

Make It Real:
College Algebra
Instructor Solutions

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Section 1.1

- The decision factor equation suggests a economy car with high gas mileage and low miles. The *reason is because the style is weighted by 1000 and the gas mileage by 100 while the number of miles is deducted from the overall score.*
- The decision factor equation would tell us to buy Car 1 because Car1 has a decision factor score of $100(35) + 1000(2) - 0.1(18298) = 3670.2$,
Car 2 has a decision factor score of $100(16) + 1000(0) - 0.1(16000) = 0$, and
Car 3 has a decision factor score of $100(28) + 1000(1) - 0.1(19845) = 1815.5$
- The style would be type 2: Midsize Sedan because

$$100(25) + 1000(S) - 0.1(20000) = 2500$$

$$2500 + 1000S - 2000 = 2500$$

$$1000S = 2000$$

$$S = 2$$
- The midsize sedan would have to get 20 mpg because

$$100(G) + 1000(1) - 0.1(45000) = -1500$$

$$100G + 1000 - 4500 = -1500$$

$$100G = 2000$$

$$G = 20$$
- The maximum mileage it can have is 3,298 miles because

$$100(30) + 1000(1) - 0.1(M) = 3670.2$$

$$3000 + 1000 - 0.1M = 3670.2$$

$$-0.1M = -329.8$$

$$M = 3298$$
- Answers vary. Decision Factor = $0(\text{Cost}) + 1000(\text{Style}) + 1000(\text{Color}) - 0.1(\text{Mileage}) - 50(\text{Year})$
- Answers vary. Decision Factor = $-500(\text{Cost}) + 10(\text{Style}) + 0(\text{Color}) - 0.1(\text{Mileage}) + 100(\text{Year})$
- Answers vary. Decision Factor = $-10(\text{Cost}) + 5000(\text{Style}) + 100(\text{Color}) - 0.05(\text{Mileage}) + 150(\text{Year})$
- Answers vary. Decision Factor = $0(\text{Cost}) + 15000(\text{Style}) + 5000(\text{Color}) - 0(\text{Mileage}) - 2(\text{Year})$
- Answers vary. Decision Factor = $0(\text{Cost}) + 25000(\text{Style}) + 10000(\text{Color}) - 0.01(\text{Mileage}) - 2(\text{Year})$
- A mathematical model is a table, graph, or formula that represents a real-world situation and used to make predictions and/or answer questions. Mathematical models are similar to other types of “models” in that they both represent or stand for something else.
- We can use mathematical models to quantify a situation or physical occurrence in order to study, analyze, predict, and synthesize information and data to solve problems.
- Mathematical models can be in tabular, graphic, formulaic, or even as a verbal description.

14. a. The number of homes sold was increasing from the 4th quarter of 2003 until the 2nd quarter of 2004 and also from the 4th quarter of 2004 until the 3rd quarter of 2005. The number of homes sold was decreasing from the 2nd quarter of 2004 until the 4th quarter of 2004 and again from the 3rd quarter of 2005 until the 4th quarter of 2005.
- b. There really is no distinguishable pattern. The change in the number of homes sold varies.
15. a. The total revenue (in millions) of McDonald's increases each year.
- b. The total revenue (in millions) of McDonald's increases each year at a variable rate.
16. a. As the number of McDonald's locations increases the total revenue (in millions) increases.
- b. A reasonable prediction would be to consider the data from 2004 to 2005. There was an increase of \$1395 million in total revenue and 325 more locations for an increase of \$4.29 million per location on average. With 114 more locations (32,000 – 31886) we could assume \$4.29 million per location or $\$20,460 + 4.29(114) = \$20,949.06$ million for 32,000 locations.
17. a. If we assume that the value of the vehicle continues to drop by 15% then we need to decrease the value in 2010 by 15%. $\$10,147 \times 0.15 = \1522.05 . $\$10,147 - \$1522.05 = \$8624.95$.
- b. The differences were from 2006 to 2007 -\$2910, from 2007 to 2008 -\$2478, from 2008 to 2009 -\$2107, and from 2009 to 2010 -\$1791. The dollar amount of depreciation decreases each year by a lesser amount.
- c. No because the car will technically always have some value left.
18. a. As the years increase, the percentage of male non-teachers earning more than male teachers is increasing at a varying rate.
- b. For some reason, males with non-teaching jobs must have gotten larger increases in their pay than male teachers from 1990 to 2000.
- c. In 1940 male non-teachers were earning less than male teachers.
19. a. The percentage of non-teaching women earned less than teachers from 1940 to some time in the 1980's and then began to earn more. It also appears that the percentage of non-teaching women who earn a higher salary is increasing.
- b. Question 1: What factors may have caused non-teaching women to begin earning more? Answer: Other higher paying jobs became open to women instead of low paying, low skill labor.
- Question 2: Why did the percentage of non-teaching women who earn less than teachers change so dramatically in the 1960s? Answer: In American history the 60s was a time for minority and women's rights that may have begun to have an effect on women's salaries.
20. a. As the number of years of service in the NBA increases so do the minimum salaries.
- b. Question 1: Why do the minimum salaries increase as the number of years of service increase? Answer: The expectation is that the players become better with more experience so should make more money.
- Question 2: Between what two years of service does the minimum salary increase the most? Answer: From 0 to 1 years of service the increase is \$242,986.

