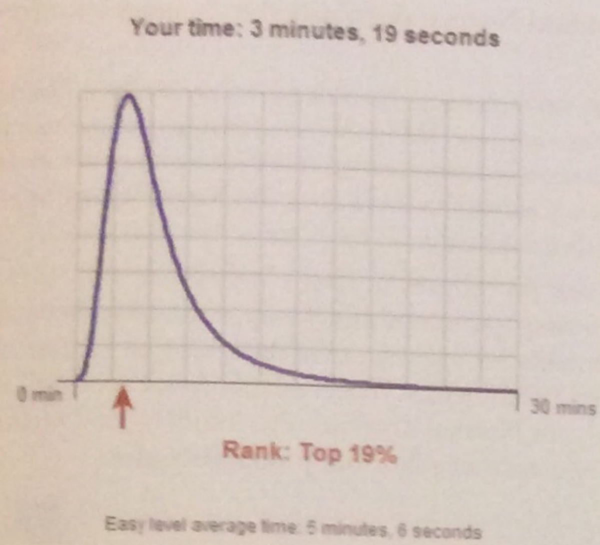


4. From long experience, the author's times to finish an easy sudoku puzzle at this Web site follow a Normal distribution with mean 4.2 minutes and standard deviation 0.7 minutes. In what percent of the games that he plays does the author finish an easy puzzle in less than 3 minutes and 15 seconds? Show your work. (*Note:* 3 minutes and 15 seconds is not the same as 3.15 seconds!)
5. The author's wife also enjoys playing sudoku online. Her times to finish an easy puzzle at this Web site follow a Normal distribution with mean 3.8 minutes and standard deviation 0.9 minutes. In her most recent game, she finished in 3 minutes. Whose performance is better, relatively speaking: the author's 3 minutes and 19 seconds or his wife's 3 minutes? Justify your answer.

Section 2.2 Summary

- We can describe the overall pattern of a distribution by a **density curve**. A density curve always remains on or above the horizontal axis and has total area 1 underneath it. An area under a density curve gives the proportion of observations that fall in an interval of values.
- A density curve is an idealized description of the overall pattern of a distribution that smooths out the irregularities in the actual data. We write the **mean of a density curve** as μ and the **standard deviation of a density curve** as σ to distinguish them from the mean $\bar{x}$ and the standard deviation s_x of the actual data.
- The mean and the median of a density curve can be located by eye. The mean μ is the balance point of the curve. The median divides the area under the curve in half. The standard deviation σ cannot be located by eye on most density curves.
- The mean and median are equal for symmetric density curves. The mean of a skewed curve is located farther toward the long tail than the median is.
- The **Normal distributions** are described by a special family of bell-shaped, symmetric density curves, called **Normal curves**. The mean μ and standard deviation σ completely specify a Normal distribution $N(\mu,\sigma)$. The mean is the center of the curve, and σ is the distance from μ to the change-of-curvature points on either side.
- All Normal distributions obey the **68–95–99.7 rule**, which describes what percent of observations lie within one, two, and three standard deviations of the mean.
- All Normal distributions are the same when measurements are standardized. If x follows a Normal distribution with mean μ and standard deviation σ, we can standardize using

$$z = \frac{x - \mu}{\sigma}$$

The variable z has the **standard Normal distribution** with mean 0 and standard deviation 1.

- **Table A** at the back of the book gives percentiles for the standard Normal curve. By standardizing, we can use Table A to determine the percentile for a given z-score or the z-score corresponding to a given percentile in any Normal distribution. You can use your calculator or the *Normal Curve* applet to perform Normal calculations quickly.
- To perform certain inference procedures in later chapters, we will need to know that the data come from populations that are approximately Normally distributed. To assess Normality for a given set of data, we first observe the shape of a dotplot, stemplot, or histogram. Then we can check how well the data fit the 68–95–99.7 rule for Normal distributions. Another good method for assessing Normality is to construct a **Normal probability plot**.

2.2 TECHNOLOGY CORNERS

TI-Nspire instructions in Appendix B; HP Prime instructions on the book's Web site.

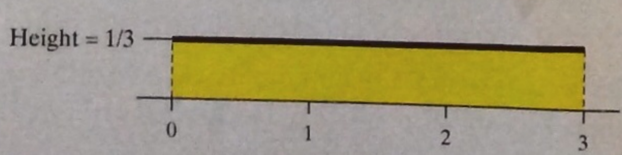
Section 2.2 Exercises

33. **Density curves** Sketch a density curve that might describe a distribution that is symmetric but has two peaks.

34. **Density curves** Sketch a density curve that might describe a distribution that has a single peak and is skewed to the left.

Exercises 35 to 38 involve a special type of density curve—one that takes constant height (looks like a horizontal line) over some interval of values. This density curve describes a variable whose values are distributed evenly (uniformly) over some interval of values. We say that such a variable has a ***uniform distribution***.

35. **Biking accidents** Accidents on a level, 3-mile bike path occur uniformly along the length of the path. The figure below displays the density curve that describes the uniform distribution of accidents.

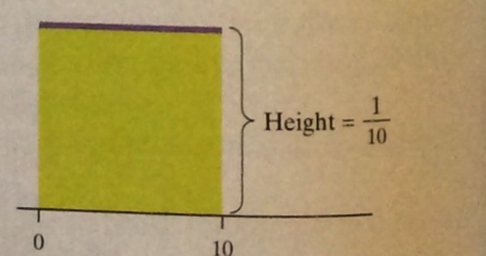


(a) Explain why this curve satisfies the two requirements for a density curve.

(b) The proportion of accidents that occur in the first mile of the path is the area under the density curve between 0 miles and 1 mile. What is this area?

(c) Sue's property adjoins the bike path between the 0.8 mile mark and the 1.1 mile mark. What proportion of accidents happen in front of Sue's property? Explain.

36. **Where's the bus?** Sally takes the same bus to work every morning. The amount of time (in minutes) that she has to wait for the bus to arrive is described by the uniform distribution below.



(a) Explain why this curve satisfies the two requirements for a density curve.

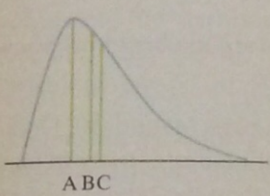
(b) On what percent of days does Sally have to wait more than 8 minutes for the bus?

(c) On what percent of days does Sally wait between 2.5 and 5.3 minutes for the bus?

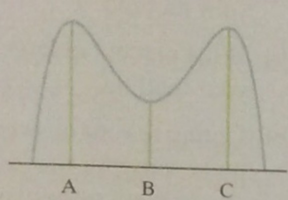
37. **Biking accidents** What is the mean μ of the density curve pictured in Exercise 35? (That is, where would the curve balance?) What is the median? (That is, where is the point with area 0.5 on either side?)

