CHAPTER 2

Section 2.1
Statistical Literacy and Critical Thinking

1 Qualitative data consist of values that can be placed in different non-numerical categories, (such as male, female, or Democrat, Republican), whereas quantitative data consist of values representing counts or measurements.

2 Discrete data have only particular values, such as integers, while continuous data can take on any value. Counts of people are an example of discrete data, since they can be only whole numbers (integers); weights of people are continuous data, since they can take on any value.

3 Data at the nominal level of measurement are described solely by names, labels, or categories. The ordinal level applies to qualitative data that can be arranged in some order (such as low to high). The interval level applies to quantitative data for which intervals are meaningful, but ratios are not. The ratio level applies to quantitative data for which both intervals and ratios are meaningful.

4 Temperatures on the Fahrenheit or Celsius scales are at the interval level of measurement because each degree of difference has a precise meaning, but they are not at the ratio level because the zero points on these temperature scales are arbitrary. Distances are at the ratio level because a distance of zero has an unambiguous meaning; thus, ratios of distances are meaningful.

5 This statement does not make sense. Party affiliations are qualitative data, and identifying them with numbers does not change that fact. It does not make sense to average qualitative data, as you can tell by realizing that the statement is claiming that the average party affiliation is halfway between Republican and Independent. There's no way to define what that might mean.

6 This statement does not make sense. ZIP codes do not consistently measure distance from the east coast or from any other reference point, so they are qualitative data.

7 This statement does not make sense. Temperatures on the Fahrenheit scale are at the interval, not ratio, level of measurement, so ratios like "twice as…" are not meaningful.

8 This statement does makes sense. Although calendar years generally represent data at the interval level of measurement (see Example 3c), the time since a particular date, such as the beginning of a century, has a clear starting point and therefore represents data at the ratio level of measurement. Therefore, it is correct to say that a particular year is halfway through a century.

Concepts and Applications

9 Blood groups are qualitative because they don't measure or count anything.

10 Pulse rates are quantitative because they consist of measurements.

11 Blood alcohol concentration data are quantitative because they consist of measurements.

12 The categories of sports are qualitative because they don't measure or count anything.

13 The responses "yes", "no" or "no response" are qualitative because they don't measure or count anything.

14 Head circumferences are quantitative because they consist of measurements.

15 Identifications of the television shows watched are qualitative because they don't measure or count anything.

16 The number of households is quantitative because it consists of a count.

17 The SAT scores are quantitative because they are measures obtained from tests.

18 The area codes are qualitative because they don't measure or count anything.

19 The weights are continuous data because they can be any value within some range of values. Nothing is being counted.

20 The page counts are discrete because they are counts. Only whole numbers are used, and no values between those numbers are possible.

21 The number of likes is discrete because it is a count. Only a whole number is possible as a result.

22 The delay times are continuous data because they can be any value within some range of values.

23 The commute times are continuous data because they can have any value within some range of values.

24 The times are discrete data because they can be only one of several values, with no values in between.

25 The number of commercial aircraft in the air are discrete data because they can be only one of several values, with no values in between.

26 The speeds of commercial aircraft in the air are continuous data because they can be any value within some range of values.

27 The movie ratings are discrete data because they can be only one of several values, with no values in between.

28 The number of stars in each galaxy are discrete data because they can be whole numbers only.

29 Body temperatures are at the interval level of measurement because a zero temperature does not represent a status of "no heat."

30 Weights of Corvettes are at the ratio level of measurement because there is a true zero.

31 Rotten Tomato Scores are at the ordinal level because they are qualitative data that can be arranged in a meaningful order. A score of 0% is a lower rating than a score of 100%.

32 Types of movies are at the nominal level of measurement. They have no numerical values and cannot be ordered. The categories are just descriptive labels (i.e. drama, comedy).

33 Hurricane categories are at the ordinal level because they are qualitative data that can be arranged in a meaningful order. A score of 1 is a numeric label indicating the intensity of the hurricane.

34 Hurricane names are at the nominal level of measurement. They have no numerical values and cannot be ordered. The categories are just names.

35 Classifications of cars as subcompact, compact, intermediate, or full-size are ordinal data because they can be put in an increasing order. They are not at the interval level because there is no way to say the difference between a subcompact and a compact car is the same as the difference between a compact and an intermediate car.