21. a. The ticket face value for the Super Bowl is increasing at an increasing rate.
- b. (Answers vary.)
- 1) How much longer can the ticket face value for the Super Bowl increase at such a large rate?
Answer: We can't tell because we don't know the economic conditions will be and how interested the fans are in seeing a particular game.
- 2) Why has the ticket face value increased so much over the years? Answer: Interest in the sport of NFL football has dramatically increased over the years.
22. a. The average price for unleaded, regular gasoline has both increased and decreased over the years from 1990-2004.
- b. (Answers vary.)
- 1) What factors have contributed to the increase and decrease of the average price per gallon for unleaded, regular gasoline? Answer: The demand for fuel because of other economic conditions and expanding economies worldwide.
- 2) Explain whether these data can be used to predict future years' average price per gallon. Answer: It is not likely since there are many, many factors that determine the cost of a gallon of gasoline.
23. a. As the price of a gallon of gasoline increases, the fuel consumption in billions of gallons varies and does not have a clear trend for the costs between \$1.06 to \$1.59 per gallon.
- b. (Answers vary.)
- 1) At what cost might the fuel consumption begin to clearly decrease? Answer: it will have to be more than \$1.59 per gallon because the consumption increases and decreases over the range of prices in the table.
- 2) Why does it appear the fuel consumption increased when the price per gallon increased from \$1.23 to \$1.36? Answer: Demand for fuel at that time must have been high regardless of the increase in price per gallon.
24. a. From the 4th quarter of 2002 until the 3rd quarter of 2004 the iPod sales increased slowly. From the 3rd quarter of 2004 until the 4th quarter of 2005 sales increased quickly. From the 4th quarter of 2005 until the 1st quarter of 2006 sales increased very quickly. From the 1st quarter of 2006 until the 2nd quarter of 2006 sales decreased a lot.
- b. A possible explanation would be that it took some time for marketing and word-of-mouth promotion to be successful.
- c. A possible explanation would be that so many iPods had been sold that the market was becoming saturated or perhaps competitors' efforts to offer other options had slowed sales of the iPod.
25. a. The time period that hurricanes decreased the longest was from 1940 to 1979.
- b. The decade that the greatest number of hurricanes struck was from 1940-1949.
- c. The decade that the least number of hurricanes struck was from 1970-1979.

4 **1.1: Mathematical Modeling**

26. a. As the years increase, the number of alternative-fueled vehicles in use has increased.
- b. $\approx 400,000 - 250,000$
 $\approx 150,000$
- c. $\approx 440,000$
27. a. As the years increase, the number of doctorates awarded in mathematics has decreased.
- b. $\approx 1000 - 900$
 ≈ 100
- c. $\approx 1000 + 100$ (3)
 ≈ 1300
28. a. Possible factors could be Vietnam war costs, space program accidents, or funding cuts.
- b. Possible factors could be an added emphasis on the space program from Reagan's "star wars" program, increased funding, and new important goals for space exploration.
- c. Just under 30 launches per year. ($207/7 = 29.6$)
- d. A little over 15. ($61/4 = 15.3$)
29. a. As the number of women in the workforce (in 1000s) increases, the number of children enrolled in the Head Start program increases.
- b. (Answers vary.)
Question 1: Why would the number of children enrolled in the Head Start program increase when the number of women in the workforce (in 1000s) increase?
Question 2: Will the trend displayed in the graph continue in the future?
30. a. The average Arizona Diamondback's salary increased from 1998 to 2002 then decreased from 2002 to 2004 but then began to increase again from 2004 to 2005.
- b. (Answers vary.)
Question 1: Approximately how much more was the average player's salary in 2005 than in 1998?
Answer: $\$2,250,000 - \$1,100,000 = \$1,150,000$.
- Question 2: Approximately how much did the average player's salary drop from 2002 to 2004?
Answer: $\$3,200,000 - \$1,600,000 = \$1,600,000$.
31. a. There is no trend that can be seen because the scatterplot does not show an increasing or a decreasing pattern.
- b. (Answers vary.)
Question 1: Can you accurately predict what a Boston Red Sox player's average salary will be from a New York Yankee player's salary? Answer: It is hard to tell from the graph but if the trend continues the answer would be "no".
Question 2: How would the scenario described in question 1) above be represented graphically?
Answer: The graph would have to begin to show a trend of some type - increasing, decreasing, constant, or a combination.

32. a. As the years increase, the number of students per teacher in Texas public schools decreases.

b. (Answers vary.)

Question 1: What factors are affecting the number of students per teacher in Texas public schools?

Answer: The enrollment in Texas schools is dropping but the number of faculty is staying the same.

Question 2: What would it mean in terms of the number of students per teacher if for the years 2003 and 2004, the graph increased? Explain. Answer: The number of students per teacher in Texas had begun to increase.

33. a. As the years increase, the average SAT math scores increased and the average SAT verbal scores both increased and decreased.

b. (Answers vary.)

Question 1: What possible factors may explain why the graphs are changing as they do? Answer:

Schools are focusing on improving their students' Math SAT exam scores but not their Verbal scores.

Question 2: What would be the challenges in predicting the average SAT math score in 2010 from the graph provided? Answer: The year 2010 is so far out from the gathered data that extrapolating that far into the future is not generally accurate due to the wide variety of factors affecting the scores.

34. The advantages of mathematical models is that we can oftentimes see from data if there are patterns that we can use to predict and/or answer important questions about that would ordinarily would not be able to if we didn't frame the data as a mathematical model. Mathematical models do have drawbacks too for instance models often oversimplify the variables and factors that effect a situation and therefore we make conclusions based on information that is not fully represented.

