x^{-1}$

3.2.6.47.

Answer. $-3 + 6t^{-2} + 12t^{-4}$

3.2.6.49.

Answer. $-4 - 2u^{-1} + 6u^{-2}$

3.2.6.51.

Answer. $4x^{-2}(x^4 + 4)$

3.2.6.53.

Answer. $a^{-3}(3 - 3a^4 + a^6)$

3.2.6.55.

Answer.

(a) No, because $\frac{1}{(x+y)^2}$ is not $\frac{1}{x^2} + \frac{1}{y^2}$.

(b) Let $x = 1$, $y = 2$, then $(x+y)^{-2} = (1+2)^{-2} = 3^{-2} = \frac{1}{9}$, but $x^{-2} + y^{-2} = 1^{-2} + 2^{-2} = 1 + \frac{1}{4} = \frac{5}{4}$

3.2.6.57.

Answer.

(a) $x + x^{-1} = x + \dfrac{1}{x} = \dfrac{x^2}{x} + \dfrac{1}{x} = \dfrac{x^2+1}{x}$

(b) $x^3 + x^{-3} = x^3 + \dfrac{1}{x^3} = \dfrac{x^6}{x^3} + \dfrac{1}{x^3} = \dfrac{x^6+1}{x^3}$

(c) $x^n + x^{-n} = x^n + \dfrac{1}{x^n} = \dfrac{x^{2n}}{x^n} + \dfrac{1}{x^n} = \dfrac{x^{2n}+1}{x^2}$

3.2.6.59.

Answer.

$$\begin{aligned} a^{-2}a^{-3} &= \frac{1}{a^2}\cdot\frac{1}{a^3} = \frac{1}{a^2\cdot a^3} \\ &= \frac{1}{a^{2+3}} \qquad \text{By the first law of exponents.} \\ &= \frac{1}{a^5} = a^{-5} \end{aligned}$$

3.2.6.61.

Answer.

$$\begin{aligned} \frac{a^{-2}}{a^{-6}} &= a^{-2} \div a^{-6} = \frac{1}{a^2} \div \frac{1}{a^6} \\ &= \frac{1}{a^2}\cdot\frac{a^6}{1} = \frac{a^6}{a^2} \\ &= a^{6-2} \qquad \text{By the second law of exponents.} \\ &= a^4 \end{aligned}$$

3.3 · Roots and Radicals

3.3.10 · Roots and Radicals (Homework 3.3)

3.3.10.1.

Answer.

(a) 11 (b) 3 (c) 5

3.3.10.3.

Answer.

(a) 2 (b) 2 (c) 9

3.3.10.5.

Answer.

(a) 3 (b) 3 (c) 2

3.3.10.7.

Answer.

(a) 2 (b) $\frac{1}{2}$ (c) $\frac{1}{8}$

3.3.10.9.

Answer.

(a) $\sqrt{3}$ (b) $4\sqrt[3]{x}$ (c) $\sqrt[5]{4x}$

3.3.10.11.

Answer.

(a) $\frac{1}{\sqrt[3]{6}}$ (b) $\frac{3}{\sqrt[8]{xy}}$ (c) $\sqrt[4]{x-2}$

3.3.10.13.

Answer.

(a) $7^{1/2}$ (b) $(2x)^{1/3}$ (c) $2z^{1/5}$

3.3.10.15.

Answer.

(a) $-3\cdot 6^{-1/4}$ (b) $(x-3y)^{1/4}$ (c) $-(1+3b)^{-1/5}$

3.3.10.17.

Answer.

(a) 125 (b) 2 (c) 63 (d) $-2x^7$

3.3.10.19.

Answer.

(a) 1.414 (b) 4.217 (c) 1.125 (d) 0.140 (e) 2.782

3.3.10.21.

Answer.

(a) $g(x) = 3.7x^{1/3}$ (b) $\dfrac{H(x)}{85^{1/4}x^{1/4}} =$ (c) $F(t) = 25t^{-1/5}$

3.3.10.23.

Answer. $x = 91.125$

3.3.10.25.

Answer. $x = 241$

3.3.10.27.

Answer. $x = \dfrac{19}{2}$

3.3.10.29.

Answer. $x = \pm\sqrt{30}$

3.3.10.31.

Answer. $L = \dfrac{gT^2}{4\pi^2}$

3.3.10.33.

Answer. $s = \pm\sqrt{t^2 - r^2}$

3.3.10.35.

Answer. $v = \dfrac{4}{3}\pi r^3$

3.3.10.37.

Answer. $p = \dfrac{8Lvf}{\pi R^4}$

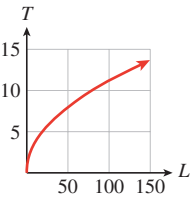
3.3.10.39.

Answer.

(a) $T = \dfrac{2\pi}{\sqrt{32}}L^{1/2}$

(b) 90 feet

(c)



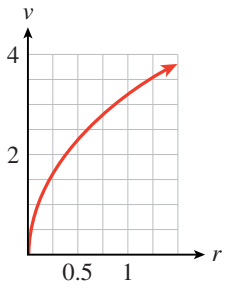
3.3.10.41.

Answer.

(a) 3 meters per second

(b) $b \approx 2.2$ meters per second

(c)



(d) 1.9 meters

(e) 1.2meters per second

3.3.10.43.

Answer.

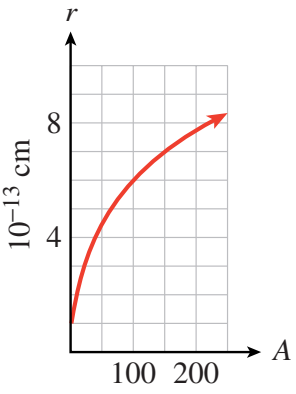
(a) 6.5×10^{-13} cm; 1.17×10^{-36} cm^3

(b) $1.8 \times 10^{14} g/\text{cm}^3$

(c)

Element	Carbon	Potassium	Cobalt	Technetium	Radium
Mass number, A	14	40	60	99	226
Radius, r (10^{-13} cm)	3.1	4.4	5.1	6	7.9

(d)



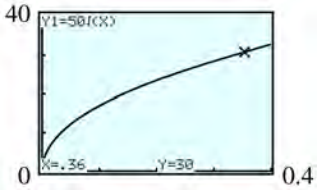
3.3.10.45.

Answer.

(a) $s = 50\sqrt{d}$

(b) 30 cm/sec

(c)



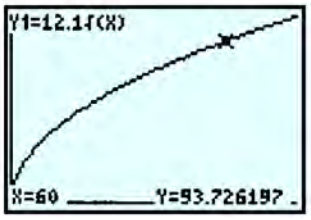
3.3.10.47.

Answer.

(a) $r = 12.1\sqrt{P}$

(b) 94 ft/sec

(c)



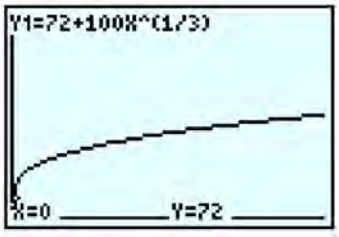
3.3.10.49.

Answer.

(a) 287; 343

(b) 2015; 2058

(c) The membership grows rapidly at first but is growing less rapidly with time.



3.3.10.51.

Answer.

(a) I (b) III (c) II (d) none

3.3.10.53.

Answer.

(a) The graphs of $x^{1/n}$ become closer and closer to horizontal when n increases (for $x > 1$).

(b) 10, 4.64, 3.16, 2.51

(c) 1.58, 1.05, 1.005; the values decrease towards 1.

3.3.10.55.

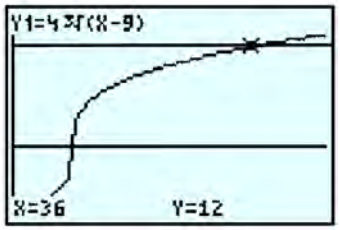
Answer. The graphs of y_1 and y_2 are symmetric about $y_3 = x$.

3.3.10.57.

Answer. The graphs of y_1 and y_2 are symmetric about $y_3 = x$.

3.3.10.59.

Answer.

(a) 

(b) $x = 36$

3.3.10.61.

Answer.

(a) $x^{1/2}$

(b) $\left(x^{1/2}\right)^{1/2}$

(c)

$$\begin{aligned}\sqrt{\sqrt{x}} &= \left(x^{1/2}\right)^{1/2} && \text{By definition of fractional exponents.}\\ &= x^{1/4} && \text{By the third law of exponents.}\\ &= \sqrt[4]{x} && \text{By definition of fractional exponents.}\end{aligned}$$

3.3.10.63.

Answer. $\frac{1}{4}x^{1/2} - 2x^{-1/2} + \frac{1}{\sqrt{2}}x$

3.3.10.65.

Answer. $3x^{-1/3} - \frac{1}{2}$

3.3.10.67.

Answer. $x^{0.5} + x^{-0.25} - x^0$

3.4 · Rational Exponents

3.4.8 · Rational Exponents (Homework 3.4)

3.4.8.1.

Answer.

(a) 27 (b) 25 (c) 125

3.4.8.3.

Answer.

(a) $\frac{1}{64}$ (b) $\frac{1}{16}$ (c) $\frac{1}{256}$

3.4.8.5.

Answer.

(a) $\sqrt[5]{x^4}$ (b) $\frac{1}{\sqrt[6]{b^5}}$ (c) $\frac{1}{\sqrt[3]{(pq)^2}}$

3.4.8.7.

Answer.

(a) $3\sqrt[5]{x^2}$ (b) $\frac{4}{\sqrt[3]{z^4}}$ (c) $-2\sqrt[4]{xy^3}$

3.4.8.9.

Answer.

(a) $x^{2/3}$ (b) $2a^{1/5}b^{3/5}$ (c) $-4mp^{-7/6}$

3.4.8.11.

Answer.

(a) $(ab)^{2/3}$ (b) $8x^{-3/4}$ (c) $\frac{1}{3}RT^{-1/2}K^{-5/2}$

3.4.8.13.

Answer.

(a) 8 (b) -81 (c) $2y^3$

3.4.8.15.

Answer.

(a) $-a^4b^8$ (b) $2x^3y^9$ (c) $-3a^2b^3$

3.4.8.17.

Answer.

(a) 7.931

(b) 10.903

(c) 0.090

(d) 35.142

3.4.8.19.

Answer.

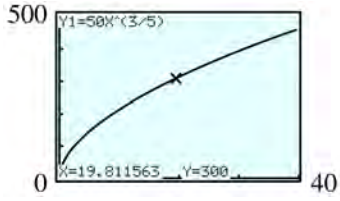
(a)

t	5	10	15	20
$I(t)$	131	199	254	302

Range: $[0, 302]$

(b) ≈ 19.812 or about 20 days

(c)



3.4.8.21.

Answer. All the graphs are increasing and concave up. For $x > 1$, each graph increases more quickly than the previous one.

3.4.8.23.

Answer.

(a) $V = L^3$, $A = 6L^2$

(b) $L = V^{1/3}$, $L = \left(\frac{A}{6}\right)^{1/2}$

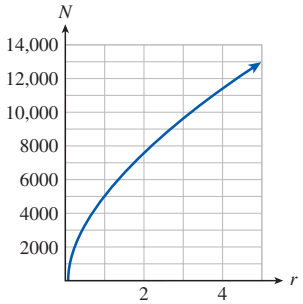
(c) $A = 6V^{2/3}$

(d) $\frac{A}{V} = \frac{6}{L}$. As L increases, the surface-to-volume ratio decreases.

3.4.8.25.

Answer.

(a)



(b) \$7114.32

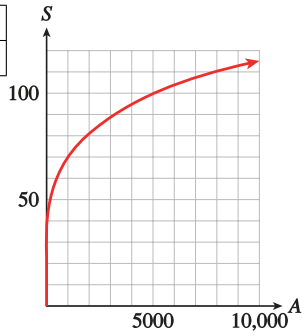
3.4.8.27.

Answer.

(a)

A	10	100	1000	5000	10,000
S	25	42	69	98	115

(b)



(c) 81, 71

(d) 126,000 sq km

3.4.8.29.

Answer.

(a) Home range size: II, lung volume: III, brain mass: I, respiration rate: IV

(b) If $p > 1$, the graph is increasing and concave up. If $0 < p < 1$, the graph is increasing and concave down. If $p < 0$, the graph is decreasing and concave up.

3.4.8.31.

Answer.

(a) Tricosanthes is the snake gourd and Lagenaria is the bottle gourd. Tricosanthes is thinner and Lagenaria is fatter.

(b) $a \approx 9.5$

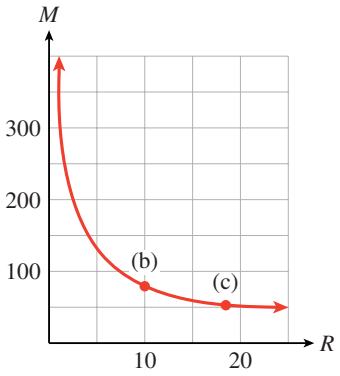
(c) $a \approx 2$

(d) Yes

3.4.8.33.

Answer.

(a)



(b) ≈ 78.5 or about 79 species

(c) 18.4°C

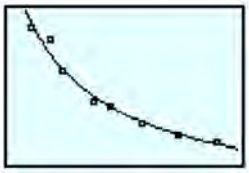
(d) $f(9) \approx 85$, $f(10) \approx 79$, $f(19) \approx 49$, $f(20) \approx 47$; from 9°C to 10°C has the greater decrease, corresponding to the steeper slope. If the temperature range is 9°C, there will be approximately 85 species. If the temperature range is 10°C, there will be approximately 79 species. If the temperature range is 19°C, there will be approximately 49 species. If the temperature range is 20°C, there will be approximately 47 species.

3.4.8.35.

Answer.

(a) $P = \dfrac{k}{\pi} d^{p-2}$

(b)



The power function is a good fit on this interval.

(c) 1.3

3.4.8.37.

Answer.

(a) $4a^2$ (b) $9b^{5/3}$

3.4.8.39.

Answer.

(a) $4w^{3/2}$ (b) $3z^2$

3.4.8.41.

Answer.

(a) $\dfrac{1}{2k^{1/4}}$ (b) $\dfrac{4}{3h^{1/3}}$

3.4.8.43.

Answer.

(a) Wren: 15 days, greylag goose: 28 days

(b) $\dfrac{I(m)\cdot W(m)}{m} = 0.18m^{-0.041}$

(c) Because $m^{-0.041}$ is close to m^0, the fraction lost is close to 0.18.

3.4.8.45.
Answer. $x = 64$

3.4.8.47.
Answer. $x = \dfrac{1}{243}$

3.4.8.49.
Answer. $x \approx 2.466$

3.4.8.51.
Answer.

(a) $p = 1.115 \times 10^{-12} a^{3/2}$

(b) 1.88 years

3.4.8.53.
Answer. $\dfrac{13}{3}$

3.4.8.55.
Answer. 0.665

3.4.8.57.
Answer. $2x^{3/2} - 2x$

3.4.8.59.
Answer. $\dfrac{1}{2}y^{1/3} + \dfrac{3}{2}y^{-7/6}$

3.4.8.61.
Answer. $2x^{1/2} - x^{1/4} - 1$

3.4.8.63.
Answer. $a^{3/2} - 4a^{3/4} + 4$

3.4.8.65.
Answer. $x(x^{1/2} + 1)$

3.4.8.67.
Answer. $\dfrac{y-1}{y^{1/4}}$

3.4.8.69.
Answer. $\dfrac{a^{2/3} + a^{1/3} - 1}{a^{1/3}}$

3.5 · Chapter Summary and Review

3.5.2 · Chapter 3 Review Problems

3.5.2.1.
Answer.

a $d = 1.75t^2$

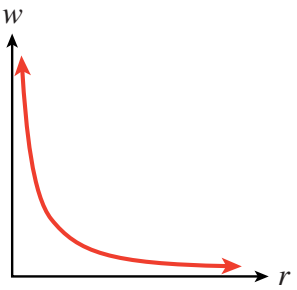
b 63 cm

3.5.2.3.
Answer. 480 bottles

3.5.2.5.
Answer.

a $w = \dfrac{k}{r^2}$

b



c $3960\sqrt{3} \approx 6860$ miles

3.5.2.7.

Answer.
$y = 1.2x^2$

3.5.2.9.

Answer.
$y = \dfrac{20}{x}$

3.5.2.11.

Answer.

a $\dfrac{1}{81}$

b $\dfrac{1}{64}$

3.5.2.13.

Answer.

a $\dfrac{1}{243m^5}$

b $\dfrac{-7}{y^8}$

3.5.2.15.

Answer.

a $\dfrac{2}{c^3}$

b $\dfrac{99}{z^2}$

3.5.2.17.

Answer.

a $25\sqrt{m}$

b $\dfrac{8}{\sqrt[3]{n}}$

3.5.2.19.

Answer.

a $\dfrac{1}{\sqrt[4]{27q^3}}$

b $7\sqrt{u^3v^3}$

3.5.2.21.

Answer.

a $2x^{2/3}$

b $\dfrac{1}{4}x^{1/4}$

3.5.2.23.

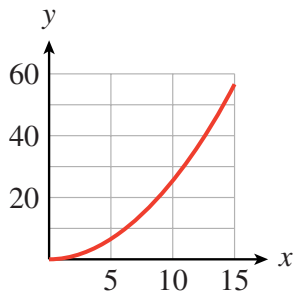
Answer.

a $6b^{-3/4}$

b $\dfrac{-1}{3}b^{-1/3}$

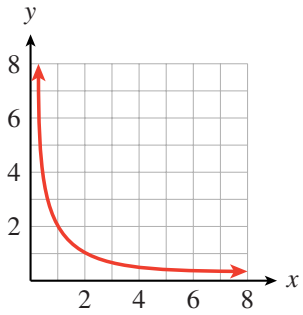
3.5.2.25.

Answer.



3.5.2.27.

Answer.



3.5.2.29.

Answer. $f(x) = \frac{2}{3}x^{-4}$

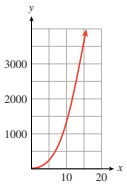
3.5.2.31.

Answer.

(a)

x	16	$\frac{1}{4}$	3	100
$Q(x)$	4096	$\frac{1}{8}$	$4\sqrt{3^5} \approx 62.35$	400,000

(b)



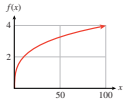
3.5.2.33.

Answer.

(a)

x	0	1	5	10	20	50	70	100
$f(x)$	0	1	1.62	2.00	2.46	3.23	3.58	3.98

(b)

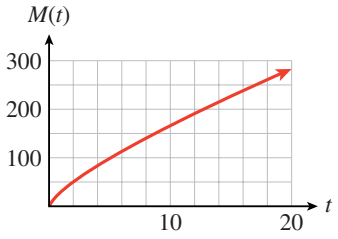


3.5.2.35.

Answer. 112 kg

3.5.2.37.

Answer.

a 

b 283.7 or ≈ 284

c 2051

3.5.2.39.

Answer.

a It is the cost of producing the first ship.

b $C = \dfrac{12}{\sqrt[8]{x}}$ million

c About \$11 million; about 8.3%

d About 8.3%

3.5.2.41.

Answer. $t = 10$

3.5.2.43.

Answer. $x = 7$

3.5.2.45.

Answer. $x = 5$

3.5.2.47.

Answer. $x = 75$

3.5.2.49.

Answer. $y = 29,524$

3.5.2.51.

Answer. $g = \dfrac{2v}{t^2}$

3.5.2.53.

Answer. $p = \pm 2\sqrt{R^2 - R}$

3.5.2.55.

Answer. $49t^2$

3.5.2.57.

Answer. $\dfrac{k^7}{64}$

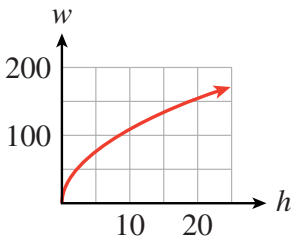
3.5.2.59.

Answer. $8a^2$

3.5.2.61.

Answer.

(a) 132.6 km

(b) 

3.5.2.63.

Answer.

(a) 480

(b) 498

3.5.2.65.

Answer.

a $450

b $t = 8$: It costs $864 to insulate a ceiling with 8 cm of insulation over an area of 600 square meters.

c $C = 0.72A$

d $C = 18T$

e $C = 0.18AT$

f $1440

3.5.2.67.

Answer.

a $N = \dfrac{k}{d^2E^3}$, where N is number of people, d is distance in miles from the road, E is the elevation gain, and k is the constant of variation.

b $k \approx 0.01$

c 3

4 · Exponential Functions

4.1 · Exponential Growth and Decay

4.1.8 · Exponential Growth and Decay (Homework 4.1)

4.1.8.1.

Answer.

(a) $28 (b) $31.36

4.1.8.3.