36 These clinical trial results are at the nominal level of measurement. They have no numerical values and cannot be ordered. The categories are just names.

37 Final course grades are at the ordinal level because they are qualitative data that can be arranged in a meaningful order. We can say that an A is higher than a B, but the difference between an A and a B is not necessarily the same as the difference between a B and a C (or even between another A and B).

38 Social Security Numbers are at the nominal level of measurement. Each one represents the name of a person.

39 Numbers of words spoken are at the ratio level of measurement because there is a true zero.

40 Car safety ratings are at the ordinal level since they can be put in a sensible order, but it is not possible to say that the difference between a 0 and a 1 is the same as the difference between a 1 and a 2.

41 The ratio level does not apply. The ratio is not meaningful because the stars don't measure or count anything. Differences between star values are not meaningful, so the ratings are not even at the interval level, let alone the ratio level.

42 The ratio level does not apply. A Category 4 hurricane is more intense than a Category 2 hurricane, but it is not "twice as" intense.

43 The ratio level does not apply. IQ tests do not measure intelligence on the type of scale required for the ratio level. Someone with an IQ score of 140 is not necessarily twice as intelligent someone with an IQ score of 70.

44 The ratio level does not apply. There is no true zero on this scale. A temperature of 0°F is an arbitrary setting and does not represent "no heat," so the ratio implied by "twice as" is not meaningful.

45 Since the age of anything cannot be less than zero, there is a true zero for age and the ratio level applies to ages. The age of 1000 years is twice the age of 500 years.

46 The ratio level does not apply. The "like" rating of 8 does not indicate that the female likes that male twice as much as she likes the other male with the "like" rating of 4.

47 The salary of $2 million is twice the salary of $1 million, so the actual salaries are at the ratio level. But used as measures of how "good" the actors are, the salaries are not at the ratio level because the higher paid actor is not twice as good as the lower paid actor.

48 The ratio level does not apply. SAT scores do not measure qualification for college in a way that results in values at the ratio level of measurement.

49 The Kentucky Derby running times are quantitative and are at the ratio level. The data are continuous. The times have a natural zero starting point and they can be any values within a particular range.

50 The jersey numbers for New Orleans Saints football players are qualitative because they are numeric labels and are at the nominal level of measurement.

51 The colors of M&M's are qualitative since they are descriptive labels and are at the nominal level of measurement.

52 The FBI service times are quantitative and are at the ratio level of measurement. The data are continuous (although they appear to be discrete after rounding to some unit, such as days). The times have a natural zero starting point and they can be any values within some range.

53 The FBI hiring years are quantitative and are at the interval level of measurement. The data are discrete because they consist of whole numbers only. The years are measured from an arbitrary reference (the year 0), not a natural zero starting point. Differences between the years are meaningful values, but ratios are not meaningful.

54 The Michelin tire ratings are quantitative because they are numeric labels of quality and are at the ordinal level of measurement. The data are discrete.

55 The *Consumer Reports* ratings are qualitative at the ordinal level of measurement. The ratings consist of an ordering, but they do not represent counts or measurements.

56 The group numbers are qualitative at the nominal level of measurement; they consist of categories only and do not measure or count anything. The drug amounts are quantitative at the ratio level of measurement; they are data from a continuous scale.

Section 2.2

Statistical Literacy and Critical Thinking

1 A random error occurs because of random and unpredictable events. A systematic error occurs because of some problem in the measurement system. We can minimize the effects of random errors by averaging multiple measurements. If a systematic error is discovered, it can be accounted for by adjusting the affected measurements to correct for the error.

2 The absolute error is how far a measurement is from the true value, while the relative error describes this difference as a percentage of the true value. Answers will vary for the examples.

3 Accuracy describes how close a measurement approximates a true value, while precision describes the amount of detail in a measurement. Answers will vary for the examples.

4 If you state a measurement with more precision than the measuring process actually allowed you to achieve (such as stating a weight to the nearest hundredth of a pound when the scale only allowed measurement to the nearest tenth), then you are in essence claiming to have measured something that you didn't, which is misleading.

5 This statement does make sense. The absolute error in the cell measurement must be miniscule in comparison to the error in the measurement of the Milky Way, which could easily be measured in light-years.