35. Just because a trend is "perfectly" captured by a mathematical model does not necessarily mean that this trend will continue into the future or even between particular data points. Also, if the data is not collected properly due to human error or incorrect assumptions then the predictions can also be mistaken.

Section 1.2

1. $T(d)$ where d = number of dollars your home is assessed for, T = amount of property tax. T is the dependent variable and d is the independent variable.
2. $f(m)$. independent variable = time since your last manicure. Dependent variable = length of your fingernails.
3. $c(w)$. independent variable = weight of a package in ounces. Dependent variable = cost to mail the package.
4. $W(t)$ where W = number of gallons of water, t = temperature in degrees. W is the dependent variable and t is the independent variable.
5. $B(a)$ where B = a person's blood alcohol level, a = number of alcoholic drinks consumed in a two-hour period. B is the dependent variable and a is the independent variable.
6. A function.
7. A function.
8. Not a function.

9. Not a function.

10. A function.

11. Not a function.

12. A function.

13. A function.

14. A function.

15. Not a function.

16. A function.

17. A function.

18. Not a function.

19. Not a function.

20. A function.

21. A function.

22. A function.

23. A function.

24. Not a function.

25. A function.

26. $f(x) = 2x^2 - 3x$; $f(4) = 2(4)^2 - 3(4) = 32 - 12 = 20$

27. $v(t) = \frac{\sqrt{0.3t}}{10}$; $v(3) = \frac{\sqrt{0.3(3)}}{10} \approx 0.095$

28. $r(s) = |9s^3 - 2s + 18|$; $r(-2) = |9(-2)^3 - 2(-2) + 18| = |-72 + 4 + 18| = -50$

29. $t(v) = -v^2 + 3v - \frac{4}{v}$; $t(-4) = -(-4)^2 + 3(-4) - \frac{4}{(-4)} = -27$

30. $h(x) = 3^x - 17x + x^2$; $h(b) = 3^b - 17b + b^2$

31. $m(x) = \sqrt{x^2 - 4x}$; $m(\odot + 3) = (\sqrt{(\odot + 3)^2 - 4(\odot + 3)}) = (\sqrt{(\odot^2 + 6\odot + 9 - 4\odot - 12)}) = (\sqrt{\odot^2 + 2\odot - 3})$

32. $n(d) = -2d + d^3$; $n(\square) = -2\square + \square^3$

33. $r(s) = |9s^3 - 2s + 18|$; $r(\Theta + \Delta) = |9(\Theta + \Delta)^3 - 2(\Theta + \Delta) + 18|$

34. $t(v) = -v^2 + 3v - \frac{4}{v}$;

$$t(\Delta - \nabla) = -(\Delta - \nabla)^2 + 3(\Delta - \nabla) - \frac{4}{\Delta - \nabla} = -(\Delta^2 - 2\Delta\nabla + \nabla^2) + 3\Delta - 3\nabla - \frac{4}{\Delta - \nabla}$$

$$= -\Delta^2 + 2\Delta\nabla - \nabla^2 + 3\Delta - 3\nabla - \frac{4}{\Delta - \nabla}$$

35. $h(x) = 3^x - 17x + x^2$; $h(b^2 + 7) = 3^{b^2+7} - 17(b^2 + 7) + (b^2 + 7)^2$

36. a. 164 pounds. In the third week since the diet started the person’s weight was 164 pounds.

b. $t = 5$. In the 5th week since the diet started the person’s weight was 160 pounds.

c. 165 pounds. This prediction will be fairly accurate since the weights do not vary greatly.

d. It does not seem reasonable for the person’s weight to be 100 pounds.

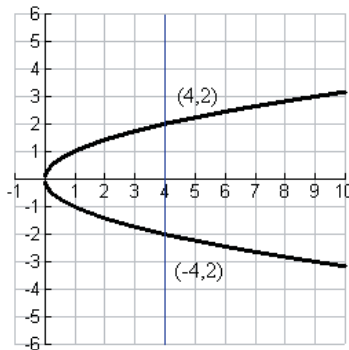
37. $C(2.76, 310)$

$$C(2.76, 310) = \frac{(2.76)(310)}{25} \approx \$34.22$$

38. $g(2, 3, 1)$

39. (Answers vary.) A process is a function in which the input undergoes some sort of a process to produce an output while a correspondence is a function in which there is simply a pairing up of one input with only one output.

40. The vertical line test is a valid way to determine if a graph represents a function because when a vertical line intersects a graph more than once this shows that for a particular input value there is more than one output value. See the graph below,



41. In many real life problems to have multiple outputs for one input does not make sense. For example, on March 17th 2015 to have more than one high temperature for Milwaukee Wisconsin is impossible.

42. When a person eats a protein bar a specific amount of calories are needed to burn up the nutrients in the bar.

43. Major cities in the United States host the Super Bowl each year so a correspondence is created by considering the city along with what number of Super Bowl it hosts.