Answer. It is 99% of what it was 2 years ago.

4.1.8.5.

Answer.

(a) $P = 1200 + 150t$; 1650 (b) $P = 1200 \cdot 1.5^t$; 4050

4.1.8.7.

Answer.

(a) $V = 18,000 - 2000t$; $8000 (b) $V = 18,000 \cdot 0.8^t$; $5898.24

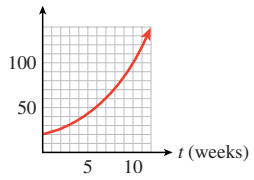
4.1.8.9.

Answer. A: 20%; B: 2%; C: 7.5%; D: 100%; E: 115%

4.1.8.11.

Answer.

a $P = 20,000 \cdot 2.5^{t/6}$

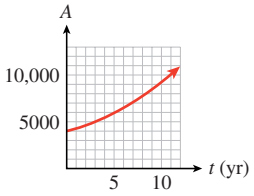
b 

c 36,840 bees; 424,128 bees

4.1.8.13.

Answer.

a $A = 4000 \cdot 1.08^t$

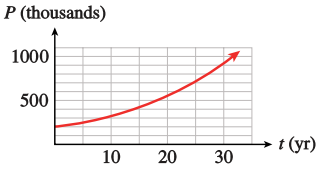
b 

c $4665.60; $8635.70

4.1.8.15.

Answer.

a $P = 200,000 \cdot 1.05^t$

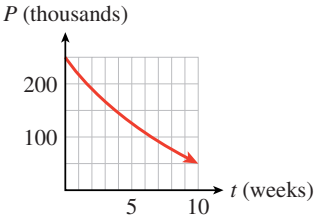
b 

c $359,171; $746,691

4.1.8.17.

Answer.

a $P = 250,000 \cdot 0.75^{t/2}$

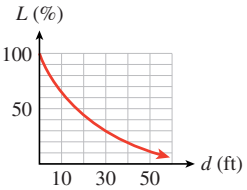
b 

c 162,380; 79,102

4.1.8.19.

Answer.

a $L = 0.85^{d/4}$

b 

c 44%; 16%

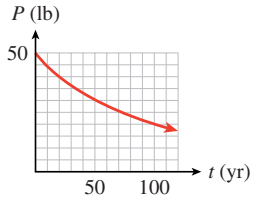
4.1.8.21.

Answer.

a $P = 50 \cdot 0.992^t$

c 46.1 lb; 22.4 lb

b



4.1.8.23.

Answer.

a 3^{x+4} b 3^{4x} c 12^x

4.1.8.25.

Answer.

a b^{-2t} b $b^{t/2}$ c 1

4.1.8.27.

Answer. $P(t+1) = 12(3)^{t+1} = 12(3)^t \cdot 3 = P(t) \cdot 3$

4.1.8.29.

Answer. $P(x+k) = P_0 a^{x+k} = P_0 a^x \cdot a^k = P(x) \cdot a^k$

4.1.8.31.

Answer.

a In the expression $2 \cdot 3^t$, only the 3 is raised to a power t, and the result is doubled, but if both the 2 and the 3 were raised to the power t, the result would be 6^t.

b

t	0	1	2
$P(t)$	2	6	18
$Q(t)$	1	6	36

4.1.8.33.

Answer. 4

4.1.8.35.

Answer. 1.2

4.1.8.37.

Answer. $r \approx 0.14$

4.1.8.39.

Answer. $r \approx 0.04$

4.1.8.41.

Answer.

a $P(t) = 1,545,387b^t$

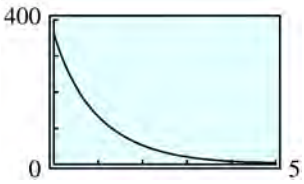
b Growth factor 1.049; Percent rate of growth 4.9%

c 2,493,401

4.1.8.43.

Answer.

a 365



b $N(t) = 365(0.356)^t$

c

d 0.03. (Therefore, none)

4.1.8.45.

Answer. The growth factor is 1.5.

t	0	1	2	3	4
P	8	12	18	27	40.5

4.1.8.47.

Answer. The growth factor is 1.2.

x	0	1	2	3	4
Q	20	24	28.8	34.56	41.47

4.1.8.49.

Answer. The decay factor is 0.8.

w	0	1	2	3	4
N	120	96	76.8	61.44	49.15

4.1.8.51.

Answer. The decay factor is 0.8.

t	0	1	2	3	4
C	10	8	6.4	5.12	4.10

4.1.8.53.

Answer. The growth factor is 1.1.

n	0	1	2	3	4
B	200	220	242	266.2	292.82

4.1.8.55.

Answer.

(a) Initial value 4, growth factor $2^{1/3}$

(b) $f(x) = 4 \cdot 2^{x/3}$

4.1.8.57.

Answer.

(a) Initial value 80, decay factor $\frac{1}{2}$

(b) $f(x) = 80 \cdot \left(\frac{1}{2}\right)^x$

4.1.8.59.

Answer. 84.6%, 55.8%

4.1.8.61.

Answer. No, an increase of 48% in 6 years corresponds to a growth factor of $1.48^{1/6} \approx 1.0675$, or an annual growth rate of about 6.75%.

4.1.8.63.

Answer.

a $P(t) = 16,986,335(1 + r)^t$ b 2.07%

4.1.8.65.

Answer.

a 3.53% b 3.53% c No d 3.53%

4.1.8.67.

Answer.

a 39; 1.045 b 35; 1.047 c Species B

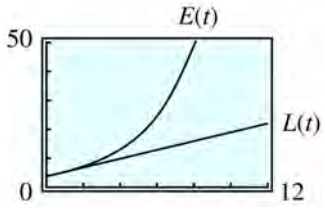
4.1.8.69.

Answer.

a

t	0	2	4	6	8
$L(t)$	3	6	9	12	15

$L(t) = 3 + 1.5t$



b

t	0	2	4	6	8
$E(t)$	3	6	12	24	48

$E(t) = 3 \cdot 2^{t/2}$

4.1.8.71.

Answer.

a 244 tigers per year

b 0.97; 3%

c Linear: 3067; Exponential: 4170

4.2 · Exponential Functions

4.2.6 · Exponential Functions (Homework 4.2)

4.2.6.1.

Answer.

(a) 26; increasing

(b) 1.2; decreasing

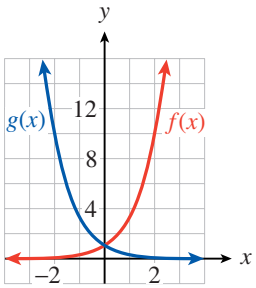
(c) 75; decreasing

(d) $\frac{2}{3}$; increasing

4.2.6.3.

Answer.

x	-3	-2	-1	0	1	2	3
$f(x) = 3^x$	$\frac{1}{27}$	$\frac{1}{9}$	$\frac{1}{3}$	1	3	9	27
$g(x) = \left(\frac{1}{3}\right)^x$	27	9	3	1	$\frac{1}{3}$	$\frac{1}{9}$	$\frac{1}{27}$

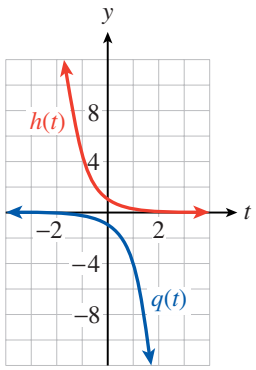


The two graphs are reflections of each other across the y-axis. f is increasing, g is decreasing. f has the negative x-axis as an asymptote, and g has the positive x-axis as its asymptote.

4.2.6.5.

Answer.

t	-3	-2	-1	0	1	2	3
$h(t) = 4^{-t}$	64	16	4	1	$\frac{1}{4}$	$\frac{1}{16}$	$\frac{1}{64}$
$q(t) = -4^t$	$\frac{-1}{64}$	$\frac{-1}{16}$	$\frac{-1}{4}$	-1	-4	-16	-64



The graphs are reflections of each other across the origin. Both are decreasing, but h has the negative t-axis as an asymptote, and q has the positive t-axis as its asymptote.

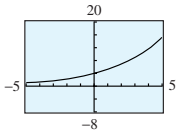
4.2.6.7.

Answer.

a I b IV c III d II

4.2.6.9.

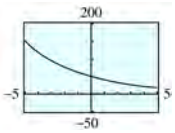
Answer.

a 

b $[1.08, 14.85]$

4.2.6.11.

Answer.

a 

b $[16.38, 152.59]$

4.2.6.13.

Answer. Because they are defined by equivalent expressions, (b), (c), and (d) have identical graphs

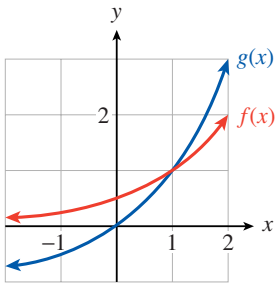
4.2.6.15.

Answer.

a To evaluate f we subtract 1 from the input before evaluating the exponential function; to evaluate g we subtract 1 from the output of the exponential function.

b

x	$y = 2^x$	$f(x)$	$g(x)$
-2	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{-3}{4}$
-1	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{-1}{2}$
0	1	$\frac{1}{2}$	0
1	2	1	1
2	4	2	3



c The graph of f is translated 1 unit to the right; the graph of g is shifted 1 unit down.

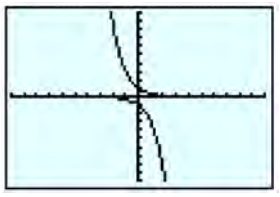
4.2.6.17.

Answer.

a To evaluate f we take the negative of the output of the exponential function; to evaluate g we take the negative of the input.

b

x	$y = 3^x$	$f(x)$	$g(x)$
-2	$\frac{1}{9}$	$\frac{-1}{9}$	9
-1	$\frac{1}{3}$	$\frac{-1}{3}$	3
0	1	-1	1
1	3	-3	$\frac{1}{3}$
2	9	-9	$\frac{1}{9}$



c The graph of f is reflected about the x-axis; the graph of g is reflected about the y-axis.

4.2.6.19.

Answer.

a $3(5^{a+2})$ is not equivalent to $9 \cdot 3(5^a)$.

b $3(5^{2a})$ is not equivalent to $2 \cdot 3(5^a)$.

4.2.6.21.

Answer.

a $8^w - 8^z$ is not equivalent to 8^{w-z}.

b 8^{-x} is equivalent to $\frac{1}{8^x}$.

4.2.6.23.

Answer.

a $P_0 = 300$

b

x	0	1	2
$f(x)$	300	600	1200

c $b = 2$

d $f(x) = 300(2)^x$

4.2.6.25.

Answer.

a $S_0 = 150$

b $b \approx 0.55$

c $S(d) = 150(0.55)^d$

4.2.6.27.

Answer. $\frac{2}{3}$

4.2.6.29.

Answer. $\frac{-1}{4}$

4.2.6.31.

Answer. $\frac{1}{7}$

4.2.6.33.

Answer. $\frac{-5}{4}$

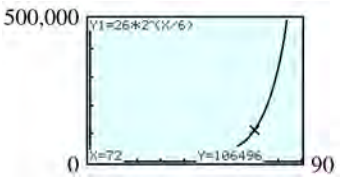
4.2.6.35.

Answer. ± 2

4.2.6.37.

Answer.

a $N(t) = 26(2)^{t/6}$

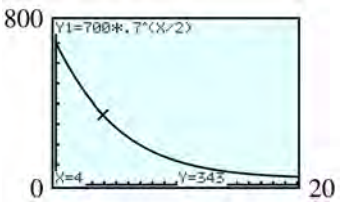
b 

c 72 days later

4.2.6.39.

Answer.

a $V(t) = 700(0.7)^{t/2}$

b 

c 4 yr

4.2.6.41.

Answer.
$x = 2.26$

4.2.6.43.

Answer.
$x = -1.40$

4.2.6.45.

Answer.

a Power

b Exponential

c Power

d Neither

4.2.6.47.

Answer.

a Exponential $y = 3 \cdot 2^x$

b Power $P = 0.5t^2$

4.2.6.49.

Answer.

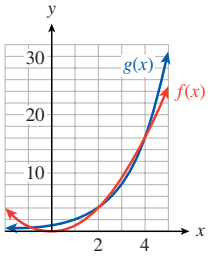
a Power $y = 100x^{-1}$

b Exponential $P = \frac{1}{4} \cdot 2^x$

4.2.6.51.

Answer.

x	$f(x) = x^2$	$g(x) = 2^x$
-2	4	$\frac{1}{4}$
-1	1	$\frac{1}{2}$
0	0	1
1	1	2
2	4	4
3	9	8
4	16	16
5	25	32



a Range of f: $[0, \infty)$; Range of g: $(0, \infty)$

b 3

c -0.7667, 2, 4

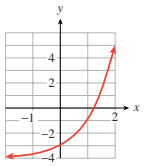
d $(-0.7667, 2)$ and $(4, \infty)$

e g

4.2.6.53.

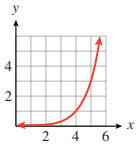
Answer.

a $y = 3^x - 4$



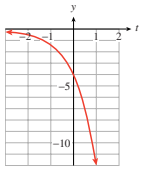
Domain: $(-\infty, \infty)$; range: $(-4, \infty)$, x-intercept $(1.26, 0)$; y-intercept $(0, -3)$; horizontal asymptote $y = -4$

b $y = 3^{x-4}$,



Domain: $(-\infty, \infty)$; range: $(0, \infty)$, no x-intercept; y-intercept $\left(0, \frac{1}{81}\right)$; the x-axis is the horizontal asymptote.

c $y = -4 \cdot 3^x$,

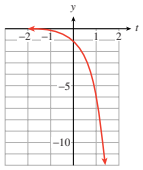


Domain: $(-\infty, \infty)$; range: $(-\infty, 0)$, no x-intercept; y-intercept $(0, -4)$; the x-axis is the horizontal asymptote.

4.2.6.55.

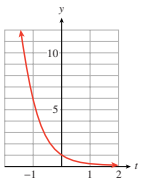
Answer.

a $y = -6^t$



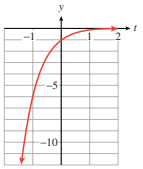
Domain: $(-\infty, \infty)$; range: $(-\infty, 0)$, no t-intercept; y-intercept $(0, -1)$; the t-axis is the horizontal asymptote.

b $y = 6^{-t}$,



Domain: $(-\infty, \infty)$; range: $(0, \infty)$, no t-intercept; y-intercept $(0, 1)$; the t-axis is the horizontal asymptote.

c $y = -6^{-t}$,

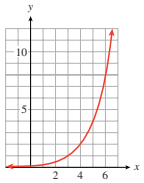


Domain: $(-\infty, \infty)$; range: $(-\infty, 0)$, no t-intercept; y-intercept $(0, -1)$; the t-axis is the horizontal asymptote.

4.2.6.57.

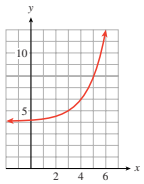
Answer.

a $y = 2^{x-3}$



Domain: $(-\infty, \infty)$; range: $(0, \infty)$, no x-intercept; y-intercept $\left(0, \frac{1}{8}\right)$; the x-axis is the horizontal asymptote.

b $y = 2^{x-3} + 4$,

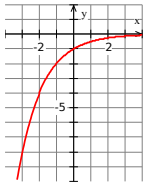


Domain: $(-\infty, \infty)$; range: $(4, \infty)$, no x-intercept; y-intercept $> \left(0, \frac{33}{8}\right)$; horizontal asymptote $y = 4$

4.2.6.59.

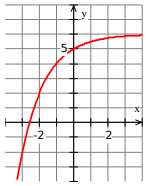
Answer.

a $y = -\left(\frac{1}{2}\right)^t$



Domain: $(-\infty, \infty)$; range: $(-\infty, 0)$, no t-intercept; y-intercept $(0, -1)$; the t-axis is the horizontal asymptote.

b $y = 6 - \left(\frac{1}{2}\right)^t$,



Domain: $(-\infty, \infty)$; range: $(-\infty, 6)$, t-intercept approximately $(-2.58, 0)$; y-intercept $(0, 5)$; horizontal asymptote is $y = 6$

4.2.6.61.

Answer.

a The graph of $y = 2^x$ has been reflected about the y-axis and shifted up 2 units.

b $y = 2^{-x} + 2$

4.2.6.63.

Answer.

a The graph of $y = 2^x$ has been reflected about the x-axis and shifted up 10 units.

b $y = -2^x + 10$

4.2.6.65.

Answer.

a I b III c II

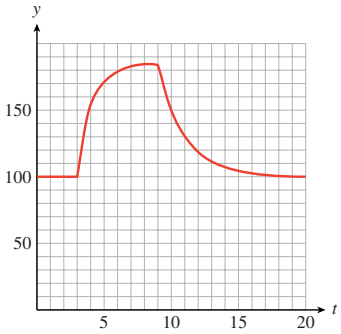
4.2.6.67.

Answer.

a

t	3.5	4	8	10	15
$f(t)$	128	154.75	184.05	150.93	103.96

b



c From 0 to 3 minutes, the volunteer is walking with heart rate 100 beats per minute. The volunteer jogged at a steady pace from 3 to 4 minutes, and the heart rate increased to about 155 beats per minutes. From 4 to 9 minutes, the jogging pace increased, and the heart rate rose to about 185 beats per minute. The cooldown started at 9 minutes, and the heart rate decreased rapidly and leveled off to about 100 beats per minute.

4.3 · Logarithms

4.3.7 · Logarithms (Homework 4.3)

4.3.7.1.

Answer.

(a) 2 (b) 5

4.3.7.3.

Answer.

(a) $\frac{1}{2}$ (b) -1

4.3.7.5.

Answer.

(a) 1 (b) 0

4.3.7.7.

Answer.

(a) 5 (b) 6

4.3.7.9.

Answer.

(a) -1 (b) -3

4.3.7.11.

Answer.

$\log_2(1024) = 10$

4.3.7.13.

Answer.

$\log(5) \approx 0.699$

4.3.7.15.

Answer.

$\log_t(16) = \frac{3}{2}$

4.3.7.17.

Answer.

$\log_{0.8}(M) = 1.2$

4.3.7.19.

Answer.

$\log_x(W - 3) = 5t$

4.3.7.21.

Answer.

$\log_3(2N_0) = -0.2t$

4.3.7.23.

Answer.

a b

$\log_4(2.5)$ 0.7

4.3.7.25.

Answer.

a b

$\log(0.003)$ -2.5

4.3.7.27.

Answer.

a $0 < \log(7) < 1$

b 0.85

4.3.7.29.

Answer.

a $3 < \log_3(67.9) < 4$

b 3.84

4.3.7.31.

Answer.

(a) 0.7348 (c) 2.7348

(b) 1.7348 (d) 3.7348

When the input to the common logarithm is multiplied by 10, the output is increased by 1.

4.3.7.33.

Answer.

(a) 0.3010 (c) 0.9031

(b) 0.6021 (d) 1.2041

When the input to the common logarithm is doubled, the output is increased by about 0.3010.

4.3.7.35.

Answer. -0.23

4.3.7.37.

Answer. 2.53

4.3.7.39.

Answer. 0.77

4.3.7.41.

Answer. -0.68

4.3.7.43.

Answer. 3.63

4.3.7.45.

Answer. $2 \cdot 5^x \neq 10^x$; the first step should be to divide both sides of the equation by 2; $x = \log_5(424)$.

4.3.7.47.

Answer. $\frac{10^{4x}}{4} \neq 10^x$; the first step should be to write $4x = \log(20)$; $x = \frac{\log(20)}{4}$.

4.3.7.49.

Answer.

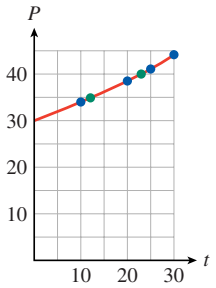
(a) 33, 855, 812

(b) 38, 515, 295; 41, 080, 265; 43, 816, 051

(c) 2002

(d) 2012

(e)

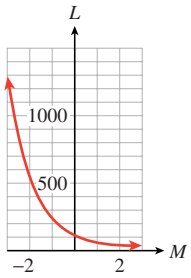


4.3.7.51.

Answer.

(a) 85.5

(b) Decreasing; range: $[5.4, 1355.2]$



(c) 1.45

(d) $\frac{1}{100}$

(e) $10^{0.4} \approx 2.5119$

(f) 2.15×10^{-6} to $855,067$

4.3.7.53.

Answer. 9.60 in

4.3.7.55.

Answer. 1.91 mi

4.3.7.57.

Answer. 3.34 mi

4.3.7.59.

Answer. 1

4.3.7.61.

Answer. 0

4.3.7.63.

Answer. 1

4.3.7.65.

Answer. 0

4.4 · Properties of Logarithms

4.4.7 · Properties of Logarithms (Homework 4.4)

4.4.7.1.