38. **Where's the bus?** What is the mean μ of the density curve pictured in Exercise 36? What is the median?

39. **Mean and median** The figure below displays two density curves, each with three points marked. At which of these points on each curve do the mean and the median fall?

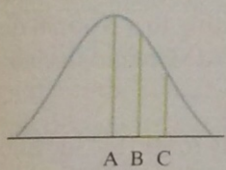


(a)

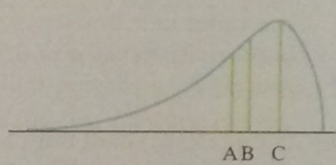


(b)

40. **Mean and median** The figure below displays two density curves, each with three points marked. At which of these points on each curve do the mean and the median fall?



(a)



(b)

41. **Men's heights** The distribution of heights of adult American men is approximately Normal with mean 69 inches and standard deviation 2.5 inches. Draw an accurate sketch of the distribution of men's heights. Be sure to label the mean, as well as the points 1, 2, and 3 standard deviations away from the mean on the horizontal axis.

42. **Potato chips** The distribution of weights of 9-ounce bags of a particular brand of potato chips is approximately Normal with mean $\mu = 9.12$ ounces and standard deviation $\sigma = 0.05$ ounce. Draw an accurate sketch of the distribution of potato chip bag weights. Be sure to label the mean, as well as the points 1, 2, and 3 standard deviations away from the mean on the horizontal axis.

43. **Men's heights** Refer to Exercise 41. Use the 68–95–99.7 rule to answer the following questions. Show your work! pg 111

(a) Between what heights do the middle 95% of men fall?

(b) What percent of men are taller than 74 inches?

(c) What percent of men are between 64 and 66.5 inches tall?

(d) A height of 71.5 inches corresponds to what percentile of adult male American heights?

44. **Potato chips** Refer to Exercise 42. Use the 68–95–99.7 rule to answer the following questions. Show your work!

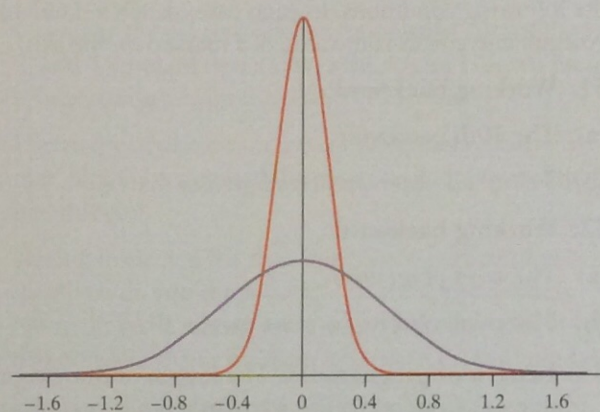
(a) Between what weights do the middle 68% of bags fall?

(b) What percent of bags weigh less than 9.02 ounces?

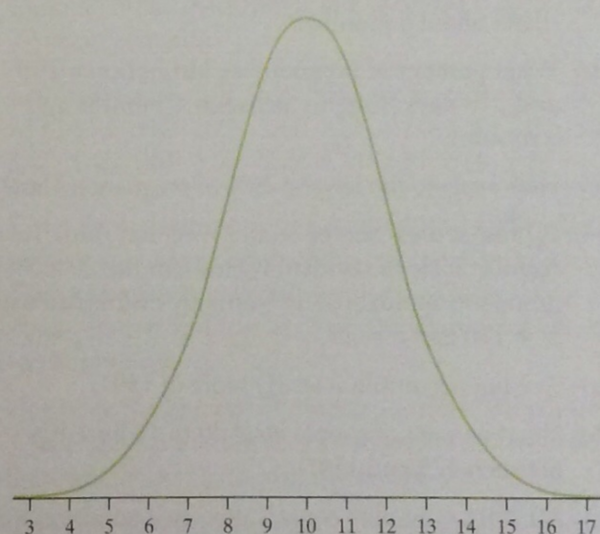
(c) What percent of 9-ounce bags of this brand of potato chips weigh between 8.97 and 9.17 ounces?

(d) A bag that weighs 9.07 ounces is at what percentile in this distribution?

45. **Estimating SD** The figure below shows two Normal curves, both with mean 0. Approximately what is the standard deviation of each of these curves?



46. **A Normal curve** Estimate the mean and standard deviation of the Normal density curve in the figure below.



For Exercises 47 to 50, use Table A to find the proportion of observations from the standard Normal distribution that satisfies each of the following statements. In each case, sketch a standard Normal curve and shade the area under the curve that is the answer to the question.

47. **Table A practice**

(a) $z < 2.85$

(b) $z > 2.85$

(c) $z > -1.66$

(d) $-1.66 < z < 2.85$

48. Table A practice

(a) $z < -2.46$ (c) $0.89 < z < 2.46$

(b) $z > 2.46$ (d) $-2.95 < z < -1.27$

pg 115 **49. More Table A practice**

(a) z is between -1.33 and 1.65

(b) z is between 0.50 and 1.79

50. More Table A practice

(a) z is between -2.05 and 0.78

(b) z is between -1.11 and -0.32

For Exercises 51 and 52, use Table A to find the value z from the standard Normal distribution that satisfies each of the following conditions. In each case, sketch a standard Normal curve with your value of z marked on the axis.

51. Working backward

(a) The 10th percentile.

(b) 34% of all observations are greater than z.

52. Working backward

(a) The 63rd percentile.

(b) 75% of all observations are greater than z.

53. Length of pregnancies The length of human pregnancies from conception to birth varies according to a distribution that is approximately Normal with mean 266 days and standard deviation 16 days.

pg 118 (a) At what percentile is a pregnancy that lasts 240 days (that's about 8 months)?

pg 119 (b) What percent of pregnancies last between 240 and 270 days (roughly between 8 months and 9 months)?

pg 120 (c) How long do the longest 20% of pregnancies last?

54. IQ test scores Scores on the Wechsler Adult Intelligence Scale (a standard IQ test) for the 20 to 34 age group are approximately Normally distributed with $\mu = 110$ and $\sigma = 25$.

(a) At what percentile is an IQ score of 150?

(b) What percent of people aged 20 to 34 have IQs between 125 and 150?

(c) MENSA is an elite organization that admits as members people who score in the top 2% on IQ tests. What score on the Wechsler Adult Intelligence Scale would an individual aged 20 to 34 have to earn to qualify for MENSA membership?

55. Put a lid on it! At some fast-food restaurants, customers who want a lid for their drinks get them from a large stack left near straws, napkins, and condiments. The lids are made with a small amount of flexibility so they can be stretched across the mouth of the cup and then snugly secured. When lids are too small or too large, customers can get very frustrated, especially if they end up spilling their drinks. At one particular restaurant, large drink cups require lids with a "diameter" of between 3.95 and 4.05 inches. The restaurant's lid supplier claims that the diameter of their large lids follows a Normal distribution with mean 3.98 inches and standard deviation 0.02 inches. Assume that the supplier's claim is true.