8 Chapter 1.3: Functions Represented by Tables and Formulas

44. $p(27) = 121.46(27) + 5231.31 = 8510.73$. In 2007 the number of children enrolled in preprimary school was 8,510,730. $p(27) = 8,510,730$
45. $E(t) = 1019.65t + 27861.97$; $E(20) = 1019.65(20) + 27861.97 = 48254.97$. In 2010 the average annual expenditures of all U.S. consumers is \$48,254.97. $E(20) = 48254.97$
46. $C(y) = 168.9y + 6741$; $9000 = 168.9y + 6741$; $2259 = 168.9y$; $13.37 = y$; $y \approx 13$. In 2016 the number of students enrolled for Spring semester at Chandler-Gilbert Community College is 9000. $c(13) \approx 9000$
47. $300,000 = 5844.95t + 56589.91$; $243,410 = 5844.95t$; $41.64 = t$. The median sales price of new homes will be \$300,000 in 2021.
48. a. $t = 2002$ The number of recreational visits to U.S. National Parks was 277.3 million in 2002.
b. $P(2000) = 285.9$. In 2000 the number of recreational visits to U.S. National Parks was 285.9 million.
c. (Answers vary.) The predictions will not be accurate because the data varies.
d. (Answers vary.) Since the number of recreational visits varies so greatly it is nearly impossible to arrive at an accurate answer.
49. a. $v(s) = 630$. $s = \text{Arizona}$. In 2004 the state with 630,000 oversea visitors was Arizona.
b. $v(\text{Hawaii}) = 2215$. In 2004 Hawaii had 2,215,000 oversea visitors.
50. a. \$400,000. The value of the Arizona home was \$400,000 in Aug 2005.
b. $m = \text{January 2006}$. In January 2006 the approximate value of the home was \$440,000.
c. $m = \text{July 2006}$. Factors that could effect the value of the home would be an economic downturn or more home coming on the market competing for buyer's business.
51.
 $f(x) = 4x - 3$ · okay
 $f(x) - 4x = -3$ · okay
 $x(f - 4) = -3$ · incorrect.
The error is thinking that $f(x)$ means f times x . $f(x)$ is function notation and NOT multiplication.
52. In the equation $x(f) = 9f + 6$ the f is the independent variable and x is the dependent variable.

Section 1.3

- 1 a. $P(5, 8) = 2(5) + 2(8) = 26$
b. For a 5 x 8 rectangle the perimeter is 26 inches.
- 2 a. $P(103, 808) = 2(103) + 2(808) = 1822$
b. For a 103 x 808 rectangle the perimeter is 1822 inches.

3. a. $V(100) = \frac{4}{3}\pi(100)^3 \approx 4,188,790.21$
 b. For a sphere with radius 100 the volume is 4,188,790.21 cubic centimeters.
4. a. $V(63) = \frac{4}{3}\pi(63)^3 \approx 1,047,394.42$
 b. For a sphere with radius 63 the volume is 1,047,394.42 cubic centimeters.
5. a. $A(9,14,24) = \frac{9(14+24)}{2} = 171$
 b. For a trapezoid with height 9 and bases 14 and 24, the area is 171 square meters.
6. a. $A(17,25,30) = \frac{17(25+30)}{2} = 467.5$
 b. For a trapezoid with height 17 and bases 25 and 30, the area is 467.5 square meters.
7. The “average rate of change” means that if some sort of change were constant over a particular interval then it would be whatever the average rate of change is. For example if the average rate of change were a speed of 25 miles per hour for a time period of 4 hours, means that if the speed were the same for those four hours the speed would have been 25 miles per hour (even though the speed in actuality may vary quite significantly).
8. (Answers vary.) From 2008 to 2012 the population increased from 150,000 to 183,000 so the average rate of change would be $\frac{183,000 - 150,000}{2012 - 2008} = \frac{33,000}{4} = 8250$. This means that if the population were to increase the same amount each year then there would have been 8,250 more people each year.
9. Car insurance premiums are based upon age, driving record, style of car, value of car, sex of driver, etc. Considering these variables the independent variables would be age, driving record, style of car, value of car, and sex of driver while the premium would be the dependent variable.
10. a. The data does represent a function as there is only one output for each input value.
 b.

$\frac{30-21}{40-35} = \frac{9}{5} = 1.8$
$\frac{47-30}{45-40} = \frac{17}{5} = 3.4$
$\frac{75-47}{50-45} = \frac{28}{5} = 5.6$
$\frac{124-75}{55-50} = \frac{51}{5} = 10.2$
$\frac{198-124}{60-55} = \frac{74}{5} = 14.8$
$\frac{348-198}{65-60} = \frac{150}{5} = 30$
$\frac{628-348}{70-65} = \frac{280}{5} = 56$

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c. (sample answer for each 5-year interval): The monthly premium for \$1,000,000 of coverage increases as a constant rate of \$1.80 for each year in the male's age from 35 to 40 years old.

11. a. The data does represent a function as there is only one output for each input value.

b.

$\frac{25-21}{40-35} = \frac{4}{5} = \0.80
$\frac{41-25}{45-40} = \frac{16}{5} = \3.20
$\frac{57-41}{50-45} = \frac{16}{5} = \3.20
$\frac{88-57}{55-50} = \frac{31}{5} = \6.20
$\frac{130-88}{60-55} = \frac{42}{5} = \8.40
$\frac{209-130}{65-60} = \frac{79}{5} = \15.80
$\frac{361-209}{70-65} = \frac{152}{5} = \30.40

c. (sample answer for each 5-year interval): The monthly premium for \$1,000,000 of coverage increases as a constant rate of \$0.80 for each year in the female's age from 35 to 40 years old.

12. a. The data does represent a function as there is only one output for each input value.

b.

$\frac{37-44}{1} = -7\%$
$\frac{34-37}{1} = -3\%$
$\frac{32.5-34}{1} = 1.5\%$
$\frac{31.5-32.5}{1} = -1\%$
$\frac{30.5-31.5}{1} = -1\%$
$\frac{30-30.5}{1} = -0.5\%$

c. (sample answer for each 1-year interval): The % of 16-year-olds with driver's license decreased as a constant rate at 7% per year from 1998 to 1999.