Answer.

(a) 10^8

(b) 2; 6; 8; $2 + 6 = 8$

4.4.7.3.

Answer.

(a) b^3

(b) 8; 5; 3; $8 - 5 = 3$

4.4.7.5.

Answer.

(a) 10^{15}

(b) 15; 3; $15 = 3 \cdot 5$

4.4.7.7.

Answer.

(a) $\log_b(2) + \log_b(x)$

(b) $\log_b(2) - \log_b(x)$

4.4.7.9.

Answer.

(a) $1 + 4\log_3(x)$

(b) $\frac{1}{t}\log_5(1.1)$

4.4.7.11.

Answer.

(a) $\frac{1}{2} + \frac{1}{2}\log_b(x)$

(b) $\frac{1}{3}\log_3((x^2+1))$

4.4.7.13.

Answer.

(a) $\log(P_0) + t\log(1 - m)$

(b) $4t[\log_4(4 + r) - 1]$

4.4.7.15.

Answer.

(a) $\log_b(4)$ (b) $\log_4(x^2y^3)$

4.4.7.17.

Answer.

(a) $\log(2x^{5/2})$ (b) $\log(t-4)$

4.4.7.19.

Answer.

(a) $\log\left(\frac{1}{27}\right)$ (b) $\log_6(2w^2)$

4.4.7.21.

Answer.

(a) 1.7917 (b) -0.9163

4.4.7.23.

Answer.

(a) 2.1972 (b) 1.9560

4.4.7.25.

Answer. 2.8074

4.4.7.27.

Answer. 0.8928

4.4.7.29.

Answer. ± 1.3977

4.4.7.31.

Answer. -1.6092

4.4.7.33.

Answer. 0.2736

4.4.7.35.

Answer. -12.4864

4.4.7.37.

Answer.

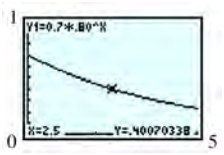
(a) $S(t) = S_0(1.09)^t$ (b) 4.7 hours

4.4.7.39.

Answer.

(a) $C(t) = 0.7(0.80)^t$

(b) After 2.5 hours

(c) 

4.4.7.41.

Answer.

(a) $J(t) = 1,041,000 \cdot 1.0182^t$ (b) In 2040

4.4.7.43.

Answer.

(a) $S(t) = S_0 \cdot 0.9527^t$ (b) 28.61 hours

4.4.7.45.

Answer.

(a) 5 (b) 6 (c) 5

(a) and (c) are equal.

4.4.7.47.

Answer.

(a) 6 (b) 9 (c) 6

(a) and (c) are equal.

4.4.7.49.

Answer.

(a) $\log(24) \approx 1.38$ (b) $\log(240) \approx 2.38$ (c) $\log(230) \approx 2.36$

None are equal.

4.4.7.51.

Answer.

(a) $\log(60) \approx 1.78$ (b) $\log(5) \approx 0.70$ (c) $\dfrac{\log(75)}{\log(15)} \approx 1.59$

None are equal.

4.4.7.53.

Answer. 12.9%

4.4.7.55.

Answer. About 11 years

4.4.7.57.

Answer.

(a) $A = 1000\left(1 + \dfrac{0.12}{n}\right)^{5n}$

(b)

X	Y1
1	1762.3
2	1790.8
4	1806.1
12	1816.7
52	1820.9
365	1821.9

X=

A increases.

(c) 16; 31; 553

(d) Increasing, concave down, asymptotically approaching $A \approx 1822.12$

4.4.7.59.

Answer. $k = \dfrac{1}{t}\dfrac{\log(N/N_0)}{\log(a)}$

4.4.7.61.

Answer. $t = \dfrac{1}{k}\log\left(\dfrac{A}{A_0} + 1\right)$

4.4.7.63.

Answer. $q = \dfrac{\log(w/p)}{\log(v)}$

4.4.7.65.

Answer.

(a) $x = b^m$, $y = b^n$

(b) $\log_b(b^m \cdot b^n)$

(c) $\log_b(b^m \cdot b^n) = \log_b(b^{m+n})$

(d) $\log_b(b^{m+n}) = m + n$

(e) $\log_b(b^{m+n}) = \log_b(x) + \log_b(y)$

4.4.7.67.

Answer.

(a) $x = b^m$

(b) $\log_b(b^m)^k$

(c) $\log_b(b^m)^k = \log_b(b^{mk})$

(d) $\log_b(b^{mk}) = mk$

(e) $\log_b(b^{mk}) = (\log_b(x)) \cdot k$

4.5 · Exponential Models

4.5.6 · Exponential Models (Homework 4.5)

4.5.6.1.

Answer. $A(x) = 0.14(50)^{x/3}$

4.5.6.3.

Answer. $f(x) = \dfrac{65,536}{729}\left(\dfrac{3}{4}\right)^x$

4.5.6.5.

Answer. $M(x) = 62,500(0.2)^x$

4.5.6.7.

Answer. $s(x) = \dfrac{1}{135}(9)^x$

4.5.6.9.

Answer. $y = \dfrac{4}{3}(3)^{x/4}$

4.5.6.11.

Answer. $y = 50(2)^{-x/4}$

4.5.6.13.

Answer.

(a) $y = 2.6 - 1.3x$

(b) $y = 2.6(0.5)^x$

(c)

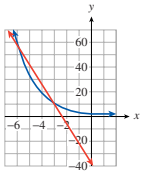
4.5.6.15.

Answer.

(a) $y = -36 - 16x$

(b) $y = \dfrac{12}{5}(5)^{-x/3}$

(c)



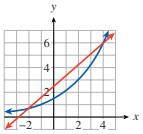
4.5.6.17.

Answer.

(a) $y = 2.5 + 0.875x$

(b) $y = 1.5(2)^{x/2}$

(c)



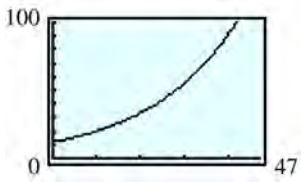
4.5.6.19.

Answer.

(a) $P = P_0(1.052)^t$; t is the number of years since 1990.

(b) $\dfrac{\log(2)}{\log(1.052)} \approx 13.7$ years

(c)



4.5.6.21.

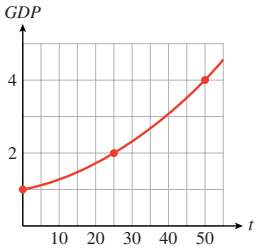
Answer.

(a) $GDP = 1.028^t$ million pounds

(b) $\dfrac{\log(2)}{\log(1.028)} \approx 25.1$ years

(c) 50.2 years

(d)



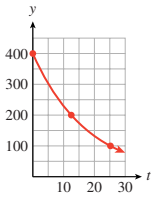
4.5.6.23.

Answer.

a $\dfrac{\log(0.5)}{\log(0.946)} \approx 12.5$ hours

b 25 hours

c



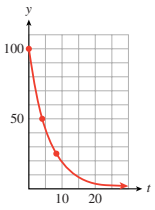
4.5.6.25.

Answer.

a $\dfrac{\log(0.5)}{\log(0.844)} \approx 4.1$ hours

b 8.2 hours

c



4.5.6.27.

Answer.

a $P = 2000(2)^{t/5}$

b 14.87%

4.5.6.29.

Answer.

a $D = D_0\left(\dfrac{1}{2}\right)^{t/18}$

b 3.78%

4.5.6.31.

Answer.

(a) $A = A_0\left(\dfrac{1}{2}\right)^{t/1620}$

(b) 0.043%

4.5.6.33.

Answer.

(a) $P = P_0(2)^{t/25}$

(b) 2.81%

4.5.6.35.

Answer.

(a) $ab^D = 2 \cdot ab^0 = 2a$

(b) $b^D = 2$

(c) $f(t+D) = ab^{t+D} = a \cdot b^t \cdot b^D = ab^t \cdot 2 = 2f(t)$

(d) For any value of t, after D units of time, the new value of f is 2 times the old value.

4.5.6.37.

Answer.

(a) $ab^R = \dfrac{1}{3} \cdot ab^0 = \dfrac{1}{3}a$

(b) $b^R = \dfrac{1}{3}$

(c) $g(t+R) = ab^{t+R} = a \cdot b^t \cdot b^R = ab^t \cdot \dfrac{1}{3} = \dfrac{1}{3}g(t)$

(d) For any value of t, after R units of time, the new value of g is $\frac{1}{3}$ times the old value.

4.5.6.39.

Answer.

(a) $A = A_0 \left(\dfrac{1}{2}\right)^{t/5730}$

(b) About 760 years old

4.5.6.41.

Answer.

(a) $A = A_0 \left(\dfrac{1}{2}\right)^{t/432}$

(b) About 220 years

4.5.6.43.

Answer. ≈ 30 years; ≈ 33 years

4.5.6.45.

Answer. \$445.89; \$376.50

4.5.6.47.

Answer.

(a) $N(t) = 2200(2)^{t/1.5}$

(b) The given model has a smaller growth factor, 1.356, than $2^{1/1.5} \approx 1.59$.

(c)

Name of chip	Year	Moore's law	$N(t)$	Actual number
Pentium IV	2000	2,306,867,200	20,427,413	42,000,000
Pentium M (Banias)	2003	9,227,468,800	50,932,200	77,000,000
Pentium M (Dothan)	2004	14,647,693,680	69,064,063	140,000,000

(d) About 2.3 years

4.6 · Chapter Summary and Review

4.6.2 · Chapter 4 Review Problems

4.6.2.1.

Answer.

a $D = 8(1.5)^{t/5}$

b 18; 44

4.6.2.3.

Answer.

a $M = 100(0.85)^t$

b 52.2 mg; 19.7 mg

4.6.2.5.

Answer. $16n^{2x+10}$

4.6.2.7.

Answer. $\dfrac{1}{m^{x+2}}$

4.6.2.9.

Answer. $g(t) = 16(0.85)^t$

4.6.2.11.

Answer. $f(x) = 500\left(\dfrac{1}{5}\right)^x$

4.6.2.13.

Answer. 4.8% loss

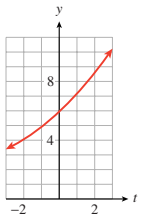
4.6.2.15.

Answer. 6% loss

4.6.2.17.

Answer.

(a)



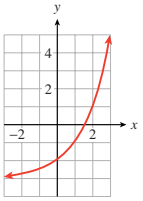
(b) y-intercept $(0, 6)$; asymptote: $y = 0$

(c) $[3.472, 10.368]$

4.6.2.19.

Answer.

(a)



(b) x-intercept $\left(\frac{\log(3)}{\log(2)}, 0\right)$; y-intercept $(0, -2)$; asymptote: $y = -3$

(c) $[-2.875, 5]$

4.6.2.21.

Answer. $\dfrac{-4}{3}$

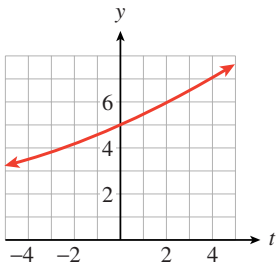
4.6.2.23.

Answer. -11

4.6.2.25.

Answer.

(a)



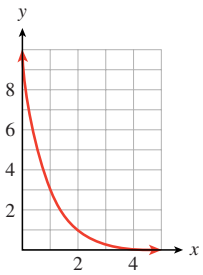
Not (quite) equivalent

(b) $2^{1/8} \approx 1.090507733 > 1.0905$

4.6.2.27.

Answer.

(a)



Equivalent

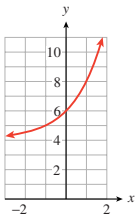
(b) $\left(\frac{1}{3}\right)^{x-2} = \left(\frac{1}{3}\right)^{x} \cdot \left(\frac{1}{3}\right)^{-2} = \left(\frac{1}{3}\right)^{x} \cdot 9$

4.6.2.29.

Answer.

(a) $y = 4 + 2^{x+1}$

(b) Shift the graph of f 1 unit left, 4 units up.

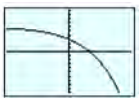


4.6.2.31.

Answer.

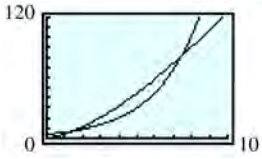
(a) $y = 6 - 3 \cdot 2^{x}$

(b) Scale vertically by 3, reflect about x-axis, shift 6 units up.



4.6.2.33.

Answer.



g eventually grows faster.

4.6.2.35.

Answer. $2^{1.5} \approx 2.83$; 2.25

4.6.2.37.

Answer. $M = M_0(2)^{t/10}$, where M is the organic content, M_0 is the organic content at 0°C, and t is the temperature in ° Celsius.

4.6.2.39.

Answer. 4

4.6.2.41.

Answer. -1

4.6.2.43.

Answer. -3

4.6.2.45.

Answer. $\log_{0.3}(x+1) = -2$

4.6.2.47.

Answer. $\dfrac{\log(5.1)}{1.3} \approx 0.5433$

4.6.2.49.

Answer. $\dfrac{\log(2.9/3)}{-0.7} \approx 0.21$

4.6.2.51.

Answer. $\log_b(x) + \dfrac{1}{3}\log_b(y) - 2\log_b(z)$

4.6.2.53.

Answer. $\dfrac{4}{3}\log(x) - \dfrac{1}{3}\log(y)$

4.6.2.55.

Answer. $\log\left(\sqrt[3]{\dfrac{x}{y^2}}\right)$

4.6.2.57.

Answer. $\log\left(\dfrac{1}{8}\right)$

4.6.2.59.

Answer. $\dfrac{\log(63)}{\log(3)} \approx 3.77$

4.6.2.61.

Answer. $\dfrac{\log(50)}{-0.3\log(6)} \approx -7.278$

4.6.2.63.

Answer. $\dfrac{\log\left(N/N_0\right)}{k}$

4.6.2.65.

Answer.

(a) 238 (b) 2010

4.6.2.67.

Answer.

(a) $C = 90(1.06)^t$ (b) \$94.48 (c) 5 years

4.6.2.69.

Answer.

(a) 7.4 years (b) 6.1

4.6.2.71.

Answer. $f(x) \approx 1600(1.035)^x$

4.6.2.73.

Answer. $g(x) \approx 600(0.075)^x$

4.6.2.75.

Answer.

(a) $\dfrac{\log(2)}{\log(1.001)} \approx 693$ years (b) 105 years

4.6.2.77.

Answer. 17%

4.6.2.79.

Answer. $2192.78

4.6.2.81.

Answer.

(a)

Day	1	2	3	$\cdots$	t	$\cdots$	30
Wage (cent)	2	4	8	$\cdots$	2^t	$\cdots$	2^{30}

(b) $W(t) = 2^t$ cents

(c) \$327.68; \$10,737,418.24

5 · Logarithmic Functions

5.1 · Inverse Functions

5.1.10 · Inverse Functions (Homework 5.1)

5.1.10.1.

Answer.

(a)

x	-1	0	1	2
$f(x)$	0	1	-2	-1

y	0	1	-2	-1
$f^{-1}(y)$	-1	0	1	2

(b) $f^{-1}(1) = 0$

(c) $f^{-1}(-1) = 2$

5.1.10.3.

Answer.

(a)

x	-1	0	1	2
$f(x)$	-1	1	3	11

y	-1	1	3	11
$f^{-1}(y)$	-1	0	1	2

(b) $f^1(1) = 0$

(c) $f^{-1}(3) = 1$

5.1.10.5.

Answer.

(a) $f(60) \approx 38$. The car that left the 60-foot skid marks was traveling at 38 mph.

(b) $f^{-1}(60) \approx 150$. The car traveling at 60 mph left 150-foot skid marks

5.1.10.7.

Answer.

(a) (60 hours, 78 grams)

(b) $f^{-1}(90) \approx 19$, so that the vampire bat's weight has dropped to 90 grams about 19 hours after its last meal.

5.1.10.9.

Answer.

(a) $g(0.05) = 0.28$. At 5% interest, \$1 earns \$0.28 interest in 5 years.

(b) 8.45%

(c) $g^{-1}(I) = (I+1)^{1/5} - 1$

(d) $g^{-1}(0.50) \approx 0.0845$

5.1.10.11.

Answer.

(a) $f(0.5) \approx 62.9$. At an altitude of 0.5 miles, you can see 62.9 miles to the horizon.

(b) 0.0126 mile, or 66.7 feet

(c) $h = f^{-1}(d) = \dfrac{d^2}{7920}$

(d) $f^{-1}(10) \approx 0.0126$

5.1.10.13.

Answer.

(a) $h^{-1}(3) \approx -4$

(b) $h^{-1}(x) = 5 - x^2$; $h^{-1}(3) = -4$

5.1.10.15.

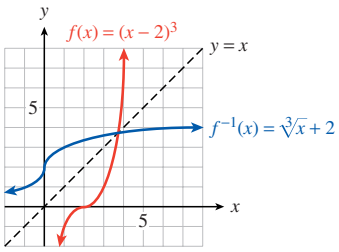
Answer.

(a) $f^{-1}(y) = 3\sqrt[3]{y} + 2$

(b) $f^{-1}(f(4)) = f^{-1}(8) = 4$

(c) $f(f^{-1}(-8)) = f(0) = -8$

(d)



5.1.10.17.

Answer. 6

5.1.10.19.

Answer. $\dfrac{2}{9}$

5.1.10.21.

Answer. 4

5.1.10.23.

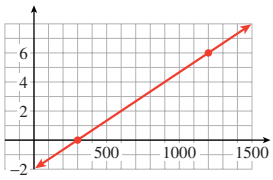
Answer.

(a)

x	0	6
y	300	1200

(b)

x	300	1200
y	0	6



5.1.10.25.

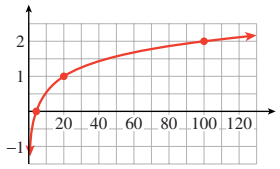
Answer.

(a)

x	0	1	2
y	5	20	100

(b)

x	5	20	100
y	0	1	2

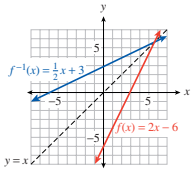


5.1.10.27.

Answer.

(a) $f^{-1}(x) = \dfrac{x+6}{2}$

(b)

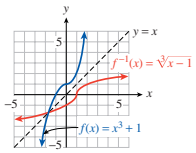


5.1.10.29.

Answer.

(a) $f^{-1}(x) = \sqrt[3]{x-1}$

(b)

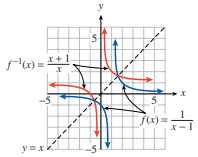


5.1.10.31.

Answer.

(a) $f^{-1}(x) = \dfrac{1}{x} + 1$

(b)



5.1.10.33.

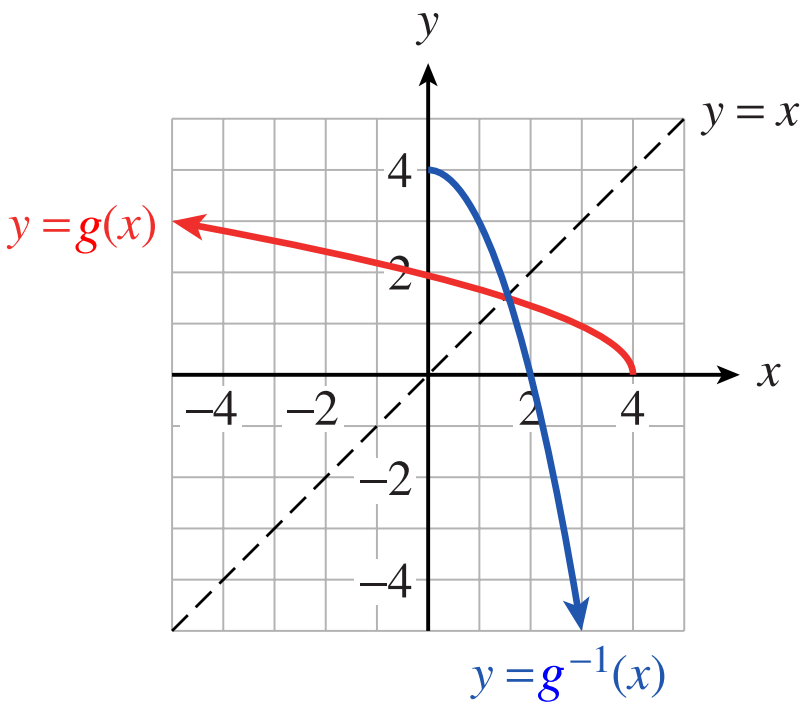
Answer.