(a) What percent of large lids are too small to fit? Show your method.

(b) What percent of large lids are too big to fit? Show your method.

(c) Compare your answers to parts (a) and (b). Does it make sense for the lid manufacturer to try to make one of these values larger than the other? Why or why not?

56. I think I can! An important measure of the performance of a locomotive is its "adhesion," which is the locomotive's pulling force as a multiple of its weight. The adhesion of one 4400-horsepower diesel locomotive varies in actual use according to a Normal distribution with mean $\mu = 0.37$ and standard deviation $\sigma = 0.04$.

(a) For a certain small train's daily route, the locomotive needs to have an adhesion of at least 0.30 for the train to arrive at its destination on time. On what proportion of days will this happen? Show your method.

(b) An adhesion greater than 0.50 for the locomotive will result in a problem because the train will arrive too early at a switch point along the route. On what proportion of days will this happen? Show your method.

(c) Compare your answers to parts (a) and (b). Does it make sense to try to make one of these values larger than the other? Why or why not?

57. Put a lid on it! Refer to Exercise 55. The supplier is considering two changes to reduce the percent of its large-cup lids that are too small to 1%. One strategy is to adjust the mean diameter of its lids. Another option is to alter the production process, thereby decreasing the standard deviation of the lid diameters.

(a) If the standard deviation remains at $\sigma = 0.02$ inches, at what value should the supplier set the mean diameter of its large-cup lids so that only 1% are too small to fit? Show your method.

(b) If the mean diameter stays at $\mu = 3.98$ inches, what value of the standard deviation will result in only 1% of lids that are too small to fit? Show your method.

(c) Which of the two options in parts (a) and (b) do you think is preferable? Justify your answer. (Be sure to consider the effect of these changes on the percent of lids that are too large to fit.)

58. **I think I can!** Refer to Exercise 56. The locomotive's manufacturer is considering two changes that could reduce the percent of times that the train arrives late. One option is to increase the mean adhesion of the locomotive. The other possibility is to decrease the variability in adhesion from trip to trip, that is, to reduce the standard deviation.

(a) If the standard deviation remains at $\sigma = 0.04$, to what value must the manufacturer change the mean adhesion of the locomotive to reduce its proportion of late arrivals to only 2% of days? Show your work.

(b) If the mean adhesion stays at $\mu = 0.37$, how much must the standard deviation be decreased to ensure that the train will arrive late only 2% of the time? Show your work.

(c) Which of the two options in parts (a) and (b) do you think is preferable? Justify your answer. (Be sure to consider the effect of these changes on the percent of days that the train arrives early to the switch point.)

59. **Deciles** The deciles of any distribution are the values at the 10th, 20th, . . . , 90th percentiles. The first and last deciles are the 10th and the 90th percentiles, respectively.

(a) What are the first and last deciles of the standard Normal distribution?

(b) The heights of young women are approximately Normal with mean 64.5 inches and standard deviation 2.5 inches. What are the first and last deciles of this distribution? Show your work.

60. **Outliers** The percent of the observations that are classified as outliers by the $1.5 \times IQR$ rule is the same in any Normal distribution. What is this percent? Show your method clearly.

61. **Flight times** An airline flies the same route at the same time each day. The flight time varies according to a Normal distribution with unknown mean and standard deviation. On 15% of days, the flight takes more than an hour. On 3% of days, the flight lasts 75 minutes or more. Use this information to determine the mean and standard deviation of the flight time distribution.

62. **Brush your teeth** The amount of time Ricardo spends brushing his teeth follows a Normal distribution with unknown mean and standard deviation. Ricardo spends less than one minute brushing his teeth about 40% of the time. He spends more than two minutes brushing his teeth 2% of the time. Use this information to determine the mean and standard deviation of this distribution.

63. **Sharks** Here are the lengths in feet of 44 great white sharks:[11]

pg 124

18.7	12.3	18.6	16.4	15.7	18.3	14.6	15.8	14.9	17.6	12.1
16.4	16.7	17.8	16.2	12.6	17.8	13.8	12.2	15.2	14.7	12.4
13.2	15.8	14.3	16.6	9.4	18.2	13.2	13.6	15.3	16.1	13.5
19.1	16.2	22.8	16.8	13.6	13.2	15.7	19.7	18.7	13.2	16.8

(a) Enter these data into your calculator and make a histogram. Include a sketch of the graph on your paper. Then calculate one-variable statistics. Describe the shape, center, and spread of the distribution of shark lengths.

(b) Calculate the percent of observations that fall within 1, 2, and 3 standard deviations of the mean. How do these results compare with the 68–95–99.7 rule?

(c) Use your calculator to construct a Normal probability plot. Include a sketch of the graph on your paper. Interpret this plot.

(d) Having inspected the data from several different perspectives, do you think these data are approximately Normal? Write a brief summary of your assessment that combines your findings from parts (a) through (c).

64. **Density of the earth** In 1798, the English scientist Henry Cavendish measured the density of the earth several times by careful work with a torsion balance. The variable recorded was the density of the earth as a multiple of the density of water. Here are Cavendish's 29 measurements:[12]

5.50	5.61	4.88	5.07	5.26	5.55	5.36	5.29	5.58	5.65
5.57	5.53	5.62	5.29	5.44	5.34	5.79	5.10	5.27	5.39
5.42	5.47	5.63	5.34	5.46	5.30	5.75	5.68	5.85	

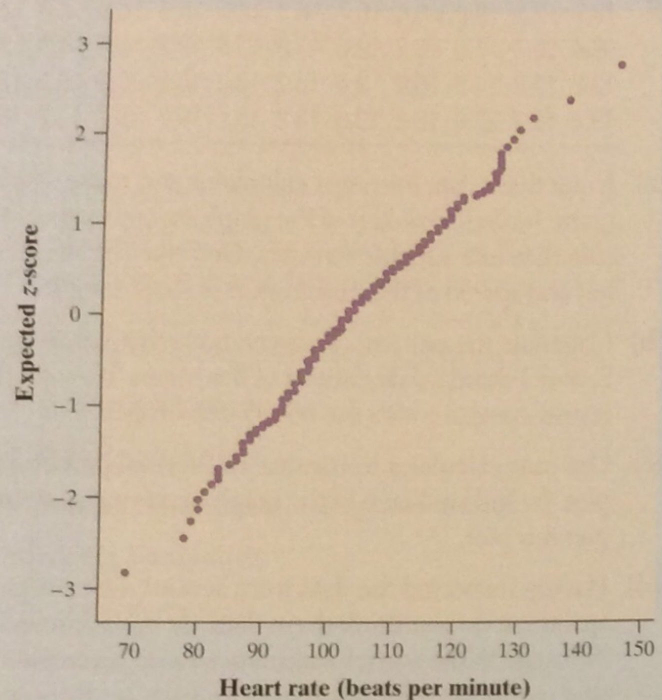
(a) Enter these data into your calculator and make a histogram. Include a sketch of the graph on your paper. Then calculate one-variable statistics. Describe the shape, center, and spread of the distribution of density measurements.