6 This statement does not make sense. For example, the astronomer could have a 1% relative error measuring something in light-years, while the biologist could easily have a 3% relative error measuring something microscopic.

7 This statement does not make sense. The number is too precise. There are too many unknowns and uncertainties to determine the value with such precision.

8 This statement does not make sense. A meter stick will not be marked with measurements as small as micrometers, so there is no way you could obtain such precision with this measuring device.

Concepts and Applications

9 Mistakes in calculations tend to result from random errors, but dishonesty tends to result in systematic errors that benefit the taxpayer.

10 This is a systematic error resulting in altimeter readings that are too low throughout the entire flight.

11 Because about half of the batteries have voltages higher than 3.8 volts and half have less than 3.8 volts, these appear to be random errors in measurement or random errors in the manufacturing process.

12 If the shooting statistics were being underreported, it is a systematic error.

13 Random errors could occur when people don't recall or don't know their total annual income. Systematic errors could occur when people tend to report an amount substantially higher than their actual annual income in order to appear more successful.

14 Random errors could occur when taxpayers make honest mistakes or when the income amounts are recorded incorrectly. Systematic errors could occur when dishonest taxpayers report income amounts that are lower than their true income amounts so that they can pay lower taxes.

15 Random errors occur with errors in the calculations. Systematic errors may undercount the actual number if some cigarettes were sold illegally without the tax being collected.

16 Random errors occur when students don’t recall the correct numbers of cigarettes that they smoke. Systematic errors could occur when students believe that they are smoking fewer cigarettes than they actually smoke.

17 Random errors could occur when people don’t recall whether they wash their hands. Systematic errors could occur when people tend to say that they wash their hands so that they don’t appear to lack basic hygiene.

18 Random errors occur with mistakes made in the calculations or honest mistakes made in assigning values to the products. Systematic errors occur when counterfeit products are bought and sold without the knowledge of the police or when there is a tendency for the police to exaggerate the value of the counterfeit goods sold.

19 Random errors could occur with an inaccurate radar gun or from honest mistakes made when the officer records the speeds. Systematic errors could occur if the radar gun is incorrectly calibrated so that it consistently reads too high or too low.

20 Random errors could occur with manual readings that are inaccurate. Systematic errors could occur with technicians who are reluctant to generate more work by filing reports on gas pumps that are providing less gas than should be provided.

21 The absolute error is $8.00. The correct bill is $512.50 - $8.00 = $504.50. Therefore, the relative error is $8.00/$504.50 = 0.0159 or 1.6%.

22 The absolute error is 26.34567 - 26.21875 = 0.12692 miles. The relative error is 0.12692/26.21875 = 0.0048 or 0.5%.

23 The absolute error is $2.00-$12.00 = -$10.00; the relative error is -$10.00/$12.00 = -0.8333 or -83.3%.

24 The absolute error in the menu is 12 – 13 = -1 doughnut. The relative error is -1/13 = -0.077 or -7.7%.

25
a) The errors are random. If they were systematic, there would be a tendency for the measurements all to be too high or all to be too low.
b) Use the mean (average) because it is likely to be in error by less than most of the individual measurements and it is more reliable than any single measurement.
c) Systematic errors might result from a problem with the measuring device or with the definition of the “length of the room” or from measuring along a path that is not perpendicular to the end walls of the room. They could also occur if all the students had been incorrectly taught how to use the tape measure.
d) No. If there is a systematic error in the measurements, that same error will be present in the mean (average).

26
a) The errors are random. If they were systematic, there would be a tendency for the measurements to be all too high or to be all too low.
b) Use the mean (average) because it is likely to be in error by less than most of the individual measurements and it is more reliable than any single measurement.
c) Systematic errors might result from using a scale that consistently reads too high (or too low) or from recording the weights incorrectly.
d) No. If there is a systematic error in the measurements, that same error will be present in the average.

27 The Department of Transportation measurement is more precise because its weight of 3428.8 pounds has more decimal places than the manufacturer’s weight of 3450 pounds. The manufacturer’s weight is more accurate because 3450 pounds is closer to the true weight (3450 pounds is in error by 10 pounds, but the weight of 3428.8 pounds is in error by 11.2 pounds).

28 The 175.5cm is more precise because it is given to the nearest 0.1cm, but the 175cm is more accurate because 175 is closer to 175.2cm than is 175.5cm.