(a) Domain: $(-\infty, 4]$; Range: $[0, \infty)$

(b) $g^{-1}(x) = 4 - x^2$

(c) Domain: $[0, \infty)$; Range: $(-\infty, 4]$

(d)



5.1.10.35.
Answer. (a) and (d)

5.1.10.37.
Answer. (a)

5.1.10.39.
Answer. (a)

5.1.10.41.
Answer. (a) and (b)

5.1.10.43.
Answer.

(a) $f(x) = 4 + 2x$; IV

(b) $f(x) = 2 - \frac{x}{2}$; III

(c) $f(x) = -4 - 2x$; I

(d) $f(x) = \frac{x}{2}$; II

5.1.10.45.
Answer.

(a) III (b) II (c) I

5.2 · Logarithmic Functions

5.2.7 · Logarithmic Functions (Homework 5.2)

5.2.7.1.

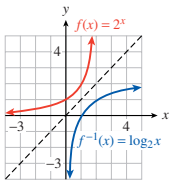
Answer.

(a)

x	-1	0	1	2
2^x	$\frac{1}{2}$	1	2	4

x	$\frac{1}{2}$	1	2	4
$\log_2(x)$	-1	0	1	2

(b)



5.2.7.3.

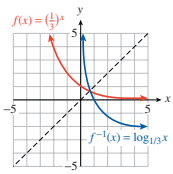
Answer.

(a)

x	-2	-1	0	1
$\left(\frac{1}{3}\right)^x$	9	3	1	$\frac{1}{3}$

x	9	3	1	$\frac{1}{3}$
$\log_{1/3}(x)$	-2	-1	0	1

(b)



5.2.7.5.

Answer.

(a) $x = 10,000$

(b) $x = 10^8$

5.2.7.7.

Answer. $0 < x < 0.01$

5.2.7.9.

Answer.

(a) $\log(100,322) \approx 5.001$

(b) $\log(693) \approx 2.841$

5.2.7.11.

Answer.

(a) $\log(-7)$ is undefined.

(b) $6\log(28) \approx 8.683$

5.2.7.13.

Answer.

(a) 15.614

(b) 0.419

5.2.7.15.

Answer.

(a) 81

(b) 4

(c) Definition of logarithm base 3

(d) 1.8

(e) a

5.2.7.17.

Answer.

(a) 2^8

(b) -2

5.2.7.19.

Answer.

(a) $2k$

(b) x^3

(c) $\sqrt{x}$

(d) $2m$

5.2.7.21.

Answer.

(a) $(9, \infty)$

(b) $f^{-1}(x) = 3^{x-4} + 9$

5.2.7.23.

Answer.

(a) $f^{-1}(x) = \log_4(100 - x) - 2$

(b) $f^{-1}(f(1)) = f^{-1}(36) = \log_4(64) - 2 = 1$

(c) $f\left(f^{-1}(84)\right) = f(0) = 100 - 4^2 = 84$

5.2.7.25.

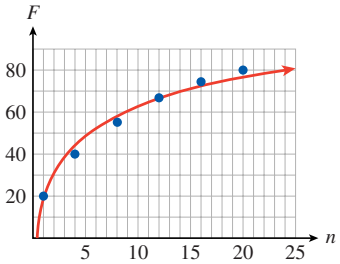
Answer.

(a) IV (b) I (c) II (d) III

5.2.7.27.

Answer.

(a)



(b) The graph resembles a logarithmic function. The (translated) log function is close to the points but appears too steep at first and not steep enough after $n = 15$. Overall, it is a good fit.

(c) f grows (more and more slowly) without bound. f will eventually exceed 100 per cent, but no one can forget more than 100% of what is learned.

5.2.7.29.

Answer.

(a) $10^{1.41} \approx 25.704$

(b) $10^{-1.69} \approx 0.020417$

(c) $10^{0.52} \approx 3.3113$

5.2.7.31.

Answer. $16^w = 256$

5.2.7.33.

Answer. $b^{-2} = 9$

5.2.7.35.

Answer. $10^{-2.3} = A$

5.2.7.37.

Answer. $u^w = v$

5.2.7.39.

Answer. $b = 2$

5.2.7.41.

Answer. $b = 100$

5.2.7.43.

Answer. $x = 11$

5.2.7.45.

Answer. $x = 7^{2/3}$

5.2.7.47.

Answer. $x = 4$

5.2.7.49.

Answer. $x = 11$

5.2.7.51.

Answer. $x = 3$

5.2.7.53.

Answer. No solution

5.2.7.55.

Answer. $A = k(10^{t/T} - 1)$

5.2.7.57.

Answer. $s = \dfrac{b^{N/N_0}}{k}$

5.2.7.59.

Answer. $H = (H_0)^{kM^2}$

5.2.7.61.

Answer.

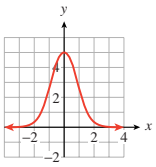
(a) II (c) III (e) I

(b) VI (d) V (f) IV

5.2.7.63.

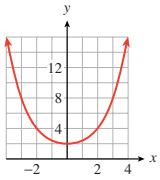
Answer.

(a)



No inverse function

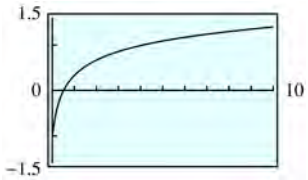
(b)



No inverse function

5.2.7.65.

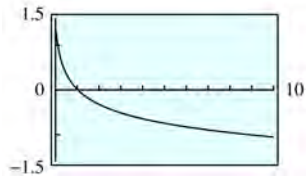
Answer.



The functions are equal.

5.2.7.67.

Answer.



The functions are equal.

5.2.7.69.

Answer.

(a)

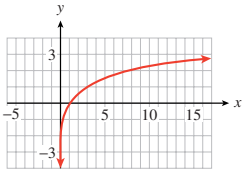
x	x^2	$\log(x)$	$\log(x^2)$
1	1	0	0
2	4	0.301	0.602
3	9	0.477	0.954
4	16	0.602	1.204
5	25	0.699	1.398
6	36	0.778	1.556

(b) $\log(x^2) = 2\log(x)$

5.2.7.71.

Answer.

x	$y = \log_e(x)$
1	0
2	0.693
4	1.386
16	2.772
$\frac{1}{2}$	-0.693
$\frac{1}{4}$	-1.386
$\frac{1}{16}$	-2.772



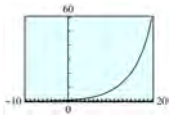
5.3 · The Natural Base

5.3.8 · The Natural Logarithm (Homework 5.3)

5.3.8.1.

Answer.

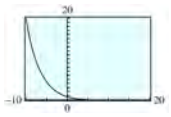
x	-10	-5	0	5	10
$f(x)$	0.135	0.368	1	2.718	7.389



5.3.8.3.

Answer.

x	-10	-5	0	5	10	15	20
$f(x)$	20.086	4.482	1	0.223	0.05	0.011	0.00248



5.3.8.5.

Answer.

(a) 2 (b) $5t$ (c) $\frac{1}{x}$ (d) $\frac{1}{2}$

5.3.8.7.

Answer.

(a) 0.64 (b) 3.81 (c) -1.20

5.3.8.9.

Answer.

(a) 4.14 (b) 1.88 (c) 0.07

5.3.8.11.

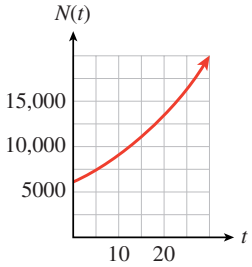
Answer.

(a) $N(t) = 6000e^{0.04t}$

(b)

t	0	5	10	15	20	25	30
$N(t)$	6000	7328	8951	10,933	13,353	16,310	19,921

(c)



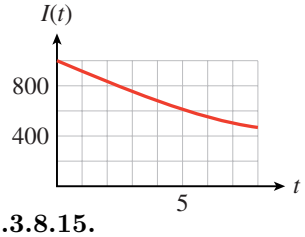
(d) 15,670

(e) 70.3 hrs

5.3.8.13.

Answer.

(a)



(b) 941.8 lumens

(c) 2.2 cm

5.3.8.15.

Answer.
$P(t) = 20\left(e^{0.4}\right)^t \approx 20 \cdot 1.492^t$;
increasing; initial value 20

5.3.8.17.

Answer.
$P(t) = 6500\left(e^{-2.5}\right)^t \approx 6500 \cdot 0.082^t$;
decreasing; initial value 6500

5.3.8.19.

Answer.

(a)

x	0	0.5	1	1.5	2	2.5
e^x	1	1.6487	2.7183	4.4817	7.3891	12.1825

(b) Each ratio is $e^{0.5} \approx 1.6487$: Increasing x-values by a constant $\Delta x = 0.5$ corresponds to multiplying the y-values of the exponential function by a constant factor of $e^{\Delta x}$.

5.3.8.21.

Answer.

(a)

x	0	0.6931	1.3863	2.0794	2.7726	3.4657	4.1589
e^x	1	2	4	8	16	32	64

(b) Each difference in x-values is approximately $\ln(2) \approx 0.6931$: Increasing x-values by a constant $\Delta x = \ln(2)$ corresponds to multiplying the y-values of the exponential function by a constant factor of $e^{\Delta x} = e^{\ln(2)} = 2$. That

is, each function value is approximately equal to double the previous one.

5.3.8.23.

Answer. 0.8277

5.3.8.25.

Answer. -2.9720

5.3.8.27.

Answer. 1.6451

5.3.8.29.

Answer. -3.0713

5.3.8.31.

Answer. $t = \dfrac{1}{k}\ln(y)$

5.3.8.33.

Answer. $t = \ln\left(\dfrac{k}{k-y}\right)$

5.3.8.35.

Answer. $k = e^{T/T_0} - 10$

5.3.8.37.

Answer.

(a)

n	0.39	3.9	39	390
$\ln(n)$	-0.942	1.361	3.664	5.966

(b) Each difference in function values is approximately $\ln(10) \approx 2.303$: Multiplying x-values by a constant factor of 10 corresponds to adding a constant value of ln 10 to the y-values of the natural log function.

5.3.8.39.

Answer.

(a)

n	2	4	8	16
$\ln(n)$	0.693	1.386	2.079	2.773

(b) Each quotient equals k, where $n = 2^k$. Because $\ln(n) = \ln(2^k) = k \cdot \ln(2)$, $k = \dfrac{\ln(n)}{\ln(2)}$.

5.3.8.41.

Answer.

(a) $N(t) = 100e^{(\ln(2))t} \approx 100e^{0.6931t}$

(b) 

5.3.8.43.

Answer.

(a) $N(t) = 1200e^{(\ln(0.6))t} \approx 1200e^{-0.5108t}$

(b) 

5.3.8.45.

Answer.

(a) $N(t) = 10e^{(\ln(1.15))t} \approx 10e^{0.1398t}$

(b) 

5.3.8.47.

Answer.

(a) $20,000$

(b) $\left(\dfrac{35,000}{20,000}\right)^{1/10} \approx e^{0.056}$

(c) $P(t) = 20,000e^{0.056t}$

(d) $107,188$

5.3.8.49.

Answer.

(a) $\left(\dfrac{385}{500}\right)^{1/2} \approx e^{-0.1307}$

(b) $N(t) = 500e^{-0.1307t}$

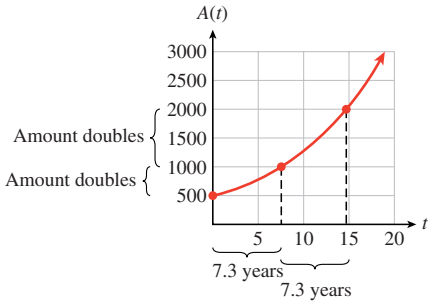
(c) 135.3 mg

5.3.8.51.

Answer.

(a) $A(t) = 500e^{0.095t}$ (b) 7.3 years (c) 7.3 years

d–e



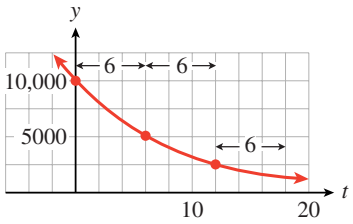
5.3.8.53.

Answer.

(a) 6 hours

(b) 6 hours

(c)

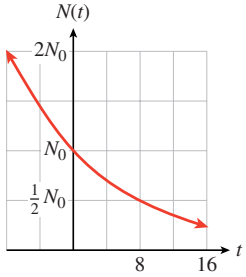


5.3.8.55.

Answer.

(a) $\frac{1}{2}N_0$, $\frac{1}{4}N_0$, $\frac{1}{16}N_0$

(b)

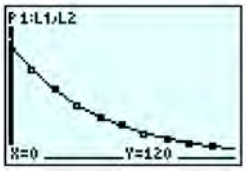


(c) $N(t) = N_0e^{-0.0866t}$

5.3.8.57.

Answer.

(a)



$y = 116(0.975)^t$

(b) $G(t) = 116e^{-0.025t}$

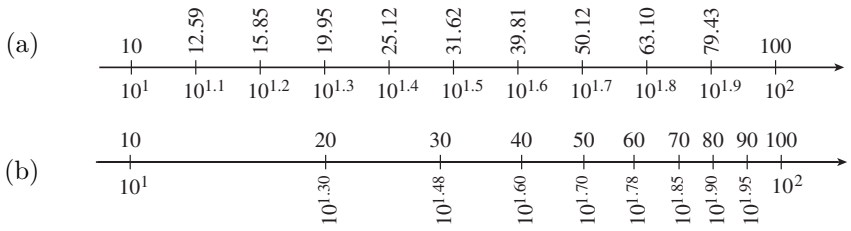
(c) 28 minutes

5.4 · Logarithmic Scales

5.4.8 · Logarithmic Scales (Homework 5.4)

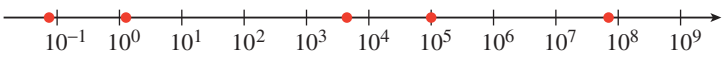
5.4.8.1.

Answer.



5.4.8.3.

Answer.



5.4.8.5.

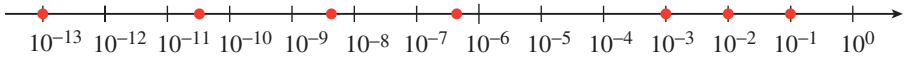
Answer. 1.58, 6.31, 15.8, 63.1

5.4.8.7.

Answer. 1, 80, 330, 1600, 7000, 4×10^7

5.4.8.9.

Answer.



5.4.8.11.

Answer. Proxima Centauri: 15.5; Barnard: 13.2; Sirius: 1.4; Vega: 0.6; Arcturus: -0.4; Antares: -4.7; Betelgeuse: -7.2

5.4.8.13.

Answer.

(a) 1

(b) 0.5012

(c) 0.1259

(d) 0.01

(e) 0.000079

(f) 3.2×10^{-7}

(g) 2×10^{-8}

(h) 8×10^{-10}

5.4.8.15.

Answer.

(a) $10^{1.75} \approx 56.2341$

(b) $10^{(\log(600))/2} \approx 24.4949$

5.4.8.17.

Answer. $10^{3.4} \approx 2512$

5.4.8.19.

Answer. A: $a \approx 45$, $p \approx 7.4\%$; B: $a \approx 400$, $p \approx 15\%$; C: $a \approx 6000$, $p \approx 50\%$; D: $a \approx 13000$, $p \approx 45\%$

5.4.8.21.

Answer. 3.2

5.4.8.23.

Answer. 0.0126

5.4.8.25.

Answer. 100

5.4.8.27.

Answer. $6,309,573$ watts per square meter

5.4.8.29.

Answer. 1000

5.4.8.31.

Answer. 12.6

5.4.8.33.

Answer. 100

5.4.8.35.

Answer. $\approx 25,000$

5.4.8.37.

Answer. 4.7

5.4.8.39.

Answer. 53

5.5 · Chapter Summary and Review

5.5.2 · Chapter 5 Review Problems

5.5.2.1.

Answer.

y	-1	1	3	11
$x = f^{-1}(y)$	-1	0	1	2

5.5.2.3.

Answer.

y	0	$\frac{-1}{3}$	-1	-3
$w = g^{-1}(y)$	-1	0	1	2

5.5.2.5.

Answer.

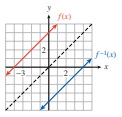
(a) $P^{-1}(350) = 40$

(b) $P^{-1}(100) = 0$

5.5.2.7.

Answer.

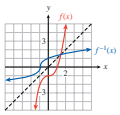
(a) $f^{-1}(x) = x - 4$

(b) 

5.5.2.9.

Answer.

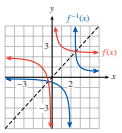
(a) $f^{-1}(x) = \sqrt[3]{x+1}$

(b) 

5.5.2.11.

Answer.

(a) $f^{-1}(x) = \dfrac{1}{x-2}$

(b) 

5.5.2.13.

Answer. 0

5.5.2.15.

Answer.

(a) $f^{-1}(300) = 200$: \$200,000 in advertising results in \$300,000 in revenue.

(b) $f(A) = 250$ or $A = f^{-1}(250)$

5.5.2.17.

Answer. $10^z = 0.001$

5.5.2.19.

Answer. $2^{x-2} = 3$

5.5.2.21.

Answer. $b^3 = 3x + 1$

5.5.2.23.

Answer. $n^{p-1} = q$

5.5.2.25.

Answer. $6n$

5.5.2.27.

Answer. $2x + 6$

5.5.2.29.

Answer. -1

5.5.2.31.

Answer. $\frac{1}{2}$

5.5.2.33.

Answer. 4

5.5.2.35.

Answer. $\frac{-15}{8}$

5.5.2.37.

Answer. $\frac{9}{4}$

5.5.2.39.

Answer. 3

5.5.2.41.

Answer. $x \approx 1.548$

5.5.2.43.

Answer. $x \approx 411.58$

5.5.2.45.

Answer. $x \approx 2.286$

5.5.2.47.

Answer. $\sqrt{x}$

5.5.2.49.

Answer. $k - 3$

5.5.2.51.

Answer.

(a) $P = 7,894,862e^{-0.011t}$ (b) 1.095%

5.5.2.53.

Answer.

(a) \$1419.07 (b) 13.9 years (c) $t = 20 \ln\left(\frac{A}{1000}\right)$

5.5.2.55.

Answer. $t = \frac{-1}{k} \ln\left(\frac{y-6}{12}\right)$

5.5.2.57.

Answer. $M = N^{Qt}$

5.5.2.59.

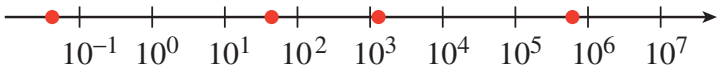
Answer. $P(t) = 750(1.3771)^t$

5.5.2.61.

Answer. $N(t) = 600e^{-0.9163t}$

5.5.2.63.

Answer.



5.5.2.65.

Answer. Order 3: 17,000; Order 4: 5000; Order 8: 40; Order 9: 11

5.5.2.67.

Answer. 5×10^{-7}

5.5.2.69.

Answer. 3160

6 · Quadratic Functions

6.1 · Factors and x-Intercepts

6.1.7 · Factors and x-intercepts (Homework 6.1)

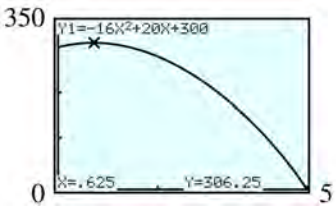
6.1.7.1.

Answer.

(a)

t	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
h	300	306	304	294	276	250	216	174	124	66	0

(b)



(c) 306.25 ft at 0.625 sec

(d) 1.25 sec

(e) 5 sec

6.1.7.3.

Answer. $\frac{-5}{2}$, 2

6.1.7.5.

Answer. 0, $\frac{-10}{3}$

6.1.7.7.

Answer. $\frac{-3}{4}$, -8

6.1.7.9.

Answer. 4

6.1.7.11.

Answer. $\frac{1}{2}$, -3

6.1.7.13.

Answer. 0, 3

6.1.7.15.

Answer. 1

6.1.7.17.

Answer. $\frac{1}{2}$, 1

6.1.7.19.

Answer. 2, 3

6.1.7.21.

Answer. -1, 2

6.1.7.23.

Answer. -3, 6

6.1.7.25.

Answer. The 3 graphs have the same x-intercepts. In general, the graph of $y = ax^2 + bx + c$ has the same x-intercepts as the graph of $y = k(ax^2 + bx + c)$.

6.1.7.27.

Answer. The 3 graphs have the same x-intercepts. In general, the graph of $y = ax^2 + bx + c$ has the same x-intercepts as the graph of $y = k(ax^2 + bx + c)$.

6.1.7.29.

Answer.
$x^2 + x - 2 = 0$

6.1.7.31.

Answer.
$x^2 + 5x = 0$

6.1.7.33.

Answer.
$2x^2 + 5x - 3 = 0$

6.1.7.35.

Answer.
$8x^2 - 10x - 3 = 0$

6.1.7.37.

Answer.
$f(x) = 0.1(x - 18)(x + 15)$

6.1.7.39.

Answer.
$g(x) = -0.08(x - 18)(x + 32)$

6.1.7.41.