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13. a. The data does represent a function as there is only one output for each input value.

b.

$\frac{16.0-7.5}{6-0} = \frac{8.5}{6} = 1.42$
$\frac{21.0-16.0}{12-6} = \frac{5}{6} = 0.83$
$\frac{24.0-21.0}{18-12} = \frac{3}{6} = 0.50$
$\frac{26.5-24.0}{24-18} = \frac{2.5}{6} = 0.417$
$\frac{28.5-26.5}{30-24} = \frac{2}{6} = 0.33$
$\frac{30.5-28.5}{36-30} = \frac{2}{6} = 0.33$

c. (sample answer for each 6-month interval): The weight of girls in pounds increases as a constant rate of 1.42 pounds for each year for female's age from birth to 6 months.

14. a. The data does represent a function as there is only one output for each input value.

b.

$\frac{17.4-7.9}{6-0} = \frac{9.5}{6} \approx 1.58$
$\frac{22.8-17.4}{12-6} = \frac{5.4}{6} = 0.9$
$\frac{25.9-22.8}{18-12} = \frac{3.1}{6} \approx 0.52$
$\frac{28.0-25.9}{24-18} = \frac{2.1}{6} = 0.35$
$\frac{29.8-28.0}{30-24} = \frac{1.8}{6} = 0.3$
$\frac{31.5-29.8}{36-30} = \frac{1.7}{6} \approx 0.28$

c. (sample answer for each 6-month interval): The weight of boys in pounds increases as a constant rate of 1.58 pounds for each year for male's age from birth to 6 months.

15. a. The data does represent a function as there is only one output for each input value.

b.

$\frac{10.1-9.2}{1965-1960} = \frac{0.9}{5} = 0.18$
$\frac{15.0-10.1}{1970-1965} = \frac{4.9}{5} = 0.98$
$\frac{20.1-15.0}{1975-1970} = \frac{5.1}{5} = 1.02$

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c. (sample answer for each 5 –year interval): The divorce rate increased as a constant rate of 0.18 divorces per 1000 married women for each year from 1960 to 1965.

16. The average rate of change in the number of divorces between 1980 and 1985 is $\frac{21.7 - 22.7}{5} = -0.2$ divorced per 1000 married women per year. Assuming the change in divorces was constant from 1980 to 1985 we can estimate $D(1982)$ by finding $22.7 - 0.2(2) = 22.3$. This means the estimated number of divorces per 1000 married women in 1982 is 22.3.
17. The average rate of change in China's demand for oil (in millions of barrels per day) between 2004 and 2005 is $\frac{6.3 - 6.1}{1} = 0.2$ millions of barrels per day per year. Assuming the change in oil demand remains constant from 2005 to 2006, we can estimate $D(2006)$ by finding $6.3 + 0.2(1) = 6.5$. This means the estimated number of China's oil demand to be 6.5 million barrels per day in 2006.
18. The average rate of change in Japan's bankruptcy filings (in thousands) between 2000 and 2002 is $\frac{225.0 - 149.0}{2} = \frac{76}{2} = 38$ thousand bankruptcies per year. Assuming the change in bankruptcies remains constant from 2000 to 2002, we can estimate $N(2001)$ by finding $149.0 + 38(1) = 187$. This means the estimated number of Japan's bankruptcies to be 187,000 in 2001.
19. From February to March the number of private trips given to US lawmakers in 2006 dropped by 32. It would not be reasonable to assume the same decrease from March to April because there would be a negative number of private trips. Therefore a reasonable estimate would be any number less than or equal to 29.
20. The average rate of change in Amazon's net income (in billions of dollars) between 2002 and 2003 is $\frac{5.3 - 3.9}{1} = 1.4$ billion dollars per year. Assuming the change in Amazon's net income remained constant from 2001 to 2003, we can estimate $R(2001)$ by finding $3.9 - 1.4 = 2.5$. This means the estimated amount of Amazon's net income in 2001 to be 2.5 billion dollars.
21. The average rate of change in Amazon's net income (in billions of dollars) between 2006 and 2007 is $\frac{14.8 - 10.7}{1} = 4.1$ billion dollars per year. Assuming the change in Amazon's net income remained constant from 2007 to 2008, we can estimate $R(2008)$ by finding $14.8 + 4.1 = 18.9$. This means the estimated amount of Amazon's net income in 2008 to be 18.9 billion dollars.
22. The average rate of change in the number of churches with an average weekly attendance of at least 2000 people between 1960 and 1970 is $\frac{10.0 - 0.0}{10} = 1$ church per year. Assuming the change in churches with at least 2000 people in attendance remained constant from 1960 to 1970, we can estimate $C(1965)$ by finding $0.0 + 1(5) = 5.0$. This means the estimated number of churches with at least 2000 in weekly attendance in 1965 was 5.
23. a. $F(2003) = 3426.0$ which means that in 2003 there were 3426 fines levied on passengers by the transportation security administration.
- b. Since the rate of change from 2003 to 2004 is $\frac{9741.0 - 3426.0}{2004 - 2003} = \frac{6315}{1}$ we can estimate the number of fines levied in 2005 as $9741.0 + 6315 = 16,056$.