(b) Calculate the percent of observations that fall within 1, 2, and 3 standard deviations of the mean. How do these results compare with the 68–95–99.7 rule?

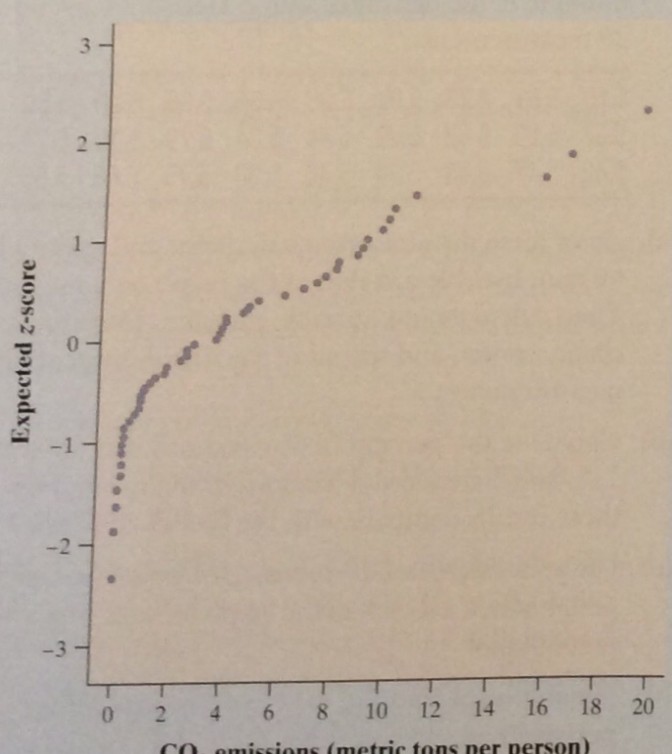
(c) Use your calculator to construct a Normal probability plot. Include a sketch of the graph on your paper. Interpret this plot.

(d) Having inspected the data from several different perspectives, do you think these data are approximately Normal? Write a brief summary of your assessment that combines your findings from parts (a) through (c).

65. **Runners' heart rates** The figure below is a Normal probability plot of the heart rates of 200 male runners after six minutes of exercise on a treadmill.[13] The distribution is close to Normal. How can you see this? Describe the nature of the small deviations from Normality that are visible in the plot.



66. **Carbon dioxide emissions** The figure below is a Normal probability plot of the emissions of carbon dioxide per person in 48 countries.[14] In what ways is this distribution non-Normal?



67. **Is Michigan Normal?** We collected data on the tuition charged by colleges and universities in Michigan. Here are some numerical summaries for the data:

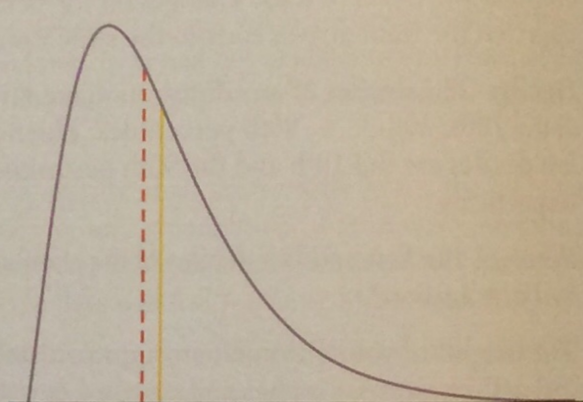
Mean	Std. Dev.	Min	Max
10614	8049	1873	30823

Based on the relationship between the mean, standard deviation, minimum, and maximum, is it reasonable to believe that the distribution of Michigan tuitions is approximately Normal? Explain.

68. **Weights aren't Normal** The heights of people of the same gender and similar ages follow Normal distributions reasonably closely. Weights, on the other hand, are not Normally distributed. The weights of women aged 20 to 29 have mean 141.7 pounds and median 133.2 pounds. The first and third quartiles are 118.3 pounds and 157.3 pounds. What can you say about the shape of the weight distribution? Why?

Multiple choice: Select the best answer for Exercises 69 to 74.

69. Two measures of center are marked on the density curve shown. Which of the following is correct?



(a) The median is at the yellow line and the mean is at the red line.

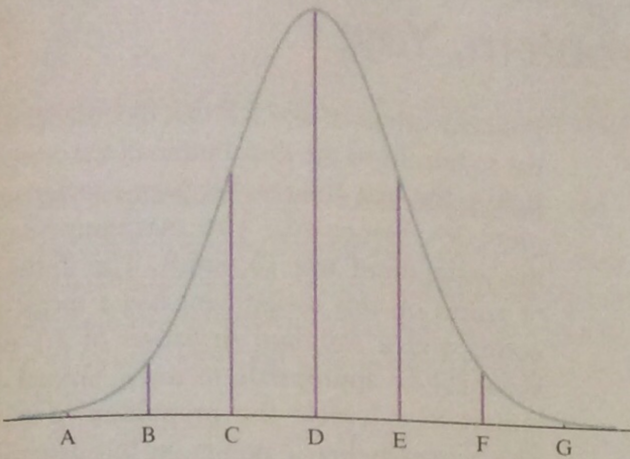
(b) The median is at the red line and the mean is at the yellow line.

(c) The mode is at the red line and the median is at the yellow line.

(d) The mode is at the yellow line and the median is at the red line.

(e) The mode is at the red line and the mean is at the yellow line.

Exercises 70 to 72 refer to the following setting. The weights of laboratory cockroaches follow a Normal distribution with mean 80 grams and standard deviation 2 grams. The following figure is the Normal curve for this distribution of weights.



0. Point C on this Normal curve corresponds to

a) 84 grams. (c) 78 grams. (e) 74 grams.
b) 82 grams. (d) 76 grams.