Answer.

(a) $10^2 + h^2 = (h + 2)^2$

(b) 24 ft

6.1.7.43.

Answer.

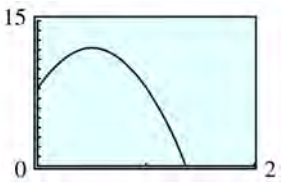
(a) $h = -16t^2 + 16t + 8$

(b) 12 ft; 8 ft

(c) $11 = -16t^2 + 16t + 8$; at $\frac{1}{4}$ sec and $\frac{3}{4}$ sec

(d) $\Delta\text{Tbl} = 0.25$

(e)



(f) 1.37 sec

6.1.7.45.

Answer.

(a)

Width	Length	Area
10	170	1700
20	160	3200
30	150	4500
40	140	5600
50	130	6500
60	120	7200
70	110	7700
80	100	8000

(b) $l = 180 - x$, $A = 180x - x^2$; 80 yd by 100 yd

(c) $180x - x^2 = 8000$, 80 yd by 100 yd, or 100 yd by 80 yd. There are two solutions because the pasture can be oriented in two directions.

6.1.7.47.

Answer.

(a) $l = x - 4$, $w = x - 4$, $h = 2$, $V = 2(x-4)^2$

(b)

x	4	5	6	7	8	9	10
V	0	2	8	18	32	50	72

(c) As x increases, V increases.

(d) 9 inches by 9 inches.

(e) $2(x-4)^2 = 50$, $x = 9$

6.1.7.49.

Answer.

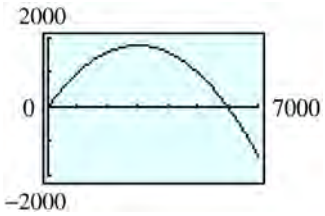
(a)

x	0	500	1000	1500	2000	2500	3000	3500
I	0	550	1000	1350	1600	1750	1800	1750

x	4000	4500	5000	5500	6000	6500	7000
I	1600	1350	1000	550	0	−650	−1400

(b) 1600, 1000, −1400

(c)



(d) No increase

(e) 3000; 1800

6.1.7.51.

Answer. ± 1

6.1.7.53.

Answer. $\sqrt[3]{-3/4}$, 1

6.1.7.55.

Answer. $-27,\ 1$

6.1.7.57.

Answer. $\log(2),\ \log(3)$

6.1.7.59.

Answer. $1,\ 2$

6.1.7.61.

Answer. $\dfrac{-1}{6},\ 1$

6.1.7.63.

Answer.

(a) $A = \dfrac{1}{2}(x^2 - y^2)$

(b) $A = \dfrac{1}{2}(x - y)(x + y)$

(c) 18 sq ft

6.2 · Solving Quadratic Equations

6.2.8 · Solving Quadratic Equations (Homework 6.2)

6.2.8.1.

Answer.

(a) $(x + 4)^2$

(b) $\left(x - \dfrac{7}{2}\right)^2$

(c) $\left(x + \dfrac{3}{4}\right)^2$

(d) $\left(x - \dfrac{2}{5}\right)^2$

6.2.8.3.

Answer. 1

6.2.8.5.

Answer. $-4,\ -5$

6.2.8.7.

Answer. $\dfrac{3}{2} \pm \sqrt{\dfrac{21}{4}} = \dfrac{-3 \pm \sqrt{21}}{2}$

6.2.8.9.

Answer. $-1 \pm \sqrt{\dfrac{5}{2}}$

6.2.8.11.

Answer. $\dfrac{-4}{3},\ 1$

6.2.8.13.

Answer. $\dfrac{1}{4} \pm \sqrt{\dfrac{13}{16}} = \dfrac{1 \pm \sqrt{13}}{4}$

6.2.8.15.

Answer. $-1,\ \dfrac{4}{3}$

6.2.8.17.

Answer. $-2,\ \dfrac{2}{5}$

6.2.8.19.

Answer.
$-1 \pm \sqrt{1 - c}$

6.2.8.21.

Answer.
$-\dfrac{b}{2} \pm \sqrt{\dfrac{b^2 - 4}{4}} = \dfrac{-b \pm \sqrt{b^2 - 4}}{2}$

6.2.8.23.

Answer.
$\dfrac{-1 \pm \sqrt{4a + 1}}{a}$

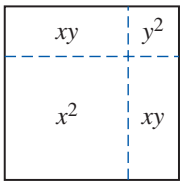
6.2.8.25.

Answer.

(a) $A = (x + y)^2$

(b) $A = x^2 + 2xy + y^2$

(c) $x^2,\ xy,\ xy,\ y^2$



6.2.8.27.

Answer. $1.618,\ -0.618$

6.2.8.29.

Answer. $1.449,\ -3.449$

6.2.8.31.

Answer. 1.695, -0.295

6.2.8.33.

Answer. 1.434, 0.232

6.2.8.35.

Answer. -5.894, 39.740

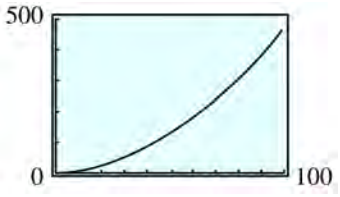
6.2.8.37.

Answer.

(a)

s	10	20	30	40	50	60	70	80	90	100
d	9	27	53	87	129	180	239	307	383	467

(b)



(c) $\dfrac{s^2}{24} + \dfrac{s}{2} = 50$; 29.16 mph

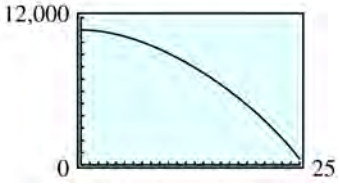
6.2.8.39.

Answer.

(a)

t	0	5	10	15	20	25
h	11,000	10,520	9240	7160	4280	600

(b)



(c) $-16t^2 - 16t + 11,000 = 1000$; 24.5 sec

(d) 1.2 sec

6.2.8.41.

Answer.

(a) $2l + 4w = 100$

(b) $l = 50 - 2w$

(c) $w(50 - 2w) = 250$; $w = 6.91,\ 18.09$

(d) 12.06 m by 6.91 m, or 4.61 m by 18.09 m

6.2.8.43.

Answer.

(a) 47.2 mi

(b) 1.26 mi

6.2.8.45.

Answer.

$w = \dfrac{-4l \pm \sqrt{16l^2 + 8A}}{4} = \dfrac{-2l \pm \sqrt{4l^2 + 2A}}{2}$

6.2.8.47.

Answer.

$t = \dfrac{4 \pm \sqrt{16 + 64h}}{32} = \dfrac{1 \pm \sqrt{1 + 4h}}{8}$

6.2.8.49.

Answer. $t = \dfrac{v \pm \sqrt{v^2 - 2as}}{a}$

6.2.8.51.

Answer. $y = \dfrac{-x \pm \sqrt{8 - 11x^2}}{2}$

6.2.8.53.

Answer. $0,\ x^2$

6.2.8.55.

Answer. $\dfrac{-3x \pm 3}{2}$

6.2.8.57.

Answer. $\dfrac{\pm\sqrt{4x^2 - 36}}{3} = \dfrac{\pm 2\sqrt{x^2 - 9}}{3}$

6.2.8.59.

Answer. $\dfrac{\pm 2x}{5}$

6.2.8.61.

Answer. $3 \pm \sqrt{\dfrac{V}{\pi h}}$

6.2.8.63.

Answer. $\pm\sqrt{\dfrac{2(E - mgh)}{m}}$

6.2.8.65.

Answer. $\pm\sqrt{\dfrac{V}{2w} - s^2}$

6.2.8.67.

Answer. $\dfrac{-b}{2a}$

6.2.8.69.

Answer. $\dfrac{-b \pm \sqrt{b^2 - 4c}}{2}$

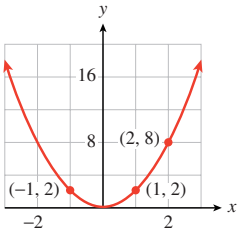
6.3 · Graphing Parabolas

6.3.9 · Graphing Parabolas (Homework 6.3)

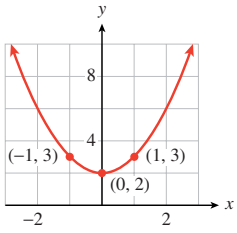
6.3.9.1.

Answer.

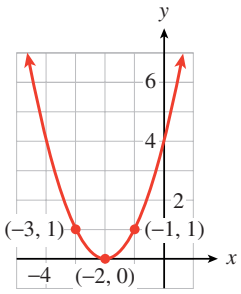
(a) The parabola opens up, twice as steep as the standard parabola.



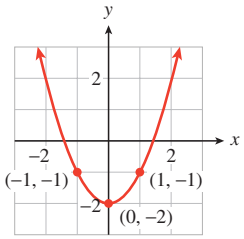
(b) The parabola is the standard parabola shifted 2 units up.



(c) The parabola is the standard parabola shifted 2 units left.

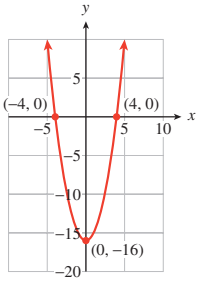


(d) The parabola is the standard parabola shifted 2 units down.

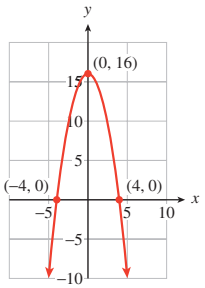


6.3.9.3.
Answer.

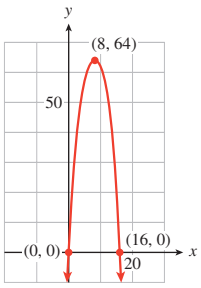
a Vertex $(0, -16)$; x-intercepts $(\pm 4, 0)$



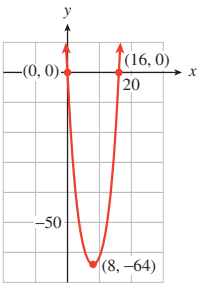
b Vertex $(0, 16)$; x-intercepts $(\pm 4, 0)$



c Vertex $(8, 64)$; x-intercepts $(0, 0)$ and $(16, 0)$



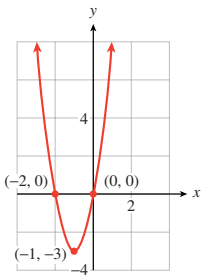
d Vertex $(8, -64)$; x-intercepts $(0, 0)$ and $(16, 0)$



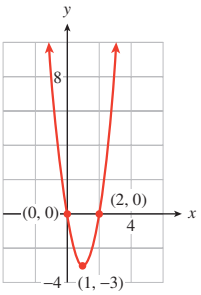
6.3.9.5.

Answer.

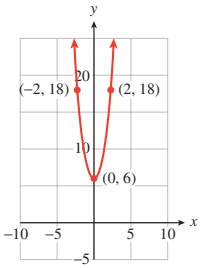
a Vertex $(1, -3)$; x-intercepts $(0, 0)$ and $(-2, 0)$



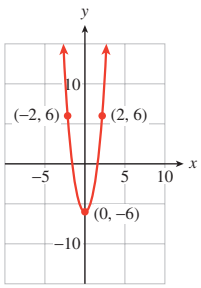
b Vertex $(1, -3)$; x-intercepts $(0, 0)$ and $(2, 0)$



c Vertex $(0, 6)$; no x-intercepts



d Vertex $(0, -6)$; x-intercepts $(\pm\sqrt{2}, 0)$



6.3.9.7.

Answer.

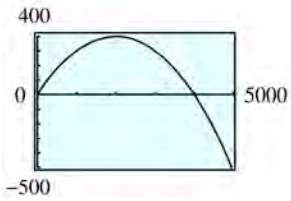
(a) II (b) IV (c) I (d) III (e) VI (f) V

6.3.9.9.

Answer.

(a) $(2000, 400)$; The largest annual increase in biomass, 400 tons, occurs when the biomass is 2000 tons.

(b)



(c) $4000 < x \leq 5000$; When there are too many fish, there will not be enough food to support all of them.

6.3.9.11.

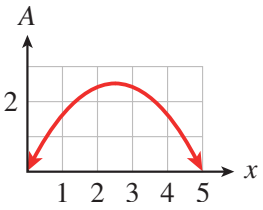
Answer.

(a)

x	1	2	3	4	5
y	1.6	1.2	0.8	0.4	0
A	1.6	2.4	2.4	1.6	0

(b) $A = x(2 - 0.4x)$ or $A = 2x - 0.4x^2$

(c)

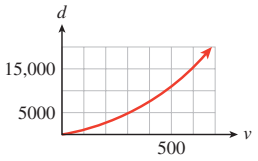


(d) The maximum number of young marmots, on average, is 2.5; the optimal number of female marmots is 2.5.

6.3.9.13.

Answer.

(a)



Vertex: $(-6, -1.5)$; Horizontal intercepts $(-12, 0)$ and $(0, 0)$. The point $(0, 0)$ means that no distance is required to stop a plane that is not moving.

(b) 594 ft/sec

6.3.9.15.

Answer.

(a) $\left(\frac{3}{2}, \frac{17}{4}\right)$, maximum

(b) $\left(\frac{2}{3}, \frac{1}{9}\right)$, minimum

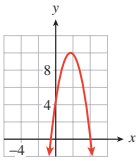
(c) $(-4.5, 18.5)$, maximum

6.3.9.17.

Answer.

(a) x-intercepts: $\left(\frac{-1}{2}, 0\right)$ and $(4, 0)$; y-intercept: $(0, 4)$; vertex: $\left(\frac{7}{4}, \frac{81}{8}\right)$

(b)

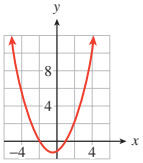


6.3.9.19.

Answer.

(a) x-intercepts: $(-2, 0)$ and $(1, 0)$; y-intercept: $(0, -1.2)$; vertex: $(-0.5, -1.35)$

(b)

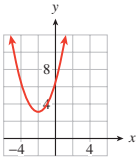


6.3.9.21.

Answer.

(a) No x-intercepts; y-intercept: $(0, 7)$; vertex: $(-2, 3)$

(b)

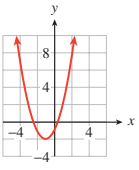


6.3.9.23.

Answer.

(a) x-intercepts: $\left(-1 \pm \sqrt{2}, 0\right)$; y-intercept: $(0, -1)$; vertex: $(-1, -2)$

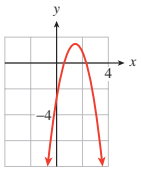
(b)



6.3.9.25.

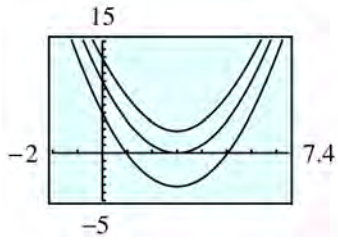
Answer.

(a) x-intercepts: $\left(\frac{3 \pm \sqrt{3}}{2}, 0\right)$; y-intercept: $(0, -3)$; vertex: $\left(\frac{3}{2}, \frac{3}{2}\right)$

(b) 

6.3.9.27.

Answer.

(a) 

$f(x) = x^2 - 6x + 5$: x-intercepts $(1, 0)$ and $(5, 0)$; $g(x) = x^2 - 6x + 9$: x-intercept $(3, 0)$; $h(x) = x^2 - 6x + 12$: No x-intercept.

(b) $16, 0, -12$: $D = 16$ means that there are two rational x-intercepts, $D = 0$ means that there is exactly one x-intercept, $D = -12$ means that there is no x-intercept.

6.3.9.29.

Answer. Two complex solutions

6.3.9.31.

Answer. One repeated rational solution

6.3.9.33.

Answer. Two distinct real solutions

6.3.9.35.

Answer. No

6.3.9.37.

Answer. Yes

6.3.9.39.

Answer.

(a) $2 - \sqrt{5}$

(b) $x^2 - 4x - 1 = 0$

6.3.9.41.

Answer.

(a) $4 + 3\sqrt{2}$

(b) $x^2 - 8x - 2 = 0$

6.3.9.43.

Answer.

(a) IV (b) V (c) I (d) VII

6.3.9.45.

Answer.

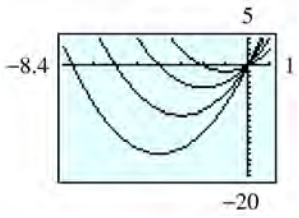
(a) $y = x^2 + x - 6;\ \ x = \dfrac{-1}{2}$

(b) $y = 2x^2 + 2x - 12;\ \ x = \dfrac{-1}{2}$

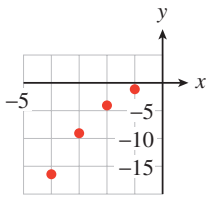
6.3.9.47.

Answer.

(a)



(b)



$(-1, -1), (-2, -4), (-3, -9), (-4, -16)$

(c) $y = -x^2$

(d) The vertex of $y = x^2 + 2kx$ is $(-k, -k^2)$

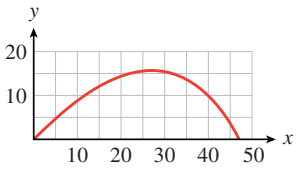
6.3.9.49.

Answer.

(a)

t	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5
x	0	6.075	11.5	16.275	20.4	23.875	26.7	28.875
y	0	7.44	12.48	15.12	15.36	13.2	8.64	1.68

(b)



(c) $y \approx 15.4$ m

(d) $x \approx 30$ m

(e) 3.6 sec

(f) $x \approx 29.2$ m

(g) $y \approx 15.55$ m

6.4 · Problem Solving

6.4.6 · Problem Solving (Homework 6.4)

6.4.6.1.

Answer.

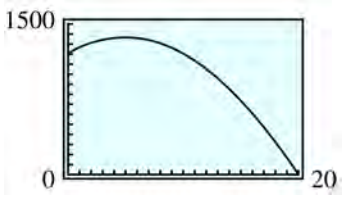
(a)

No. of price increases	Price of room	No. of rooms rented	Total revenue
0	20	60	1200
1	22	57	1254
2	24	54	1296
3	26	51	1326
4	28	48	1344
5	30	45	1350
6	32	42	1344
7	34	39	1326
8	36	36	1296
10	40	30	1200
12	44	24	1056
16	52	12	624
20	60	0	0

(b) Price of a room: $20+2x$; Rooms rented: $60-3x$; Revenue: $1200+60x-6x^2$

(c) 20

(d)



(e) \$24; \$36

(f) \$1350; \$30; 45 rooms

6.4.6.3.

Answer.

(a) (For example) 10 m by 20 m with area 200 sq m; or 15 m by 15 m, area 225 sq m

(b) $30 - x$

(c) $30x - x^2$

6.4.6.5.

Answer. 3 sec, 144 ft

6.4.6.7.

Answer. 100 baskets, \$2000

6.4.6.9.

Answer.

(a) Length: $50 - w$; Area: $50w - w^2$

(b) 625 sq in

6.4.6.11.

Answer.

(a) $300w - 2w^2$ (b) 11,250 sq yd

6.4.6.13.

Answer.

(a) Number of people: $16 + x$; Price per person: $2400 - 100x$; Total revenue: $38,400 + 800x - 100x^2$

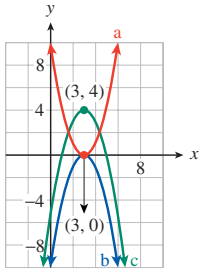
(b) 20

6.4.6.15.

Answer. $a = 0.9$; $I = \$865.80$

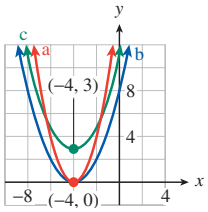
6.4.6.17.

Answer.



6.4.6.19.

Answer.

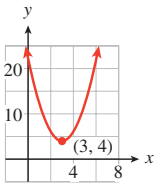


6.4.6.21.

Answer.

(a) $(3, 4)$

(b)



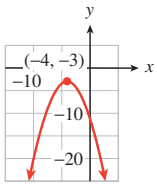
(c) $y = 2x^2 - 12x + 22$

6.4.6.23.

Answer.

(a) $(-4, -3)$

(b)



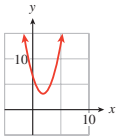
(c) $y = \dfrac{-1}{2}x^2 - 4x - 11$

6.4.6.25.

Answer.

(a) $y = (x - 2)^2 + 3$

(b)

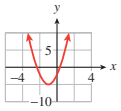


6.4.6.27.

Answer.

(a) $y = 3(x+1)^2 - 5$

(b)

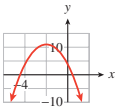


6.4.6.29.

Answer.

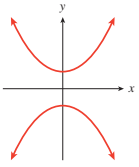
(a) $y = -2(x + 2)^2 + 11$

(b)

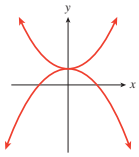


6.4.6.31.