INSTRUCTOR USE ONLY

24. a. $V(2003) = 8.94$ which means that in 2003 there were 8.94 million viewers of the daytime Emmy award.
- b. Since the rate of change from 2004 to 2005 is $\frac{7.58 - 8.26}{2005 - 2004} = \frac{-0.68}{1}$ we can estimate the number of Emmy viewers in 2006 as $7.58 - 0.68 = 6.9$ million.
25. a. $N(2) = 6.9$ which means that in the 2nd quarter of 2005 the net income of Exxon Mobil was 6.9 billion dollars.
- b. Since the rate of change from the 3rd to 4th quarter is $\frac{10.5 - 10.0}{4 - 3} = \frac{0.5}{1}$ we can estimate the amount of net income in the first quarter of 2006 as $10.5 - 0.5 = 11.0$ billion dollars.
26. a. $H(2005) = 16.5\%$ which means that in 2005 the percentage of Hispanic Marine Corps recruits was 16.5%.
- b. It appears to be true because from 2002 to 2005 the percentage of Marine Corps recruits that are Hispanic increased to over this time period.
27. a. The largest average rate of change from 2000 to 2001, 2003 to 2004, and 2004 to 2005 was Toyota, and from 2001 to 2002, 2002 to 2003 was Honda.
- b. Since Toyota had the largest average rate of change from 2003 to 2004 and from 2004 to 2005 then possibly Toyota also had the largest average rate of change in 2006.
28. a. Arizona. From 1940 to 1950 the increase in homeownerships was 8.5%.
- b. Arizona. From 1980 to 1990 the decrease in homeownership was -2.4%.
29. a. From February to March, April to July, September to October, and from November to December $N(m)$ is increasing. From February to March the average rate of change was $\frac{0.06}{1}$, from April to July the average rate of change was $\frac{0.09}{1}$, from September to October the average rate of change was $\frac{0.10}{1}$, and from November to December the average rate of change was $\frac{0.04}{1}$.
- b. There are three intervals of time when $N(m)$ is decreasing. They are from March to April ($\frac{-0.03}{1}$), July to September ($\frac{-0.12}{1}$), and October to November ($\frac{-0.11}{1}$).
- c. There are three intervals of time when $E(m)$ is decreasing. They are from April to May ($\frac{-0.01}{1}$), June to July ($\frac{-0.16}{1}$), and August to December ($\frac{-0.52}{1}$).

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30.

$$\begin{aligned} B(500, 0.05, 12, 2) &= 500\left(1 + \frac{0.05}{12}\right)^{12 \cdot 2} \\ &= \$552.47 \end{aligned}$$

The balance would be \$552.47 for an investment of \$500 invested at an interest rate of 5% with 12 compoundings per year for 2 years.

31.

$$\begin{aligned} B(350, 0.05, 12, 5) &= 350\left(1 + \frac{0.05}{12}\right)^{12 \cdot 5} \\ &\approx \$449.18 \end{aligned}$$

The balance would be \$449.18 for an investment of \$350 invested at an interest rate of 5% with 12 compoundings per year for 5 years.

$$32. \quad S(60, 0.75, 1) = \sqrt{30(60)(0.75)(1)} = 36.74$$

The minimum speed of a car at the beginning of a skid would be 36.74 miles per hour, if the skid distance is 60 feet, if 0.75 is the drag factor for the road surface, and 1% is the braking efficiency.

$$33. \quad S(155, 0.2, 0.9) = \sqrt{30(155)(0.2)(0.9)} \approx 28.93$$

The minimum speed of a car at the beginning of a skid would be 28.93 miles per hour, if the skid distance is 155 feet, if 0.2 is the drag factor for the road surface, and 0.9% is the braking efficiency.

34.

$$30,000 = 0.06s + 12000$$

$$18,000 = 0.06s$$

$$300,000 = s$$

35.

$$60,000 = 0.06s + 12000$$

$$48,000 = 0.06s$$

$$800,000 = s$$

36.

$$98.33 = \frac{9}{5}k - 459.67$$

$$558 = \frac{9}{5}k$$

$$558 \cdot \frac{5}{9} = k$$

$$310 = k$$

37.

$$70 = \frac{9}{5}k - 459.67$$

$$529.67 = \frac{9}{5}k$$

$$529.67 \cdot \frac{5}{9} = k$$

$$294.26 \approx k$$

INSTRUCTOR USE ONLY

38.

$$70 = \frac{9}{5}C + 32$$

$$38 = \frac{9}{5}C$$

$$38 \cdot \frac{5}{9} = C$$

$$21.11 \approx C$$

39.

$$F = \frac{9}{5}(70) + 32$$

$$F = 158$$

40.

$$30 = \frac{5}{9}(F - 32)$$

$$30 = \frac{5}{9}F - \frac{160}{9}$$

$$47.78 \approx \frac{5}{9}F$$

$$47.78 \cdot \frac{9}{5} \approx F$$

$$86 = F$$

41.

$$10 = \frac{5}{9}(F - 32)$$

$$10 = \frac{5}{9}F - \frac{160}{9}$$

$$27.78 \approx \frac{5}{9}F$$

$$27.78 \cdot \frac{9}{5} \approx F$$

$$50 = F$$

42.

$$50 = \frac{h(7+13)}{2}$$

$$100 = h(20)$$

$$5 = h$$

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43.

$$120 = \frac{h(8+14)}{2}$$

$$240 = h(22)$$

$$\frac{240}{22} = h$$

$$10.91 \approx h$$

44.