1. About what percent of the cockroaches have weights between 76 and 84 grams?

a) 99.7% (c) 68% (e) 34%
b) 95% (d) 47.5%

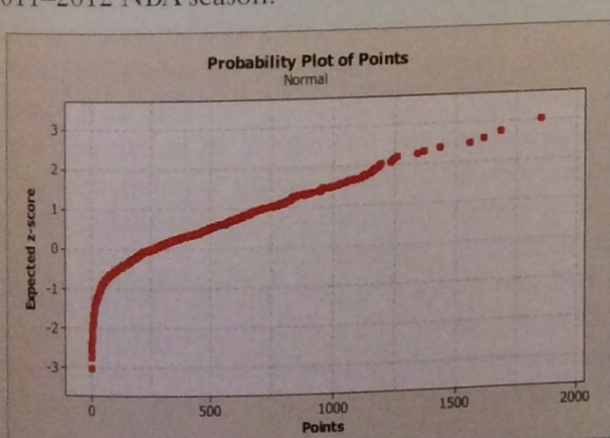
2. About what proportion of the cockroaches will have weights greater than 83 grams?

a) 0.0228 (c) 0.1587 (e) 0.0772
b) 0.0668 (d) 0.9332

3. A different species of cockroach has weights that follow a Normal distribution with a mean of 50 grams. After measuring the weights of many of these cockroaches, a lab assistant reports that 14% of the cockroaches weigh more than 55 grams. Based on this report, what is the approximate standard deviation of weights for this species of cockroaches?

a) 4.6 (d) 14.0
b) 5.0 (e) Cannot determine without more information.
c) 6.2

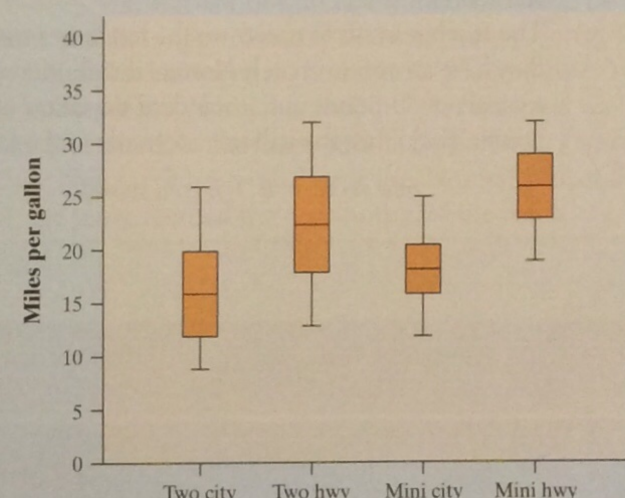
4. The following Normal probability plot shows the distribution of points scored for the 551 players in the 2011–2012 NBA season.



If the distribution of points was displayed in a histogram, what would be the best description of the histogram's shape?

(a) Approximately Normal
(b) Symmetric but not approximately Normal
(c) Skewed left
(d) Skewed right
(e) Cannot be determined

75. **Gas it up!** (1.3) Interested in a sporty car? Worried that it might use too much gas? The Environmental Protection Agency lists most such vehicles in its "two-seater" or "minicompact" categories. The figure shows boxplots for both city and highway gas mileages for our two groups of cars. Write a few sentences comparing these distributions.



76. **Python eggs** (1.1) How is the hatching of water python eggs influenced by the temperature of the snake's nest? Researchers assigned newly laid eggs to one of three temperatures: hot, neutral, or cold. Hot duplicates the extra warmth provided by the mother python, and cold duplicates the absence of the mother. Here are the data on the number of eggs and the number that hatched:[15]

	Cold	Neutral	Hot
Number of eggs	27	56	104
Number hatched	16	38	75

(a) Make a two-way table of temperature by outcome (hatched or not).

(b) Calculate the percent of eggs in each group that hatched. The researchers believed that eggs would be less likely to hatch in cold water. Do the data support that belief?

Chapter 2

Section 2.1

Answers to Check Your Understanding

page 89: 1. c 2. Her daughter weighs more than 87% of girls her age and she is taller than 67% of girls her age. 3. About 65% of calls lasted less than 30 minutes, which means that about 35% of calls lasted 30 minutes or longer. 4. $Q_1 = 13$ minutes, $Q_3 = 32$ minutes, and $IQR = 19$ minutes.

page 91: 1. $z = -0.466$. Lynette's height is 0.466 standard deviations below the mean height of the class. 2. $z = 1.63$. Brent's height is 1.63 standard deviations above the mean height of the class. 3. $-0.85 = \frac{74 - 76}{\sigma}$, so $\sigma = 2.35$ inches.

page 97: 1. Shape will not change. However, it will multiply the center (mean, median) and spread (range, IQR, standard deviation) by 2.54. 2. Shape and spread will not change. It will, however, add 6 inches to the center (mean, median). 3. Shape will not change. However, it will change the mean to 0 and the standard deviation to 1.

Answers to Odd-Numbered Section 2.1 Exercises

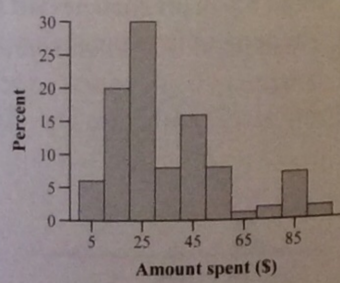
2.1 (a) She is at the 25th percentile, meaning that 25% of the girls had fewer pairs of shoes than she did. (b) He is at the 85th percentile, meaning that 85% of the boys had fewer pairs of shoes than he did. (c) The boy is more unusual because only 15% of the boys have as many or more than he has. The girl has a value that is closer to the center of the distribution.

2.3 A percentile only describes the relative location of a value in a distribution. Scoring at the 60th percentile means that Josh's score is better than 60% of the students taking this test. His correct percentage could be greater than 60% or less than 60%, depending on the difficulty of the test.

2.5 The girl weighs more than 48% of girls her age, but is taller than 78% of the girls her age.

2.7 (a) The student sent about 205 text messages in the 2-day period and sent more texts than about 78% of the students in the sample. (b) Locate 50% on the y-axis, read over to the points, and then go down to the x-axis. The median is approximately 115 text messages.

2.9 (a) $IQR \approx \$46 - \$19 = \$27$ (b) About the 26th percentile. (c) The histogram is below.



2.11 Eleanor. Her standardized score ($z = 1.8$) is higher than Gerald's ($z = 1.5$).

2.13 (a) Your bone density is far below average—about 1.5 times farther below average than a typical below-average density. (b) Solving $-1.45 = \frac{948 - 956}{\sigma}$ gives $\sigma = 5.52$ g/cm^2.

2.15 (a) He is at the 76th percentile, meaning his salary is higher than 76% of his teammates. (b) $z = 0.79$. Lidge's salary was 0.79 standard deviations above the mean salary.

2.17 Multiply each score by 4 and add 27.

2.19 (a) mean = 87.188 inches and median = 87.5 inches. (b) The standard deviation (3.20 inches) and IQR (3.25 inches) do not change because adding a constant to each value in a distribution does not change the spread.

2.21 (a) mean = 5.77 feet and median = 5.79 feet. (b) Standard deviation = 0.267 feet and IQR = 0.271 feet.