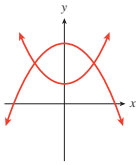
Answer. No solutions:



One solution:



Two solutions:



6.4.6.33.

Answer. $(-1, 12), (4, 7)$

6.4.6.35.

Answer. $(-2, 7)$

6.4.6.37.

Answer. No solution

6.4.6.39.

Answer. $(-2, -5), (5, 16)$

6.4.6.41.

Answer. $(1, 4)$

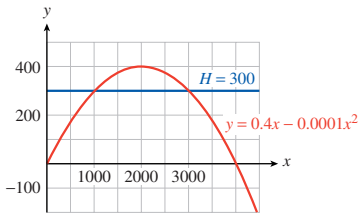
6.4.6.43.

Answer. $(3, 1)$

6.4.6.45.

Answer.

(a)



(b) Larger, by 75 tons. Smaller, by 125 tons.

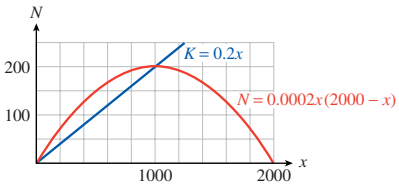
(c) 1000 tons and 3000 tons

(d) The fish population will decrease each year until it is completely depleted.

6.4.6.47.

Answer.

(a)



(b) $K > N$. The population will decrease by 48 bears.

(c) The population will increase by 18 bears.

(d) 1000

(e) Populations between 0 and 1000 will increase; populations over 1000 will decrease.

(f) 1000 (unless the population is 0)

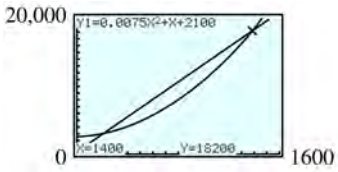
(g) 500 (unless the population is 0)

6.4.6.49.

Answer.

(a) $(200,\ 2600), (1400,\ 18,200)$

(b)



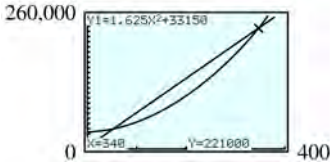
(c) $x = 800$

6.4.6.51.

Answer.

(a) $(60,\ 39,000), (340,\ 221,000)$

(b)

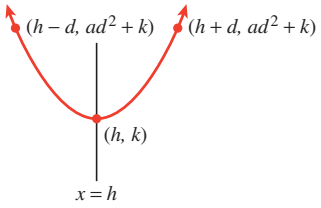


(c) $x = 200$

6.4.6.53.

Answer.

(a)



(b) See graph and (c)

(c) $ad^2 + k$

(d) The two points on the parabola that are the same horizontal distance from the line $x = h$ the axis of symmetry have the same y-coordinate, so they are symmetric about that line.

6.5 · Chapter Summary and Review

6.5.2 · Chapter 6 Review Problems

6.5.2.1.

Answer. $0,\ \dfrac{-5}{2}$

6.5.2.3.

Answer. $-1,\ 2$

6.5.2.5.

Answer. $-2,\ 3$

6.5.2.7.

Answer. $4x^2 - 29x - 24 = 0$

6.5.2.9.

Answer. $y = (x-3)(x+2.4)$

6.5.2.11.

Answer. $1,\ 2$

6.5.2.13.

Answer. $-1,\ \dfrac{1}{4}$

6.5.2.15.

Answer. $2 \pm \sqrt{10}$

6.5.2.17.

Answer. $\dfrac{3 \pm \sqrt{3}}{2}$

6.5.2.19.

Answer. $1,\ 2$

6.5.2.21.

Answer. $2 \pm \sqrt{2}$

6.5.2.23.

Answer. $\pm\sqrt{\dfrac{2K}{m}}$

6.5.2.25.

Answer. $\dfrac{3 \pm \sqrt{9-3h}}{3}$

6.5.2.27.

Answer. 9

6.5.2.29.

Answer. 10 ft by 18 ft or 12 ft by 15 ft

6.5.2.31.

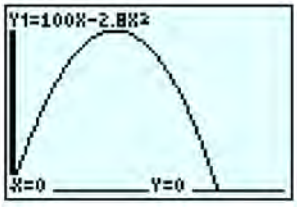
Answer. 1 sec

6.5.2.33.

Answer.

(a) $h = 100t - 2.8t^2$

(b)



(c) 893 ft

(d) $15\frac{5}{7}$ sec on the way up and 20 sec on the way down

6.5.2.35.

Answer. A_1 is the area of a square minus the area of two triangles:

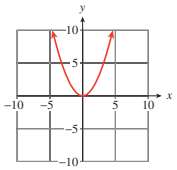
$$x^2 - 2\left(\frac{1}{2}y \cdot y\right) = x^2 - y^2$$

6.5.2.37.

Answer.

(a) Vertex and intercepts are all $(0,0)$.

(b)

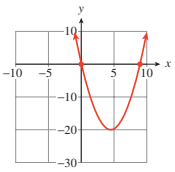


6.5.2.39.

Answer.

(a) Vertex $(\frac{9}{2}, \frac{-81}{4})$; x-intercepts $(9,0)$ and $(0,0)$; y-intercept $(0,0)$

(b)

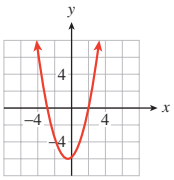


6.5.2.41.

Answer.

(a) Vertex $(\frac{-1}{2}, \frac{-25}{4})$; x-intercepts $(-3,0)$ and $(2,0)$; y-intercept $(0,-6)$

(b)

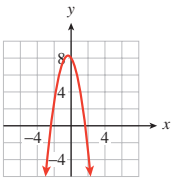


6.5.2.43.

Answer.

(a) Vertex $(\frac{-1}{4}, \frac{65}{8})$; x-intercepts $\left(\frac{-1 \pm \sqrt{65}}{4}, 0\right)$; y-intercept $(0,8)$

(b)

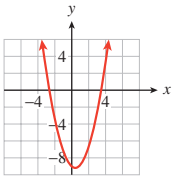


6.5.2.45.

Answer.

(a) Vertex $(\frac{1}{2}, \frac{-37}{4})$; x-intercepts $\left(\frac{1 \pm \sqrt{37}}{2}, 0\right)$; y-intercept $(0,-9)$

(b)



6.5.2.47.

Answer. Two

6.5.2.49.

Answer. One rational solution

6.5.2.51.

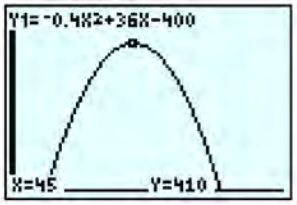
Answer. No real solutions

6.5.2.53.

Answer.

(a) 45; \$410

(b)



6.5.2.55.

Answer.

(a) $y = 60(4 + x)(32 - 4x)$

(b) 2

6.5.2.57.

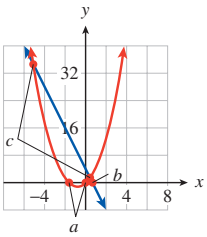
Answer.

(a) $0, \ \dfrac{-3}{2}$

(b) $\dfrac{5}{6}$

(c) $-5, \ \dfrac{1}{2}$

(d)



6.5.2.59.

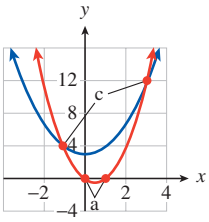
Answer.

(a) 0, 1

(b) None

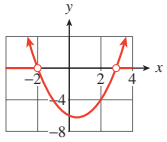
(c) $-1, \ 3$

(d)



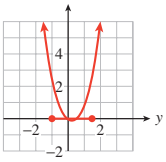
6.5.2.61.

Answer. $(-\infty, -2) \cup (3, \infty)$



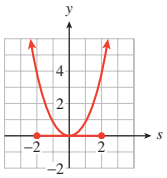
6.5.2.63.

Answer. $\left[-1, \dfrac{3}{2}\right]$



6.5.2.65.

Answer. $[-2, 2]$



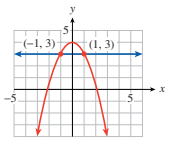
6.5.2.67.

Answer.

(a) $R = p\left(220 - \frac{1}{4}p\right)$

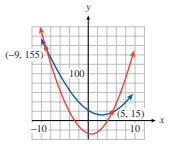
6.5.2.69.

Answer. $(1, 3),\ (-1, 3)$



6.5.2.73.

Answer. $(-9, 155),\ (5, 15)$



6.5.2.77.

Answer. $a = 1,\ b = -1,\ c = -6$

6.5.2.79.

Answer. $p(x) = \frac{-1}{2}x^2 - 4x + 10$

6.5.2.81.

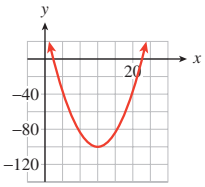
Answer. $y = 0.2(x - 15)^2 - 6$

6.5.2.83.

Answer.

(a) $f(x) = (x - 12)^2 - 100$

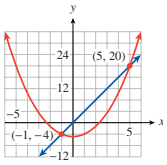
(b)



(b) Between \$4.00 and \$4.80

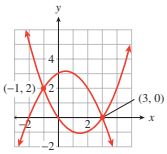
6.5.2.71.

Answer. $(-1, -4),\ (5, 20)$



6.5.2.75.

Answer. $(-1, 2),\ (3, 0)$

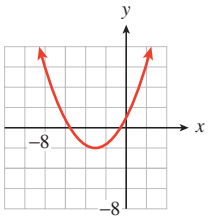


6.5.2.85.

Answer.

(a) $y = \frac{1}{3}(x + 3)^2 - 2$

(b)



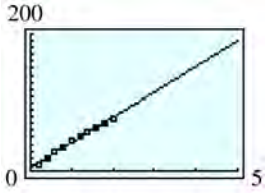
6.5.2.87.

Answer.

(a) $h = 36.98t + 5.17$

(b) 116.1 m, 153.1 m

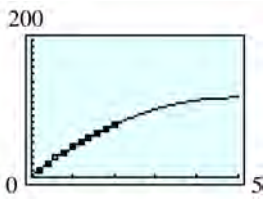
(c)



(d) $h = -4.858t^2 + 47.67t + 0.89$

(e) 100.2 m, 113.9 m

(f)



(g) Quadratic: Gravity will slow the cannonball, giving the graph a concave down shape.

7 · Polynomial and Rational Functions

7.1 · Polynomial Functions

7.1.6 · Polynomial Functions (Homework 7.1)

7.1.6.1.

Answer. $12x^3 - 5x^2 - 8x + 4$

7.1.6.3.

Answer. $x^3 - 6x^2 + 11x - 6$

7.1.6.5.

Answer. $6a^4 - 5a^3 - 5a^2 + 5a - 1$

7.1.6.7.

Answer. $y^4 + 5y^3 - 20y - 16$

7.1.6.9.

Answer. $6 + x + 5x^2$

7.1.6.11.

Answer. $4 - 7x^2 - 8x^4$

7.1.6.13.

Answer. $0x^2$

7.1.6.15.

Answer. $-8x^3$

7.1.6.17.

Answer.

(a) 4 (b) 5 (c) 7

7.1.6.19.

Answer.
$$\begin{aligned}(x+y)^3 &= (x+y)(x+y)^2\\ &= (x+y)(x^2+2xy+y^2)\\ &= x^3+2x^2y+xy^2+x^2y+2xy^2+y^3\\ &= x^3+3x^2y+3xy^2+y^3\end{aligned}$$

7.1.6.21.

Answer.
$$\begin{aligned}(x+y)(x^2-xy+y^2) &= x^3-x^2y+xy^2+x^2y-xy^2+y^3\\ &= x^3+y^3\end{aligned}$$

7.1.6.23.

Answer.

(a) The formula begins with x^3 and ends with y^3. As you proceed from term to term, the exponents on x decrease while the exponents on y increase, and on each term the sum of the exponents is 3. The coefficients of the two middle terms are both 3.

(b) The formula is the same as for $(x-y)^3$, except that the terms alternate in sign.

7.1.6.25.

Answer. $1 + 6z + 12z^2 + 8z^3$

7.1.6.27.

Answer. $1 - 15\sqrt{t} + 75t - 125t\sqrt{t}$

7.1.6.29.

Answer. $x^3 - 1$

7.1.6.31.

Answer. $8x^3 + 1$

7.1.6.33.

Answer. $27a^3 - 8b^3$

7.1.6.35.

Answer. $(x+3)(x^2-3x+9)$

7.1.6.37.

Answer. $(a-2b)(a^2+2ab+4b^2)$

7.1.6.39.

Answer. $(xy^2 - 1)(x^2y^4 + xy^2 + 1)$

7.1.6.41.

Answer. $(3a + 4b)(9a^2 - 12ab + 16b^2)$

7.1.6.43.

Answer. $(5ab - 1)(25a^2b^2 + 5ab + 1)$

7.1.6.45.

Answer. $(4t^3 + w^2)(16t^6 - 4t^3w^2 + w^4)$

7.1.6.47.

Answer.

(a) $\left(6 - \frac{5}{4}\pi\right) x^2$

(b) ≈ 132.67 square inches

7.1.6.49.

Answer.

(a) $\frac{2}{3}\pi r^3 + \pi r^2 h$

(b) $V(r) = \frac{14}{3}\pi r^3$

7.1.6.51.

Answer.

(a) $500(1+r)^2$; $500(1+r)^3$; $500(1+r)^4$

(b) $500r^2 + 1000r + 500$; $500r^3 + 1500r^2 + 1500r + 500$; $500r^4 + 2000r^3 + 3000r^2 + 2000r + 500$

(c) \$583.20, \$629.86, \$680.24

7.1.6.53.

Answer.

(a) Length: $16 - 2x$; Width: $12 - 2x$; Height: x

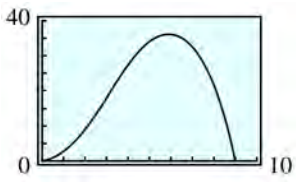
(b) $V = x(16 - 2x)(12 - 2x)$

(c) Real numbers between 0 and 6

(d)

x	1	2	3	4	5
V	140	192	180	128	60

(e)



(f) 2.26 in, 194.07 cu in

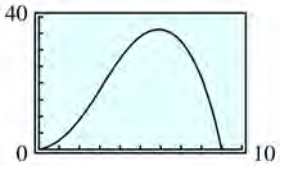
7.1.6.55.

Answer.

(a) $0, 9$

(b) $0 \leq x \leq 9$; $R \geq 0$ for these values

(c)



(d) $\frac{28}{3}$ points

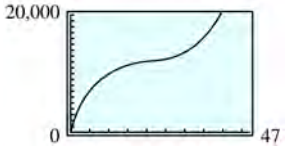
(e) 36 points

(f) 3 ml or 8.2 ml

7.1.6.57.

Answer.

(a)



(b) 900; 11,145; 15,078

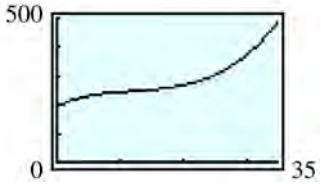
(c) 1341; 171; 627

(d) Between 1990 and 1991

7.1.6.59.

Answer.

(a)



(b) The graph is concave down until about $x = 12.5$ and is concave up afterwards. The cost is growing at the slowest rate at the inflection point at about $x = 12.5$, or 1250 students.

(c) About 2890

7.1.6.61.

Answer.

(a) 20 cm

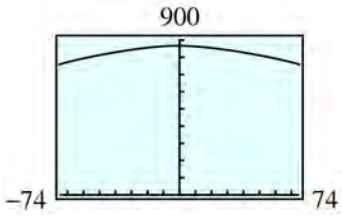
(b) 100 cm

7.1.6.63.

Answer.

(a) $763.10 < H(t) < 864$

(b)



(c) 864 min

(d) 859.8 min

(e) Within 34 days of the summer solstice

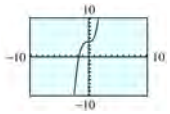
(f) More than 66 days from the summer solstice

7.2 · Graphing Polynomial Functions

7.2.7 · Graphing Polynomial Functions (Homework 7.2)

7.2.7.1.

Answer.

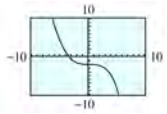


(a) The end behavior is the same as for the basic cubic because the lead coefficient is positive.

(b) There is one x-intercept, no turning points, one inflection point.

7.2.7.3.

Answer.

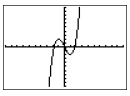


(a) The end behavior is the opposite to the basic cubic (the graph starts in the upper left and extends to the lower right) because the lead coefficient is negative.

(b) There is one x-intercept, no turning points, one inflection point.

7.2.7.5.

Answer.

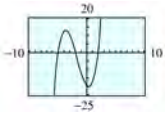


(a) The end behavior is the same as for the basic cubic because the lead coefficient is positive.

(b) There are three x-intercepts, two turning points, one inflection point.

7.2.7.7.

Answer.

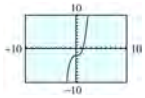


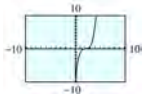
(a) The end behavior is the same as for the basic cubic because the lead coefficient is positive.

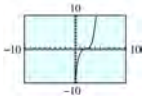
(b) There are three x-intercepts, two turning points, one inflection point.

7.2.7.9.

Answer.

(a) 

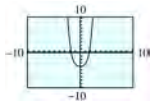
(b) 

(c) 

(b) and (c) are the same.

7.2.7.11.

Answer.

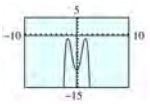


(a) The end behavior is the same as for the basic quartic because the lead coefficient is positive.

(b) There are two x-intercepts, one turning point, no inflection point.

7.2.7.13.

Answer.

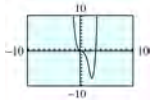


(a) The end behavior is the opposite of the basic quartic (the graph starts in the lower left and ends in the lower right) because the lead coefficient is negative.

(b) There are no x-intercepts, three turning points, two inflection points.

7.2.7.15.

Answer.

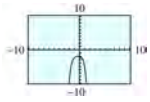


(a) The end behavior is the same as for the basic quartic because the lead coefficient is positive.

(b) There are two x-intercepts, one turning point, two inflection points.

7.2.7.17.

Answer.



(a) The end behavior is the opposite of the basic quartic (the graph starts in the lower left and ends in the lower right) because the lead coefficient is negative.

(b) There are no x-intercepts, one turning point, two inflection points.

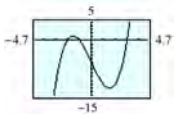
7.2.7.19.

Answer. The graph of a cubic polynomial with a positive lead coefficient will have the same end behavior as the basic cubic, and a cubic with a negative lead coefficient will have the opposite end behavior. Each graph of a cubic polynomial has one, two, or three x-intercepts, it has two, one or no turning point, and it has exactly one inflection point.

7.2.7.21.

Answer.

(a)



$(-2,0),(-1,0),(3,0)$

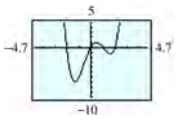
(b) $P(x) = (x+2)(x+1)(x-3)$

(c) Yes

7.2.7.23.

Answer.

(a)



$(-2,0),(0,0),(1,0),(2,0)$

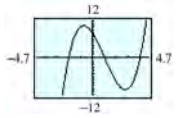
(b) $R(x) = (x+2)(x)(x-1)(x-2)$

(c) Yes

7.2.7.25.

Answer.

(a)



$(-2,0),(1,0),(4,0)$

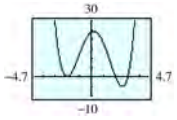
(b) $p(x) = (x+2)(x-1)(x-4)$

(c) Yes

7.2.7.27.

Answer.

(a)



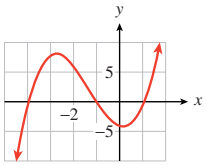
$(-2,0),(2,0),(3,0)$

(b) $r(x) = (x+2)^2(x-2)(x-3)$

(c) Yes

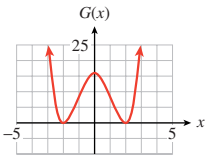
7.2.7.29.

Answer.



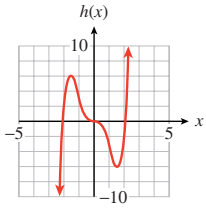
7.2.7.31.

Answer.



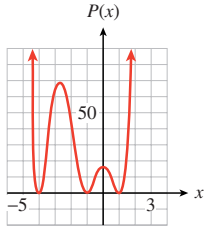
7.2.7.33.

Answer.



7.2.7.35.

Answer.

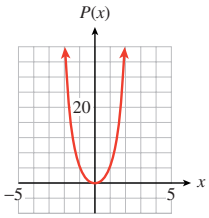


7.2.7.37.

Answer.