$$5395.40 = p\left(1 + \frac{0.06}{12}\right)^{12 \cdot 5}$$

$$5395.40 = p(1.005)^{60}$$

$$5395.40 \approx p(1.3489)$$

$$3999.85 \approx p$$

45.

$$5395.40 = p\left(1 + \frac{0.03}{12}\right)^{12 \cdot 5}$$

$$5395.40 = p(1.0025)^{60}$$

$$5395.40 \approx p(1.1616)$$

$$4644.80 \approx p$$

46. a. $T(m) = 317.54m + 2000$

b.

$$\begin{aligned} T(60) &= 317.54(60) + 2000 \\ &= \$21,052.40 \end{aligned}$$

c. $21,052.4 - 18,366 = \$2686.40$

47. a. $T(m) = 172.55m + 3000$

b.

$$\begin{aligned} T(72) &= 172.55(72) + 3000 \\ &= \$15,423.60 \end{aligned}$$

c. $15,423.60 - 13,210 = \$2,213.60$

48. a.

$$\begin{aligned} M(2000, 0.005, 24) &= 2000 \left(\frac{0.005(1+0.005)^{24}}{(1+0.005)^{24} - 1} \right) \\ &= 88.64 \end{aligned}$$

b. The monthly payments on a 24-month loan of \$2000 at 0.5% is \$88.64.

49. a.

$$\begin{aligned} M(600, 0.0082, 12) &= 600 \left(\frac{0.0082(1+0.0082)^{12}}{(1+0.0082)^{12} - 1} \right) \\ &\approx 52.45 \end{aligned}$$

INSTRUCTOR USE ONLY

b. The monthly payments on a 12-month loan of \$600 at 0.82% is \$52.45.

50.

$$FV(10, 0.00425, 60) = 10 \left(\frac{(1 + 0.00425)^{60} - 1}{0.00425} \right)$$

$$\approx \$681.80$$

The future value of an investment with a constant monthly payment of \$10 after 60 months and monthly interest rate of 0.00425 is \$681.80.

51.

$$FV(100, 0.00425, 60) = 100 \left(\frac{(1 + 0.00425)^{60} - 1}{0.00425} \right)$$

$$\approx \$6817.99$$

The future value of an investment with a constant monthly payment of \$100 after 60 months and monthly interest rate of 0.00425 is \$6817.99.

52. a.

$$FV(50, 0.00416, 48) = 50 \left(\frac{(1 + 0.00416)^{48} - 1}{0.00416} \right)$$

b.

$$FV(50, 0.00416, 48) = 50 \left(\frac{(1 + 0.00416)^{48} - 1}{0.00416} \right)$$

$$\approx \$2650.32$$

The future value of an investment with a constant monthly payment of \$50 after 48 months and monthly interest rate of 0.00416 is \$2650.32.

53. a.

$$FV(75, 0.00464, 60) = 75 \left(\frac{(1 + 0.00464)^{60} - 1}{0.00464} \right)$$

b.

$$FV(75, 0.00464, 60) = 75 \left(\frac{(1 + 0.00464)^{60} - 1}{0.00464} \right)$$

$$\approx \$5175.07$$

The future value of an investment with a constant monthly payment of \$75 after 60 months and monthly interest rate of 0.00464 is \$5175.07.

54. Since the average rate of salary increase from 2000 to 2005 was \$2200 per year there is a total increase of \$11,000 in salary over those five years and from 2005 to 2009 there was an average rate of salary increase of \$1600 per year for a total of \$6400. Over the 9 years there was a total increase of \$17,400 so an overall average rate of salary increase of $\frac{17,400}{9} \approx 1933.33$ dollars per year.

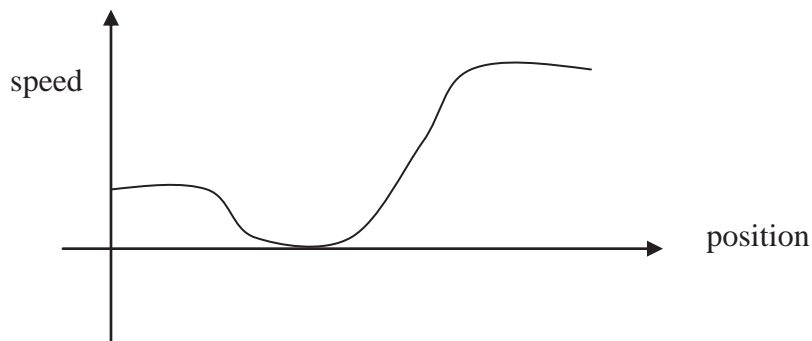
55. Over the first five months the price increased by $0.45(5) = 2.25$ and over the last 7 months the price decreased by $-0.30(7) = -2.10$ so the overall change in price was an increase of \$0.15 over 12 months for an average rate of change in the price per month of \$0.0125.

Section 1.4

1. $f(-3) \approx 8.5$
2. $x \approx -0.5$
3. $x \approx 0.6$
4. $f(0) \approx 1$
5. $f(4) \approx -2$
6. $g(-1) \approx -0.8$
7. no solution
8. $x \approx -3.1, 0, 3.1$
9. $g(0) = 0$
10. $g(1.5) = 1$
11. $f(g) = e$
12. $f(x) = a, x = 0$
13. $f(x) = e, x = g$ and $x = n$
14. $f(k) = c$
15. $f(j) = b$
16. graph A
17. graph E
18. graph C
19. graph B
20. graph D
21. The vertical intercept represents the initial amount of air in the balloon. The horizontal intercepts represent the two times when there was no air in the balloon.
22. The vertical intercept represents the initial distance the person was from the classroom. The horizontal intercept represents the time when the person reaches class.
23. The vertical intercept represents the initial number of times the lawn was mowed (which would be 0). The horizontal intercept represents the time when there were no cumulative number of lawn mowing.
24. (Answers vary) The practical domain (in years) is $0 \leq t \leq 10$. The practical range (in dollars) is $0 < B \leq 1500$.