2.23 Mean $= \frac{9}{5}(25) + 32 = 77°$F and standard deviation $= \frac{9}{5}(2) = 3.6°$F.

2.25 c

2.27 c

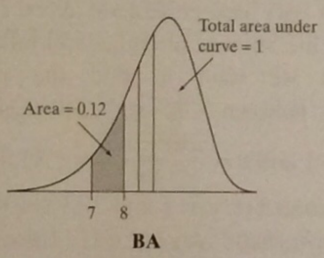
2.29 c

2.31 The distribution is skewed to the right with a center around 20 minutes and the range close to 90 minutes. The two largest values appear to be outliers.

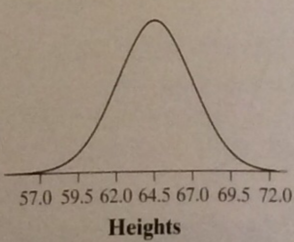
Section 2.2

Answers to Check Your Understanding

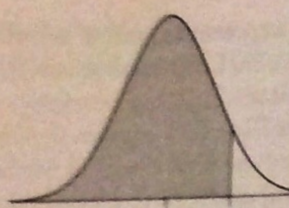
page 107: 1. It is legitimate because it is positive everywhere and it has total area under the curve = 1. 2. 12% 3. Point A in the graph below is the approximate median. About half of the area is to the left of A and half of the area is to the right of A. 4. Point B in the graph below is the approximate mean (balance point). The mean is less than the median in this case because the distribution is skewed to the left.

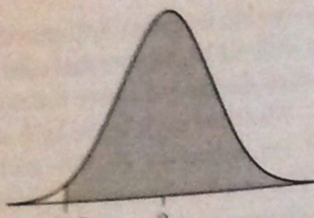


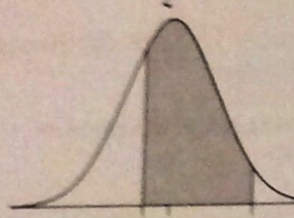
page 112: 1. The graph is given below. 2. Approximately $\frac{100\% - 68\%}{2} = 16\%$. 3. Approximately $\frac{100\% - 68\%}{2} = 16\%$ have heights below 62 inches and approximately $\frac{100\% - 99.7\%}{2} = 0.15\%$ of young women have heights above 72 inches, so the remaining 83.85% have heights between 62 and 72 inches.

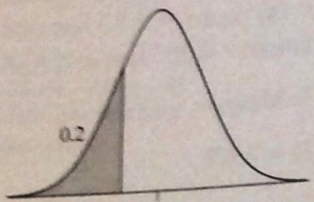


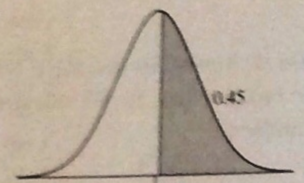
page 116: (All graphs are shown on the following page.) 1. The proportion is 0.9177. 2. The proportion is 0.9842. 3. The proportion is $0.9649 - 0.2877 = 0.6772$. 4. The z-score for the 20th percentile is $z = -0.84$. 5. 45% of the observations are greater than $z = 0.13$.



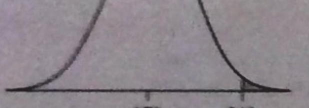


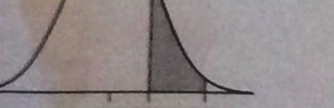


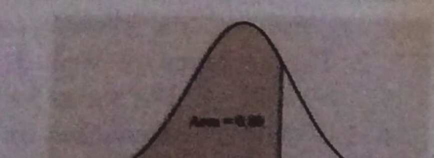




page 121: 1. For 14-year-old boys, the amount of cholesterol follows a N(170, 30) distribution and we want to find the percent of boys with cholesterol of more than 240 (see graph below). $z = \frac{240 - 170}{30} = 2.33$. From Table A, the proportion of z-scores above 2.33 is $1 - 0.9901 = 0.0099$. *Using technology:* `normalcdf (lower:240,upper:1000,μ:170,σ:30)` = 0.0098. About 1% of 14-year-old boys have cholesterol above 240 mg/dl. 2. For 14-year-old boys, the amount of cholesterol follows a N(170, 30) distribution and we want to find the percent of boys with cholesterol between 200 and 240 (see graph below). $z = \frac{200 - 170}{30} = 1$ and $z = \frac{240 - 170}{30} = 2.33$. From Table A, the proportion of z-scores between 1 and 2.33 is $0.9901 - 0.8413 = 0.1488$. *Using technology:* `normalcdf(lower:200,upper:240,μ:170,σ:30)` = 0.1488. About 15% of 14-year-old boys have cholesterol between 200 and 240 mg/dl. 3. For Tiger Woods, the distance his drives travel follows an N (304, 8) distribution and the 80th percentile is the boundary value x with 80% of the distribution to its left (see graph below). A z-score of 0.84 gives the area closest to 0.80 (0.7995). Solving $0.84 = \frac{x - 304}{8}$ gives $x = 310.7$. *Using technology:* `invNorm(area:0.8,μ:304,σ:8)` = 310.7. The 80th percentile of Tiger Woods's drive lengths is about 310.7 yards.

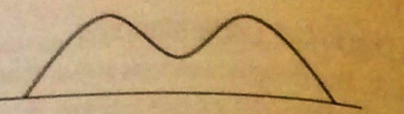






Answers to Odd-Numbered Section 2.2 Exercises

2.33 Sketches will vary, but here is one example:

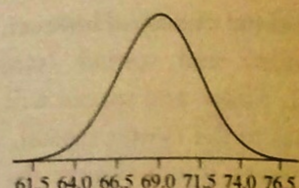


2.35 (a) It is on or above the horizontal axis everywhere, and the area beneath the curve is $\frac{1}{3} \times 3 = 1$. (b) $\frac{1}{3} \times 1 = \frac{1}{3}$. (c) Because $1.1 - 0.8 = 0.3$, the proportion is $\frac{1}{3} \times 0.3 = 0.1$.

2.37 Both are 1.5.

2.39 (a) Mean is C, median is B. (b) Mean is B, median is B.

2.41 The graph is shown below.



2.43 (a) Between $69 - 2(2.5) = 64$ and $69 + 2(2.5) = 74$ inches. (b) About $\frac{100\% - 95\%}{2} = 2.5\%$. (c) About $\frac{100\% - 68\%}{2} = 16\%$ of men are shorter than 66.5 inches and $\frac{100\% - 95\%}{2} = 2.5\%$ are shorter than 64 inches, so approximately $16\% - 2.5\% = 13.5\%$ of men have heights between 64 inches and 66.5 inches. (d) Because $\frac{100\% - 68\%}{2} = 16\%$ of the area is to the right of 71.5, 71.5 is at the 84th percentile.

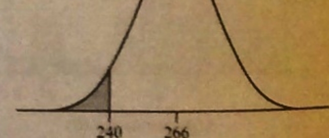
2.45 Taller curve: standard deviation ≈ 0.2. Shorter curve: standard deviation ≈ 0.5.