(a) 0 (multiplicity 2)

(b)

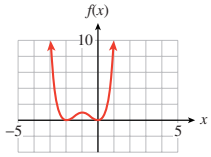


7.2.7.39.

Answer.

(a) 0 (multiplicity 2), 2 (multiplicity 2)

(b)

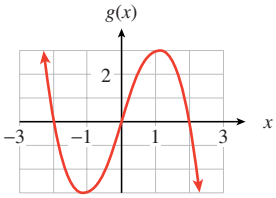


7.2.7.41.

Answer.

(a) $0, \pm 2$

(b)

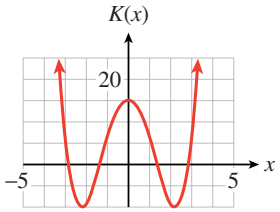


7.2.7.43.

Answer.

(a) $\pm\sqrt{2}, \pm\sqrt{8}$

(b)

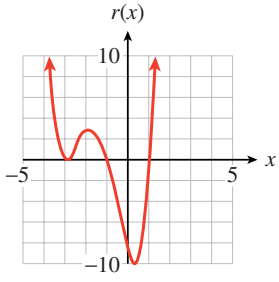


7.2.7.45.

Answer.

(a) $\pm 1, -3$ (multiplicity 2)

(b)



7.2.7.47.

Answer.
$P(x) = (x+2)(x-1)(x-4)$

7.2.7.49.

Answer. $P(x) = (x+3)^2(x-2)$

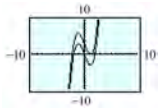
7.2.7.51.

Answer. $P(x) = (x-2)^3(x+2)$

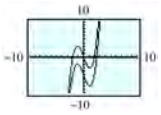
7.2.7.53.

Answer.

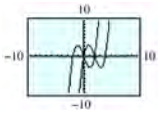
(a) $y = x^3 - 4x + 3$; The graph of $y = f(x)$ shifted 3 units up.



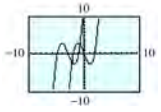
(b) $y = x^3 - 4x - 5$; The graph of $y = f(x)$ shifted 5 units down.



(c) $y = (x-2)^3 - 4(x-2)$; The graph of $y = f(x)$ shifted 2 units right.



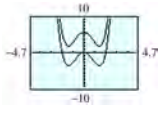
(d) $y = (x+3)^3 - 4(x+3)$; The graph of $y = f(x)$ shifted 3 units left.



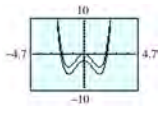
7.2.7.55.

Answer.

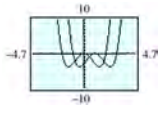
(a) $y = x^4 - 4x^2 + 6$; The graph of $y = f(x)$ shifted 6 units up.



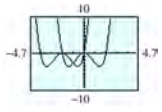
(b) $y = x^4 - 4x^2 - 2$; The graph of $y = f(x)$ shifted 2 units down.



(c) $y = (x-1)^4 - 4(x-1)^2$; The graph of $y = f(x)$ shifted 1 unit right.



(d) $y = (x+2)^4 - 4(x+2)^2$; The graph of $y = f(x)$ shifted 2 units left.



7.2.7.57.

Answer. $q(x) = 2x^2 + 4x - 7$; $r(x) = -32$

7.2.7.59.

Answer. $q(x) = x^3 - 6x$; $r(x) = -6x + 5$

7.2.7.61.

Answer.

(a) If $P(x)$ is a nonconstant polynomial with real coefficients and a is any real number, then there exist unique polynomials $q(x)$ and $r(x)$ such that

$$P(x) = (x-a)q(x) + r(x)$$

where deg $r(x) <$ deg $(x-a)$.

(b) Zero

(c) $P(a) = (a-a)q(a) + r(a) = r(a)$. Because deg $r(x) = 0$, $r(x)$ is a constant. That constant value is $P(a)$, so $P(x) = (x-a)q(x) + P(a)$.

7.2.7.63.

Answer.

(a) From the remainder theorem, $P(x) = (x-a)Q(x) + P(a)$
$= (x-a)Q(x) + 0$
$= (x-a)Q(x)$

(b) By definition of a factor, if $x-a$ is a factor of $P(x)$, then $P(x) = (x-a)q(x)$, so $P(x) = (x-a)q(x) + 0$. The uniqueness guaranteed in the remainder theorem tells us that $P(a) = 0$.

7.2.7.65.

Answer.

(a) $P(1) = 0$

(b) $\dfrac{1 \pm \sqrt{5}}{2}$

7.2.7.67.

Answer.

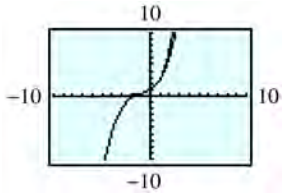
(a) $P(-3) = 0$

(b) $0, 2, 4$

7.2.7.69.

Answer.

(a) About $-1 < x < 2$

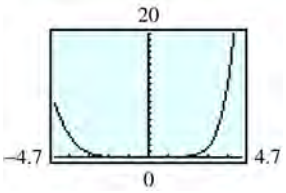


(b)

x	-1	-0.5	0	0.5	1	1.5	2
$f(x)$	0.368	0.607	1	1.649	2.718	4.482	7.389
$p(x)$	0.333	0.604	1	1.646	2.667	4.188	6.333

(c) 0.122

(d)



The error is relatively small for values of x between -3 and 2.5.

7.3 · Complex Numbers

7.3.10 · Complex Numbers (Homework 7.3)

7.3.10.1.

Answer. $-4 + 5i$

7.3.10.3.

Answer. $-4 + i$

7.3.10.5.

Answer. $\dfrac{-5}{6} - \dfrac{\sqrt{2}}{6}i$

7.3.10.7.

Answer. $-3 \pm 2i$

7.3.10.9.

Answer. $\dfrac{1}{6} \pm \dfrac{\sqrt{11}}{6}i$

7.3.10.11.

Answer. $13 + 4i$

7.3.10.13.

Answer. $-0.8 + 3.8i$

7.3.10.15.

Answer. $20 + 10i$

7.3.10.17.

Answer. $-17 + 34i$

7.3.10.19.

Answer. $46 + 14i\sqrt{3}$

7.3.10.21.

Answer. 52

7.3.10.23.

Answer. $-2 - 2i$

7.3.10.25.

Answer. $-1 + 4i$

7.3.10.27.

Answer. $7 + 4i$

7.3.10.29.

Answer. $\frac{-25}{29} + \frac{10}{29}i$

7.3.10.31.

Answer. $\frac{3}{4} - \frac{\sqrt{3}}{4}i$

7.3.10.33.

Answer. $\frac{-2}{3} + \frac{\sqrt{5}}{3}i$

7.3.10.35.

Answer. i

7.3.10.37.

Answer.

(a) 0 (b) 0

7.3.10.39.

Answer.

(a) 0 (b) 0

7.3.10.41.

Answer.

(a) 0 (b) 0

7.3.10.43.

Answer. $4z^2 + 49$

7.3.10.45.

Answer. $x^2 + 6x + 10$

7.3.10.47.

Answer. $v^2 - 8v + 17$

7.3.10.49.

Answer. $x \geq 5$; $x < 5$

7.3.10.51.

Answer.

(a) -1 (b) 1 (c) $-i$ (d) -1

7.3.10.53.

Answer.

(a) $2 - \sqrt{5}$

(b) $x^2 - 4x - 1$

7.3.10.55.

Answer.

(a) $4 + 3i$

(b) $x^2 - 8x + 25$

7.3.10.57.

Answer.

(a) 4

(b) 5

7.3.10.59.

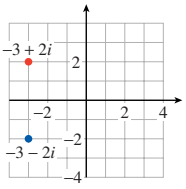
Answer.
$x^4 - 6x^3 + 23x^2 - 50x + 50$

7.3.10.61.

Answer.
$x^4 - 7x^3 + 20x^2 - 19x + 13$

7.3.10.63.

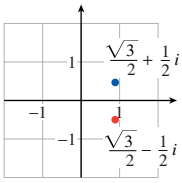
Answer.



The complex conjugates are reflections of each other across the real axis.

7.3.10.65.

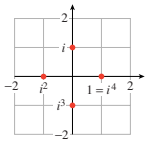
Answer.



The complex conjugates are reflections of each other across the real axis.

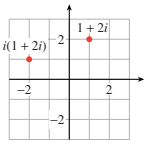
7.3.10.67.

Answer.



7.3.10.69.

Answer.



7.3.10.71.

Answer.

(a) $m = \dfrac{b}{a}$

(b) $m = \dfrac{a}{-b}$

(c) -1; The angle is $90°$.

7.4 · Graphing Rational Functions

7.4.7 · Graphing Rational Functions (Homework 7.4)

7.4.7.1.

Answer.

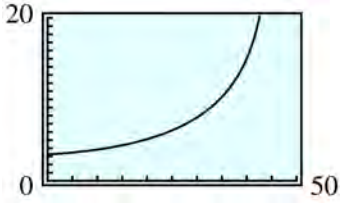
(a) $t = \dfrac{150}{50 - v}$

(b)

v	0	5	10	15	20	25	30	35	40	45	50
t	3	3.33	3.75	4.29	5	6	7.5	10	15	30	—

The travel time increases as the headwind speed increases.

(c)



7.4.7.3.

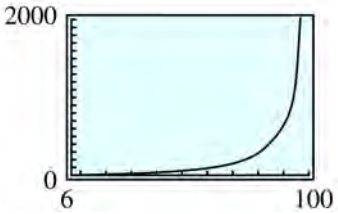
Answer.

(a) $0 \le p < 100$

(b)

p	0	15	25	40	50	75	80	90	100
C	0	12.7	24	48	72	216	288	648	—

(c) 60%



(d) $p > 96\%$

(e) $p = 100$; As the percentage immunized approaches 100, the cost grows without bound.

7.4.7.5.

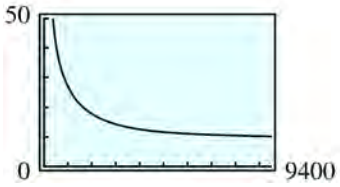
Answer.

(a) $C = 8 + \dfrac{20,000}{n}$

(b)

n	100	200	400	500	1000	2000	4000	5000	8000
C	208	108	58	48	28	18	13	12	10.5

(c)



(d) 2000

(e) $n > 5000$

(f) $C = 8$; As n increases, the average cost per calculator approaches \$8.

7.4.7.7.

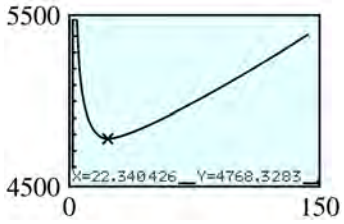
Answer.

(a) $4500 + \dfrac{3000}{x}$; $C(x) = 6x + 4500 + \dfrac{3000}{x}$

(b)

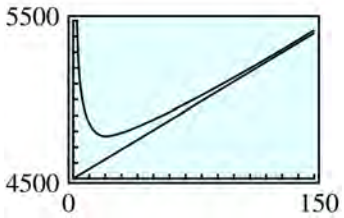
x	10	20	30	40	50	60	70	80	90	100
C	4860	4770	4780	4815	4860	4910	5018	5073	5130	

(c) \$4768.33



(d) 22; 14

(e)



The graph of C approaches the line as an asymptote.

7.4.7.9.

Answer.

(a) The surface area is $2x^2+4xh=96$. Solving for h, $h=\dfrac{96-2x^2}{4x}=\dfrac{24}{x}-\dfrac{x}{2}$.

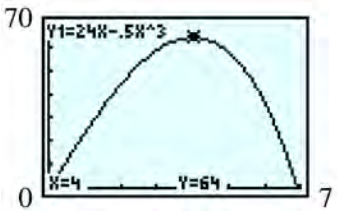
(b) $V=24x-\dfrac{1}{2}x^3$

(c)

x	1	2	3	4	5	6	7
h	23.5	11	6.5	4	2.3	1	-0.07
V	23.5	44	58.5	64	57.5	36	-3.5

If the base is more than 7 cm, the top and bottom alone exceed the total area allowed.

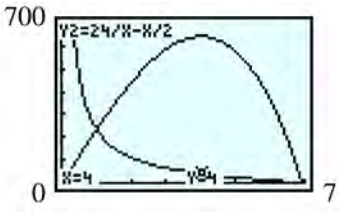
(d)



Maximum of 64 cu. cm

(e) 4 cm

(f) $h=4$ cm



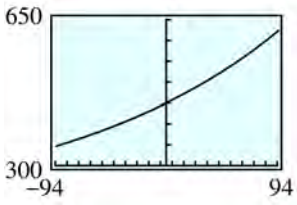
7.4.7.11.

Answer.

(a)

v	-100	-75	-50	-25	0	25	50	75	100
P	338.15	358.92	382.41	409.19	440	475.83	518.01	568.4	629.66

(b)



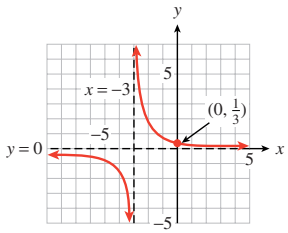
(c) -20 m/sec; 68 m/sec

(d) $v > 12$ m/sec

(e) $v = 332$; As v approaches 332 m per sec, the pitch increases without bound.

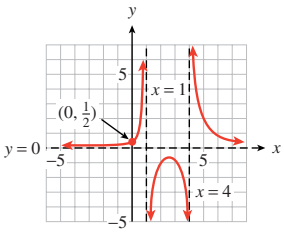
7.4.7.13.

Answer.



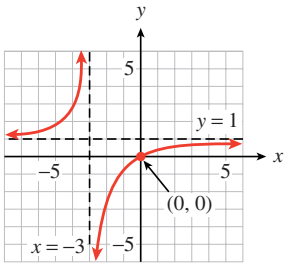
7.4.7.15.

Answer.



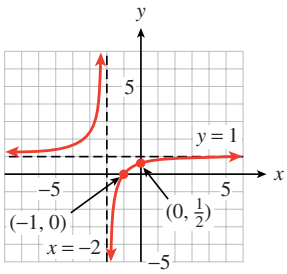
7.4.7.17.

Answer.



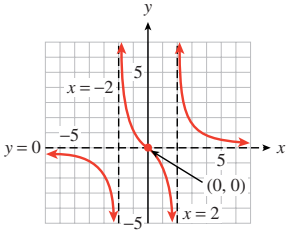
7.4.7.19.

Answer.



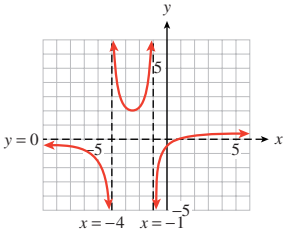
7.4.7.21.

Answer.



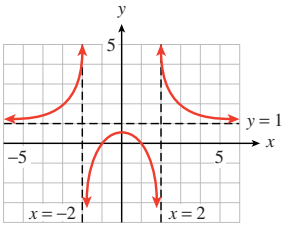
7.4.7.23.

Answer.



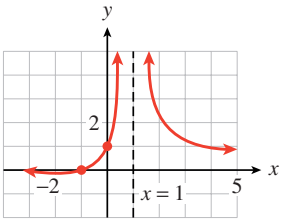
7.4.7.25.

Answer.



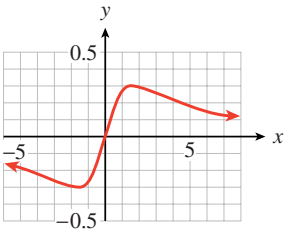
7.4.7.27.

Answer.



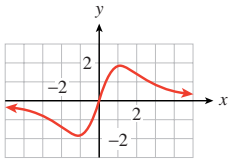
7.4.7.29.

Answer.



7.4.7.31.

Answer.

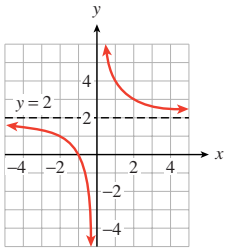


7.4.7.33.

Answer.

a $y = \dfrac{2}{x} + 2$

b

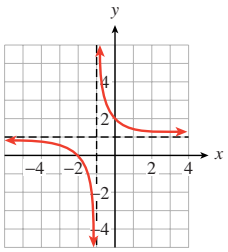


7.4.7.35.

Answer.

a $y = \dfrac{1}{x+1} + 1$

b

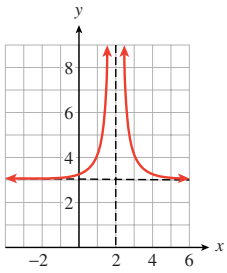


7.4.7.37.

Answer.

a $y = \dfrac{1}{(x-2)^2} + 3$

b



7.4.7.39.

Answer.

(a) $\dfrac{25}{s+8}$ (b) $\dfrac{25}{s-8}$ (c) $\dfrac{50s}{s^2-64}$

7.4.7.41.

Answer.

(a) $\dfrac{900}{400+w}$

(b) $\dfrac{900}{400-w}$

(c) Orville by $\dfrac{1800w}{160,000-w^2}$ hours

7.4.7.43.

Answer.

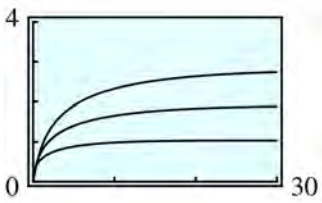
(a) $\dfrac{1}{f} = \dfrac{2q+60}{q^2+60q}$ (b) $f = \dfrac{q^2+60q}{2q+60}$

7.4.7.45.

Answer.

(a) $\dfrac{1}{y} = \dfrac{1}{x} + \dfrac{1}{k} = \dfrac{k+x}{xk}$, so by taking reciprocals, $y = \dfrac{kx}{x+k}$.

(b)



The graphs increase from the origin and approach a horizontal asymptote at $y = k$.

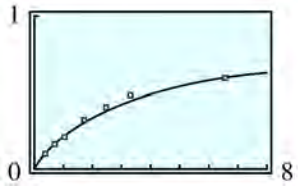
7.4.7.47.

Answer. $\dfrac{12x}{x+20}$

7.4.7.49.

Answer.

(a) V



(b) $\dfrac{V}{2}$

$V \approx 0.7,\ K \approx 2.2$ (many answers are possible)

(c)

(d) (See figure.)

7.4.7.51.

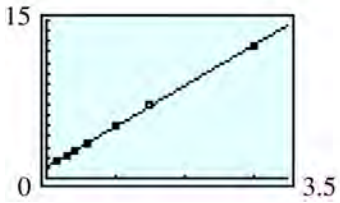
Answer.

(a) $\dfrac{1}{v} = \dfrac{K}{V} \cdot \dfrac{1}{s} + \dfrac{1}{V}$; Therefore, $a = \dfrac{K}{V}$ and $b = \dfrac{1}{V}$

(b)

$\frac{1}{s}$	3	1.5	1	0.6	0.4	0.3	0.15
$\frac{1}{v}$	12.5	7.1	5	3.3	2.6	2.2	1.7

(c)



$\dfrac{1}{v} = 3.8 \cdot \dfrac{1}{s} + 1.1$

(d) $V \approx 0.89,\ K \approx 3.37$

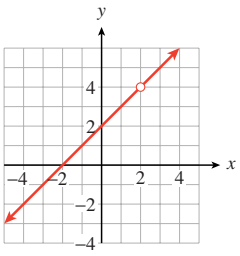
7.4.7.53.

Answer.

(a) $x \neq 2$

(b) $x + 2$

(c)



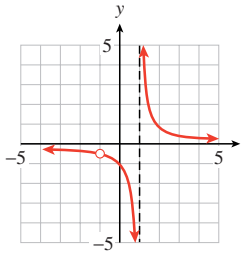
7.4.7.55.

Answer.

(a) $x \neq \pm 1$

(b) $\dfrac{1}{x-1}$

(c)



7.5 · Equations That Include Algebraic Fractions

7.5.5 · Equations that include Algebraic Fractions (Homework 7.5)

7.5.5.1.

Answer. $\dfrac{-1}{2}$

7.5.5.3.

Answer. $\dfrac{13}{8}$

7.5.5.5.

Answer. $\pm\sqrt{\dfrac{15}{8}}$

7.5.5.7.

Answer.
$\frac{1800}{1849} \approx 0.97$

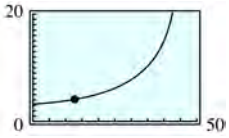
7.5.5.9.

Answer. 37 ft

7.5.5.11.

Answer.

(a) $t = \dfrac{150}{50 - v}$



(b) $4 = \dfrac{150}{50 - v}$; $v = 12.5$ mph

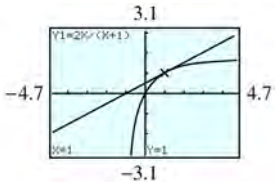
7.5.5.13.

Answer. $168 = \dfrac{72p}{100 - p}$; $p = 70\%$

7.5.5.15.