25. (Answers vary) The practical domain (in minutes) is $0 \leq m \leq 60$. The practical range (in degrees Fahrenheit) is $31 \leq T \leq 76$.
26. a. (Answers vary) The practical domain is $0 \leq y \leq 4$. The practical range is $52 \leq m \leq 64$.
- b. As the years increase the percentage of households with multiple cellular phones change.
27. a. (Answers vary) The practical domain is $0 \leq t \leq 100$. The practical range is $0 \leq c \leq 4500$.
- b. As the years increase after 1900, the cigarette consumption increases until 1960 and then decreases until 2000.
- c. The cigarette consumption in the year 1900.
28. a. No, the data does not represent a function because multiple golfers may set the tee at the same height, yet average different drive distances.
- b. The data could be as spread out as it is because each golfer has their own preference as to where to set the tee height to achieve various drive distances.
- c. Making predictions would not be accurate because the data is collected from many different golfers. If the data were all collected from one individual golfer, then changing the tee height would give relatively accurate predictions.
29. a. When the tram is 100 horizontal feet from the its original position it would be approximately 400 vertical feet.
- b. When the tram is 500 vertical feet off the ground it is either 150 or 450 vertical feet off the ground.
- c. No, the arch is only 600 feet wide.
- d. 200 feet above ground the width of the arch is approximately 500 horizontal feet. If the wingspan of the plane is 46 feet then there should be $\frac{(500-46) \text{ feet}}{2}$ on each side. So, 227 feet on either side of the plane to the inside edge of the arch.

30.



31. a. Hiker A is ahead after 1 hour because he has been hiking faster the whole time.
- b. Hiker A is hiking faster than Hiker B because his speed (the vertical coordinates) is greater at that time.

c. Hiker A is pulling away from Hiker B because his speed (vertical coordinates) is greater during the interval of time from 45 minutes to 1 hour.

Section 1.5

- Let C = total cost of gasoline and g = gallons of gasoline

$$C = f(g)$$

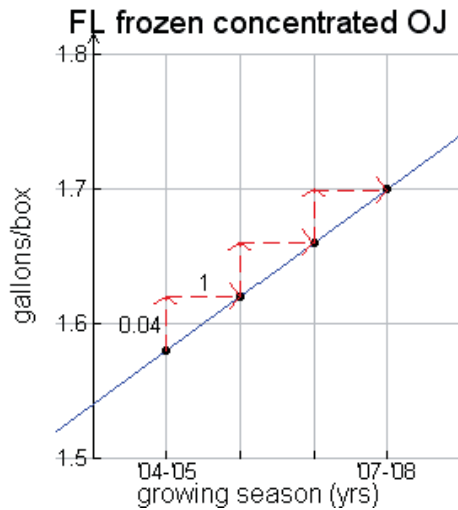
$$C(g) = 4.109g$$

- Let F – Feb 2006 personal income (billion dollars) and let M – Mar 2006 personal income (billion dollars) then $M(F) = F + 78.4$

-

Bushels/Acre	Production (billion bushels)
42.4	1.32
$42.4 + 2 = 44.4$	$1.32 + 0.18 = 1.50$

-



$$m = \frac{1.62 - 1.58 \text{ gallons / box}}{1 \text{ year}}$$

$$= 0.04 \text{ gallons/box/year at 42 degrees Brix}$$

T = Total FL frozen Concentrate OJ

y = growing seasons after '04-'05

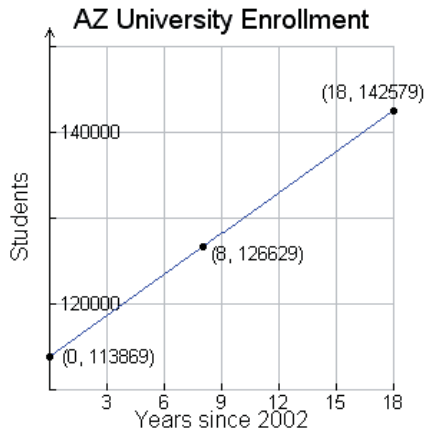
$$T(y) = 1.58 + 0.04y$$

$$T(3) = 1.58 + 0.04(3)$$

$$= 1.70$$

In the 2007-2008 growing season, the yield for Florida frozen concentrate orange juice is approximately 1.70 gallons per box at 42.0 degrees Brix.

5.

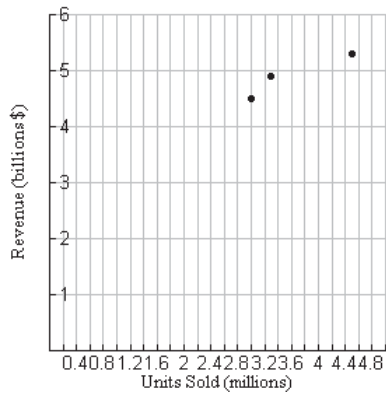


$$m = 1595 \text{ students/year}$$

$$113869 + 1595(8) = 126629$$

In 2010, Arizona Universities will have approximately 126,629 students.

6.



7.