2.47 (a) 0.9978. (b) $1 - 0.9978 = 0.0022$ (c) $1 - 0.0485 = 0.9515$ (d) $0.9978 - 0.0485 = 0.9493$

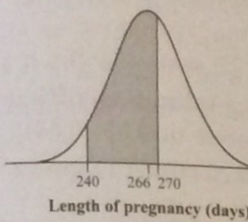
2.49 (a) $0.9505 - 0.0918 = 0.8587$ (b) $0.9633 - 0.6915 = 0.2718$

2.51 (a) $z = -1.28$ (b) $z = 0.41$

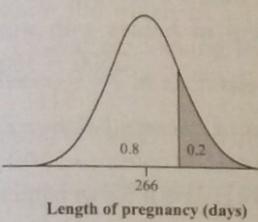
2.53 (a) The length of pregnancies follows a N(266, 16) distribution and we want the proportion of pregnancies that last less than 240 days (see graph below). $z = \frac{240 - 266}{16} = -1.63$. From Table A, the proportion of z-scores less than −1.63 is 0.0516. *Using technology:* `normalcdf(lower:-1000,upper:240,μ:266,σ:16)` = 0.0521. About 5% of pregnancies last less than 240 days, so 240 days is at the 5th percentile of pregnancy lengths.



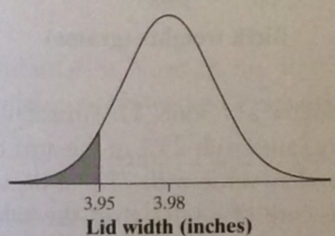
(b) The length of pregnancies follows a N(266, 16) distribution and we want the proportion of pregnancies that last between 240 and 270 days (see the following graph). $z = \frac{240 - 266}{16} = -1.63$ and $z = \frac{270 - 266}{16} = 0.25$. From Table A, the proportion of z-scores between −1.63 and 0.25 is $0.5987 - 0.0516 = 0.5471$. *Using technology:* `normalcdf(lower:240,upper:270` μ:266,σ:16) = 0.5466. About 55% of pregnancies last between 240 and 270 days.



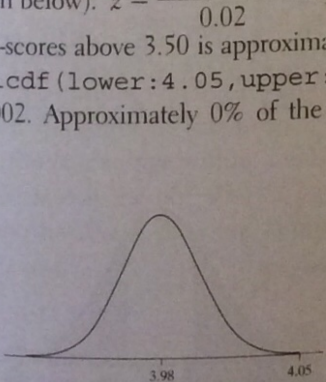
(c) The length of pregnancies follows a N(266, 16) distribution and we are looking for the boundary value x that has an area of 0.20 to the right and 0.80 to the left (see graph below). A z-score of 0.84 gives the area closest to 0.80 (0.7995). Solving $0.84 = \frac{x - 266}{16}$ gives $x = 279.44$. *Using technology:* `invNorm(area:0.8,μ:266,σ:16)` = 279.47. The longest 20% of pregnancies last longer than 279.47 days.



2.55 (a) For large lids, the diameter follows a N(3.98, 0.02) distribution and we want to find the percent of lids that have diameters less than 3.95 (see graph below). $z = \frac{3.95 - 3.98}{0.02} = -1.5$. From Table A, the proportion of z-scores below −1.5 is 0.0668. *Using technology:* `normalcdf(lower:-1000,upper:3.95,μ:3.98,σ:0.02)` = 0.0668. About 7% of the large lids are too small to fit.

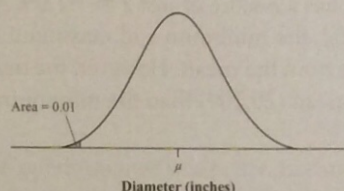


(b) For large lids, the diameter follows a N(3.98, 0.02) distribution and we want to find the percent of lids that have diameters greater than 4.05 (see graph below). $z = \frac{4.05 - 3.98}{0.02} = 3.5$. From Table A, the proportion of z-scores above 3.50 is approximately 0. *Using technology:* `normalcdf(lower:4.05,upper:1000,μ:3.98,σ:0.02)` = 0.0002. Approximately 0% of the large lids are too big to fit.

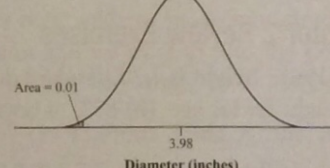


(c) Make a larger proportion of lids too small. If lids are too small, customers will just try another lid. But if lids are too large, the customer may not notice and then spill the drink.

2.57 (a) For large lids, the diameter follows a $N(\mu, 0.02)$ distribution and we want to find the value of μ that will result in only 1% of lids that are too small to fit (see graph below). A z-score of −2.33 gives the value closest to 0.01 (0.0099). Solving $-2.33 = \frac{3.95 - \mu}{0.02}$ gives $\mu = 4.00$. *Using technology:* `invNorm(area:0.01,μ:0,σ:1)` gives $z = -2.326$. Solving $-2.326 = \frac{3.95 - \mu}{0.02}$ gives $\mu = 4.00$. The manufacturer should set the mean diameter to approximately $\mu = 4.00$ to ensure that only 1% of lids are too small. (b) For large lids, the diameter follows a $N(3.98, \sigma)$ distribution and we want to find the value of σ that will result in only 1% of lids that are too small to fit (see graph below). A z-score of −2.33 gives the value closest to 0.01 (0.0099). Solving $-2.33 = \frac{3.95 - 3.98}{\sigma}$ gives $\sigma = 0.013$. *Using technology:* `invNorm(area:0.01,μ:0,σ:1)` gives $z = -2.326$. Solving $-2.326 = \frac{3.95 - 3.98}{\sigma}$ gives $\sigma = 0.013$. A standard deviation of at most 0.013 will result in only 1% of lids that are too small to fit.



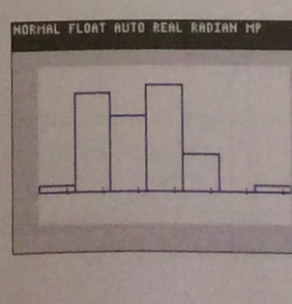
(c) Reduce the standard deviation. This will reduce the number of lids that are too small and the number of lids that are too big. If we make the mean a little larger as in part (a), we will reduce the number of lids that are too small, but we will increase the number of lids that are too big.



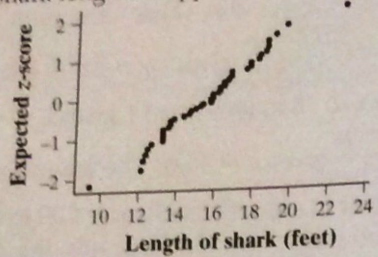
2.59 (a) $z = -1.28$ and $z = 1.28$ (b) Solving $-1.28 = \frac{x - 64.5}{2.5}$ gives $x = 61.3$ inches and solving $1.28 = \frac{x - 64.5}{2.5}$ gives $x = 67.7$ inches.