Answer.

(a)

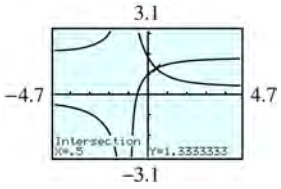


(b) $x = 1$

7.5.5.17.

Answer.

(a)

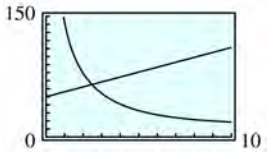


(b) $x = \dfrac{1}{2}$

7.5.5.19.

Answer.

(a)



$2.50

(b) $\dfrac{160}{x} = 6x + 49$; $x = 2.50$

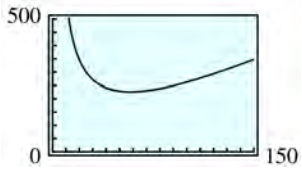
7.5.5.21.

Answer.

(a) $L = \dfrac{3200}{w}$

(b) $P = \dfrac{6400}{w} + 2w$

(c)



Lowest point: $(56.6, 226)$; The minimum perimeter is 226 ft for a width of 56.6 ft.

(d) $240 = \dfrac{6400}{w} + 2w$

(e) 40 ft by 80 ft

7.5.5.23.

Answer. Multiply both sides of the equation by bd and simplify.

$$\frac{a}{b} \cdot \frac{bc}{1} = \frac{c}{d} \cdot \frac{bc}{1}, \text{ so } ac = bd$$

7.5.5.25.

Answer. 4

7.5.5.27.

Answer. 40

7.5.5.29.

Answer. \$6187.50

7.5.5.31.

Answer. 45 mi

7.5.5.33.

Answer. 689

7.5.5.35.

Answer.

(a) $19,882$ m (b) 0.3% (c) 0.00657 in

7.5.5.37.

Answer.

(a) $AE = 1,\ DE = x - 1,\ CD = 1$

(b) $\dfrac{1}{x} = \dfrac{x-1}{x}$

(c) $\dfrac{1+\sqrt{5}}{2}$

7.5.5.39.

Answer. $r = \dfrac{S-a}{S}$

7.5.5.41.

Answer. $x = \dfrac{Hy}{2y-H}$

7.5.5.43.

Answer. $d = \pm\sqrt{\dfrac{Gm_1m_2}{F}}$

7.5.5.45.

Answer. $r = \dfrac{2QI}{I+Q}$

7.5.5.47.

Answer. $P = \dfrac{ES}{E+S}$

7.5.5.49.

Answer. 5

7.5.5.51.

Answer. 1

7.5.5.53.

Answer. $\dfrac{-14}{5}$

7.5.5.55.

Answer. $\dfrac{-1}{6}, \dfrac{-4}{3}$

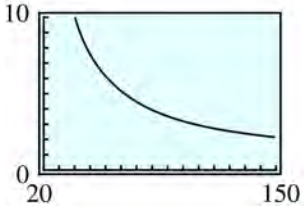
7.5.5.57.

Answer.

(a) $t_1 = \dfrac{144}{s-20}$

(b) $t_2 = \dfrac{144}{s+20}$

(c)



If the airspeed is 100 mph, the round trip will take 3 hours.

(d) $\dfrac{144}{s-20} + \dfrac{144}{s+20} = 3$

(e) 100 mph

7.5.5.59.

Answer.

(a) $t_1 = \dfrac{d}{r_1},\ t_2 = \dfrac{d}{r_2}$

(b) Total distance is $2d$; total time $\dfrac{d}{r_1} + \dfrac{d}{r_2}$.

(c) $\dfrac{2d}{\dfrac{d}{r_1} + \dfrac{d}{r_2}}$

(d) $\dfrac{2r_1 r_2}{r_1 + r_2}$

(e) $58\frac{1}{3}$ mph

7.6 · Chapter Summary and Review

7.6.2 · Chapter 7 Review Problems

7.6.2.1.

Answer. $2x^3 - 11x^2 + 19x - 10$

7.6.2.3.

Answer. $t^3 + 3t^2 - 5t - 4$

7.6.2.5.

Answer. $31x^2$

7.6.2.7.

Answer. $-13x^3$

7.6.2.9.

Answer.
$(2x - 3z)(4x^2 + 6xz + 9z^2)$

7.6.2.11.

Answer. $(y + 3x)(y^2 - 3xy + 9x^2)$

7.6.2.13.

Answer. $v^3 - 30v^2 + 300v - 1000$

7.6.2.15.

Answer.

(a) $\dfrac{1}{6}n^3 - \dfrac{1}{2}n^2 + \dfrac{1}{3}n$

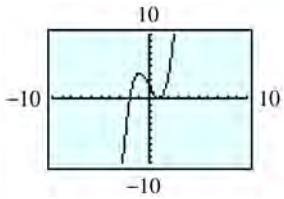
(b) 220

(c) 20

7.6.2.17.

Answer.

(a)



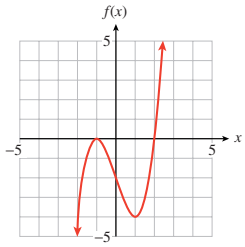
(b) $[-968, 972]$

7.6.2.19.

Answer.

(a) $2, -1$

(b)

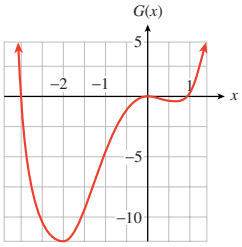


7.6.2.21.

Answer.

(a) $0, 1, -3$

(b)

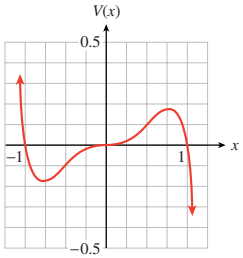


7.6.2.23.

Answer.

(a) $0, 1, -1$

(b)

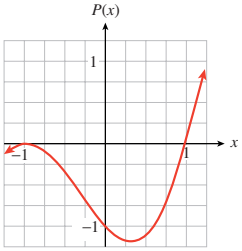


7.6.2.25.

Answer.

(a) $-1, 1$

(b)

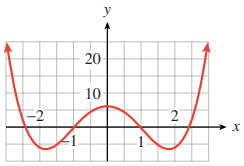


7.6.2.27.

Answer.

(a) $-1, 1, \pm\sqrt{6}$

(b)



7.6.2.29.

Answer. $x(x+2)(x-3)$

7.6.2.31.

Answer. $x^3(x+2)(x-2)$

7.6.2.33.

Answer. $x^2(x+4)(x-4)$

7.6.2.35.

Answer.

(a) $P(-2) = 0$

(b) $\dfrac{3 \pm \sqrt{13}}{2}$

7.6.2.37.

Answer. $-2 \pm i\sqrt{6}$

7.6.2.39.

Answer. $1 \pm \dfrac{\sqrt{6}}{3}i$

7.6.2.41.

Answer.

(a) -8 (b) -8

7.6.2.43.

Answer. $\dfrac{11}{10} - \dfrac{13}{10}i$

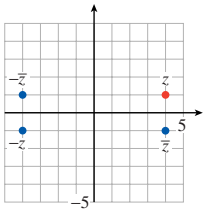
7.6.2.45.

Answer.
$x^4 - 2x^3 + 14x^2 - 18x + 45$

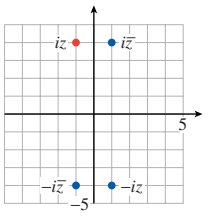
7.6.2.47.

Answer.

(a)



(b)



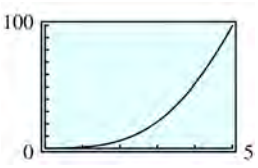
7.6.2.49.

Answer.

(a) $V = \dfrac{\pi h^3}{4}$

(b) 2π cm$^3 \approx 6.28$ cm^3; 16π cm$^3 \approx 50.27$ cm^3

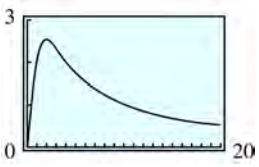
(c)



7.6.2.51.

Answer.

(a)



(b) 338

(c) Months 2 and 20

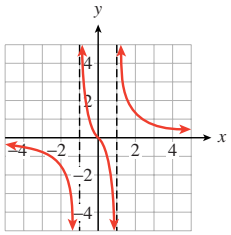
(d) During month 6. The number of members eventually decreases to zero.

7.6.2.53.

Answer. All numbers except $-2, 0, 2$.

7.6.2.55.

Answer.

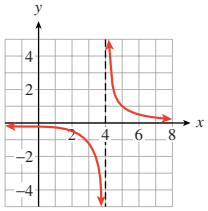


7.6.2.57.

Answer.

(a) Horizontal asymptote $y = 0$; Vertical asymptote $x = 4$; y-intercept $(0, \frac{-1}{4})$

(b)

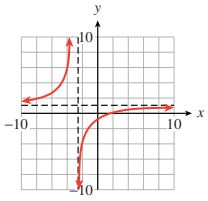


7.6.2.59.

Answer.

(a) Horizontal asymptote $y = 1$; Vertical asymptote $x = -3$; x-intercept $(2, 0)$; y-intercept $(0, \frac{-2}{3})$

(b)

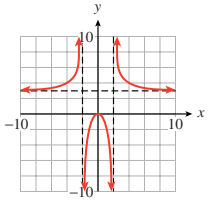


7.6.2.61.

Answer.

(a) Horizontal asymptote $y = 3$; Vertical asymptote $x = \pm 2$; x-intercept $(0, 0)$; y-intercept $(0, 0)$

(b)

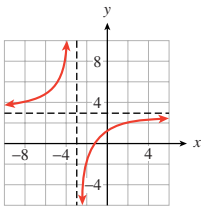


7.6.2.63.

Answer.

(a) $y = \dfrac{-5}{x+3} + 3$

(b)

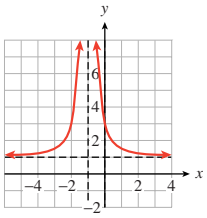


7.6.2.65.

Answer.

(a) $y = \dfrac{2}{(x+1)^2} + 1$

(b)



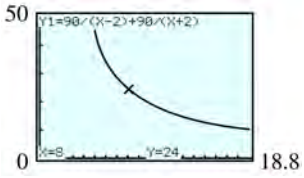
7.6.2.67.

Answer.

(a) $t_1 = \dfrac{90}{v-2}$

(b) $t_2 = \dfrac{90}{v+2}$

(c)



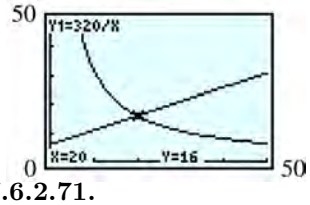
(d) $\dfrac{90}{v-2} + \dfrac{90}{v+2} = 24$

(e) 8 mph

7.6.2.69.

Answer.

(a)



(b) $\dfrac{320}{x} = \dfrac{1}{2}x + 6$; \$20

7.6.2.71.

Answer. 299

7.6.2.73.

Answer. -2

7.6.2.75.

Answer. No solution

7.6.2.77.

Answer. All a except -1 and 1

7.6.2.79.

Answer. 0

7.6.2.81.

Answer. $n = \dfrac{Ct}{C-V}$

7.6.2.83.

Answer. $q = \dfrac{pr}{r-p}$

8 · Models and data

8.1 · Linear Regression

8.1.6 · Linear Regression (Homework 8.1)

8.1.6.1.

Answer.

a

x	50	125
y	9000	15,000

b $C = 5000 + 80x$

c $m = 80$ dollars/bike, so it costs the company \$80 per bike it manufactures.

8.1.6.3.

Answer.

a

g	12	5
d	312	130

b $d = 26g$

c $m = 26$ miles/gallon, so the Porche's fuel efficiency is 26 miles per gallon.

8.1.6.5.

Answer.

a

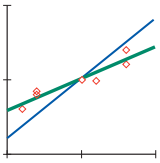
C	15
F	59
23	

b $F = 32 + \frac{9}{5}C$

c $m = \frac{9}{5}$, so an increase of 1°C is equivalent to an increase of $\frac{9}{5}$° F.

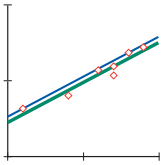
8.1.6.7.

Answer.



8.1.6.9.

Answer.



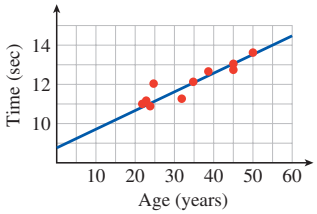
8.1.6.11.

Answer.

a 12 seconds

b 39

c



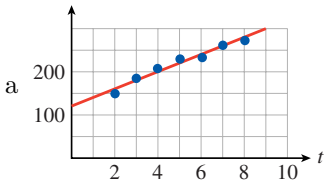
d 11.6 seconds

e $y = 8.5 + 0.1x$

f 12.7 seconds; 10.18 seconds; The prediction for the 40-year-old is reasonable, but not the prediction for the 12-year-old.

8.1.6.13.

Answer.

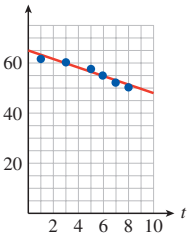
a 

b $y = 121 + 19.86t$

c 419

8.1.6.15.

Answer.

a 

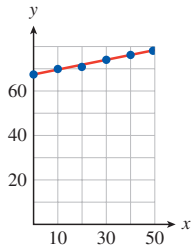
b $y = 64.2 - 1.63t$

c 58 births per 1000 women

d 32 births per 1000 women

8.1.6.17.

Answer.

a 

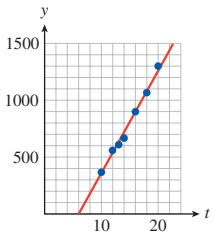
b $y = 0.18t + 67.9$

c 74.9 years

d 79 years

8.1.6.19.

Answer.

a 

b $y = 90.49t - 543.7$

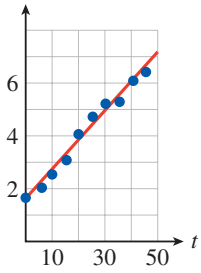
c 90.49 dollars/year: Each additional year of education corresponds to an additional \$90.49 in weekly earnings.

d No: The degree or diploma attained is more significant than the number of years. So, for example, interpolation for the years of education between a bachelor's and master's degree may be inaccurate because earnings with just the bachelor's degree will not change until the master's degree is attained. And the years after the professional degree will not add significantly to earnings, so extrapolation is inappropriate.

8.1.6.21.

Answer.

a



b $y = 1.6 + 0.11t$

c 6.2 billion tons

8.1.6.23.

Answer.

a 0.34 meters per year

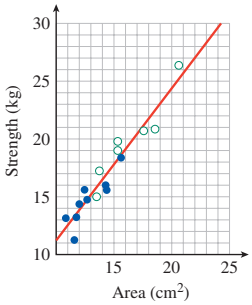
b $y = 0.34x$ ($b = 0$ because the plant has zero size until it begins.)

c Over 1300 years

8.1.6.25.

Answer.

a



b Yes

c $y = 1.29x - 1.62$

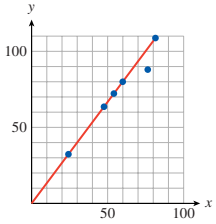
d The slope, 1.29 kg/sq cm, tells us that strength increases by 1.29 kg when the muscle cross-sectional area increases by 1 sq cm.

8.1.6.27.

Answer.

a E

b



c $y = 1.33x$; There should be no loss in mass when no gas evaporates.

d 1333 mg

e Oxygen

8.1.6.29.

Answer.

a 75°F

b The slope of −2 degrees/hour says that temperatures are dropping at a rate of 2° per hour.

8.1.6.31.

Answer.

a 20 mph

b The slope of 10 mph/second says the car accelerates at a rate of 10 mph per second.

8.1.6.33.

Answer. 2 min: 21°C; 2 hr: 729°C; The estimate at 2 minutes is reasonable; the estimate at 2 hours is not reasonable.

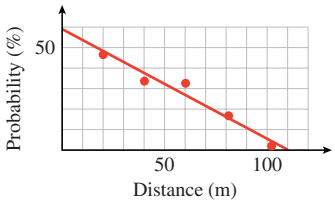
8.1.6.35.

Answer. 128 lb.

8.1.6.37.

Answer.

a $y \approx -0.54x + 58.7$



b 31.7%

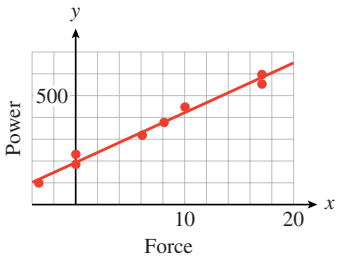
c 90 meters

d The regression line gives a negative probability, which is not reasonable.

8.1.6.39.

Answer.

a



$y \approx 22.8x + 198.5$

b ≈ 540 watts

c 198.5 watts

d ≈ −8.7 newtons

e 3.5 watts

f about 0.018 or 1.8%

8.2 · Curve Fitting

8.2.5 · Curve-fitting (Homework 8.2)

8.2.5.1.

Answer. $a = -2, b = 3, c = -4$

8.2.5.3.

Answer. $a = 1, b = -4, c = 7$

8.2.5.5.

Answer. $a = 3, b = 1, c = -2$. The equation for the parabola is $y = 3x^2 + x - 2$

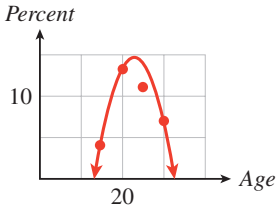
8.2.5.7.

Answer.

(a) $P = -0.16x^2 + 7.4x - 71$

(b) 14%. It predicts that 14% of the 25-year old population use marijuana on a regular basis.

(c)



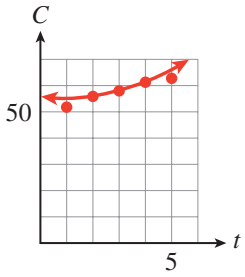
8.2.5.9.

Answer.

(a) $C = 0.75t^2 - 1.85t + 56.2$

(b) 65.7 lb

(c)



8.2.5.11.

Answer. $D = \frac{1}{2}n^2 - \frac{3}{2}n$

8.2.5.13.

Answer.

(a) $y = a(x + 2)^2 + 6$

(b) 3

8.2.5.15.

Answer.

(a) $y = \frac{3}{4}x^2 - 3$

(b) $y = ax^2 - 3$ for any $a < 0$

8.2.5.17.

Answer. $y = -2(x - 30)^2 + 280$

8.2.5.19.

Answer. $y = x^2 - 9$

8.2.5.21.

Answer. $y = -2x^2$

8.2.5.23.

Answer. $y = x^2 - 2x - 15$

8.2.5.25.

Answer. $y = x^2 - 4x + 5$

8.2.5.27.

Answer.

(a) $y = \dfrac{-1}{40}(x - 80)^2 + 164$

(b) 160.99 ft

8.2.5.29.

Answer.

(a) Vertex: $\left(\frac{1991}{2}, 79\right)$; y-intercept: $(0, 297)$

(b) $y = 0.00022(x - 995.5)^2 + 79$

8.2.5.31.

Answer.

(a) 8 m

(b) $y = \dfrac{x^2}{32}$

(c) 3.125 m

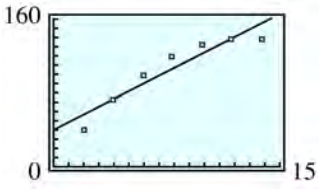
8.2.5.33.

Answer.

(a) $h = 8.24t + 38.89$

(b) 162.5 m

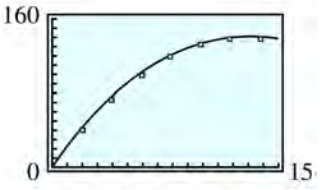
(c)



(d) $h = -0.81t^2 + 21.2t$

(e) 135.7 m

(f)



(g) Quadratic: Gravity will slow the projectile, giving the graph a concave down shape.

8.2.5.35.

Answer.

(a) $y = -0.587t^2 + 7.329t - 2.538$

(b) The predicted peak was in 2000, near the end of March. The model predicts 7 deaths for 2005.

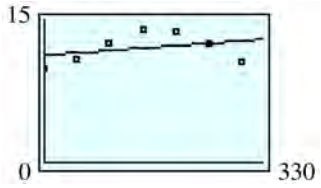
8.2.5.37.

Answer.

(a) $y = 0.0051t + 11.325$

(b) 13.2 hr

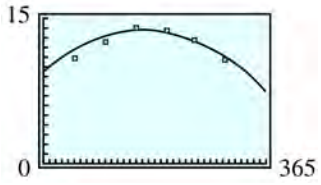
(c)



(d) $y = -0.00016t^2 + 0.053t + 9.319$

(e) 7.4 hr

(f)



(g) 9.8 hr (the same as the previous year); Neither model is appropriate.

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