2.61 Solving $1.04 = \frac{60 - \mu}{\sigma}$ and $1.88 = \frac{75 - \mu}{\sigma}$ gives $\mu = 41.43$ minutes and $\sigma = 17.86$ minutes.

2.63 (a) A histogram is given below. The distribution of shark lengths is roughly symmetric and somewhat bell-shaped, with a mean of 15.586 feet and a standard deviation of 2.55 feet. (b) 30/44 = 68.2%, 42/44 = 95.5%, and 44/44 = 100%. These are very close to the 68−95−99.7 rule.



(c) A Normal probability plot is given below. Except for one small shark and one large shark, the plot is fairly linear, indicating that the distribution of shark lengths is approximately Normal.



(d) All indicate that shark lengths are approximately Normal.

2.65 The distribution is close to Normal because the plot is nearly linear. There is a small "wiggle" between 120 and 130, with several values a little larger than would be expected in a Normal distribution. Also, the smallest value and the two largest values are a little farther from the mean than would be expected in a Normal distribution.

2.67 No. If it was Normal, then the minimum value should be around 2 or 3 standard deviations below the mean. However, the actual minimum has a z-score of just $z = -1.09$. Also, if the distribution was Normal, the minimum and maximum should be about the same distance from the mean. However, the maximum is much farther from the mean (20,209) than the minimum (8741).

2.69 b

2.71 b

2.73 a

2.75 For both kinds of cars, we see that the highway mileage is greater than the city mileage. The two-seater cars have a more variable distribution, both on the highway and in the city. Also the mileage values are slightly lower for the two-seater cars than for the minicompact cars, both on the highway and in the city, with a greater difference on the highway. All four distributions are roughly symmetric.

Answers to Chapter 2 Review Exercises

R2.1 (a) $z = 1.20$. Paul's height is 1.20 standard deviations above the average male height for his age. (b) 85% of boys Paul's age are shorter than Paul.

R2.2 (a) 58th percentile (b) $IQR = 11 - 2.5 = 8.5$ hours per week.

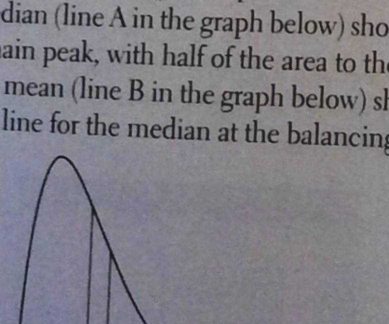
R2.3 (a) The shape of the distribution would not change.

Mean $= \dfrac{43.7}{3.28} = 13.32$ meters, median $= \dfrac{42}{3.28} = 12.80$ meters,

standard deviation $= \dfrac{12.5}{3.28} = 3.81$ meters,

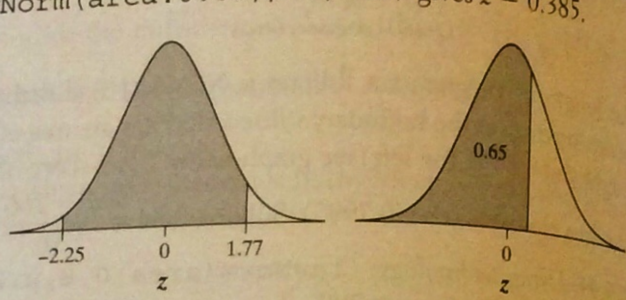
$IQR = \dfrac{12.5}{3.28} = 3.81$ meters. (b) Mean $= 43.7 - 42.6 = 1.1$ feet; standard deviation $= 12.5$ feet, because subtracting a constant from each observation does not change the spread.

R2.4 (a) The median (line A in the graph below) should be slightly to the right of the main peak, with half of the area to the left and half to the right. (b) The mean (line B in the graph below) should be slightly to the right of the line for the median at the balancing point.

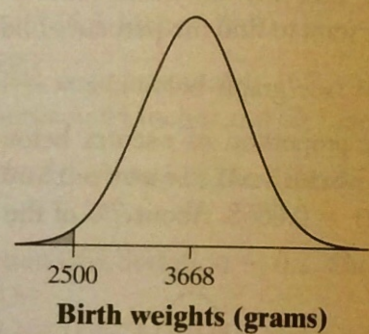


R2.5 (a) Between $336 - 3(3) = 327$ days and $336 + 3(3) = 34$ days. (b) About $\dfrac{100\% - 68\%}{2} = 16\%$.

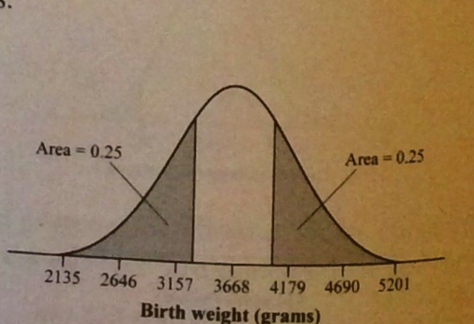
R2.6 (a) $0.9616 - 0.0122 = 0.9494$ (b) If 35% of all values are greater than a particular z-value, then 65% are lower. A z-score of 0.39 gives the value closest to 0.65 (0.6517). Using technology: `invNorm(area:0.65,μ:0,σ:1)` gives $z = 0.385$.



R2.7 (a) Birth weights follow a $N(3668, 511)$ distribution and we want to find the percent of babies with weights less than 2500 grams (see graph below). $z = \dfrac{2500 - 3668}{511} = -2.29$. From Table A, the proportion of z-scores below -2.29 is 0.0110. *Using technology:* `normalcdf(lower:-1000,upper:2500,μ:3668,σ:511)` $= 0.0111$. About 1% of babies will be identified as low birth weight.



(b) Birth weights follow a $N(3668, 511)$ distribution. The 1st quartile is the boundary value with 25% of the area to its left. The 3rd quartile is the boundary value with 75% of the area to its left (see graph below). A z-score of -0.67 gives the value closest to 0.25 (0.2514). Solving $-0.67 = \dfrac{x - 3668}{511}$ gives $Q_1 = 3325.63$. A z-score of 0.67 gives the value closest to 0.75 (0.7486). Solving $0.67 = \dfrac{x - 3668}{511}$ gives $Q_3 = 4010.37$. *Using technology:* `invNorm(area:0.25,μ:3668,σ:511)` gives $Q_1 = 3323.34$ and `invNorm(area:0.75,μ:3668,σ:511)` gives $Q_3 = 4012.66$. The quartiles are $Q_1 = 3323.34$ grams and $Q_3 = 4012.66$ grams.



R2.8 (a) The amount of ketchup dispensed follows a $N(1.05, 0.08)$ distribution and we want to find the percent of times that the amount of ketchup dispensed will be between 1 and 1.2 ounces (see