29 The digital scale is more precise (0.01 kg < 0.5 kg), and the digital scale is more accurate since 52.88 is closer to 52.55 than 53 is to 52.55. (This assumes that your actual weight is what you thought it was.)

30 The digital scale is more precise (0.01 kg < .5 kg), but the clinic scale is more accurate since 52.5 is closer to 52.55 than 51.48 is to 52.55. (This assumes that your actual weight is what you thought it was.)

31 The given number is very precise, but it is not likely to be accurate. We cannot even measure the population this precisely today, and the uncertainties were much greater in 1860.

32 The given number is very precise, but it is not likely to be accurate. Crash victims who died a considerable time after the crash are not included in the total. Some reporting errors are likely. Some deaths might have questionable causes, such as death due to a heart attack during a crash that resulted in no obvious personal injuries.

33 The given number is very precise, but it is not likely to be very accurate. There are many people in China who are not counted. Any national census is likely to be in error by a considerable amount due to the inherent difficulties in conducting such a census. The population of China likely changed during the course of the year.

34 It should be easy to accurately measure the height of a building with precision to the nearest foot, so the claim is believable, though it would be good to verify the source before quoting this number.

35 It is easy to accurately measure the height of a structure with a reasonable degree of precision, such as the nearest foot, but the given number has far too much precision (it implies the height is known to a size smaller than an atom!), so the claim is not believable.

36 The given value is not very precise because it is rounded to the nearest 0.1 billion dollars (or $100,000,000). The given value is not likely to be very accurate, because so much of the illegal drug trade is conducted in secrecy.

37 The age of 4.543 billion years (or 4,543,000,000 years) is not very precise, but the value of 8 years is very precise. It would be misleading to conclude that the age of the earth is 4,543,000,008 years, because this result has high precision that is not justified by the original value of 4.543 billion years.

38 The original weight of 4000 kg is likely to be a rounded value that is not very precise. It would be misleading to conclude that the final weight of the whale is 4002 kg, because this result has high precision that is not justified by the original weight of 4000 kg.

Section 2.3

Statistical Literacy and Critical Thinking

1 Absolute change is the actual increase or decrease from a reference value to a new value, while relative change is the size of the absolute change in comparison to the reference value. Examples will vary.

2 Absolute difference is the actual difference between the compared and reference value, while relative difference is the size of the absolute difference in comparison to the reference value. Examples will vary.

3 *More than* indicates a change from a reference value. *Of* indicates how a new value compares to a reference value as a ratio. The meanings are related as follows: If the new or compared value is (100 + P)% *of* the reference value, then it is P% *more than* the reference value.

4 A number stated as a percent (%) is a fraction, since *percent* means "per 100." A number stated as percentage points tells us how many hundredths are involved. For example, the number 20% is 10 percentage points larger than 10%, but it is also 100% larger than 10% (because 20% is double 10%).

5 The statement does not make sense. For example, if the price tripled from $1 to $3, the amount of the increase is $2, which is 200, of the original amount.

6 The statement does make sense. The cost of $66,000 is 10, (or $6000) more than $60,000.

7 This statement does make sense. Half, or 50%, of 1% is 0.5%. Therefore, a 50% increase from 1% means a new rate of 1.5%.

8 This statement does not make sense. The two percentages involve different base amounts, so the 10% reduction will be more money than the 10% increase. For example, if an item costs $100, the 10% reduction will lower the price to $90, and then the 10% increase will raise the price to $99. The 10% cut followed by the 10% increase results in a price that is less than the original price.

Concepts and Applications

9 a) 3/5 = 0.60 = 60%
b) 0.8 = 8/10 or 4/5 = 80%
c) 150% = 150/100 or 3/2 = 1.5
d) -25% = -25/100 or -1/4 = -0.25

10 a) 275% is the same as 275/100 or 11/4 = 2.75
b) 3.75 = 375/100 or 15/4 = 375%
c) -0.45 is the same as −45/100 or −9/20 = −45%
d) 90% = 90/100 or 9/10 = 0.9

11 a) 956 of 1348 pled guilty. This is 956/1348 = 0.71 or 71%
b) 392 + 58 = 450 were sent to prison. Thus 450/1348 = 0.33 = 33%, so 33% were sent to prison.
c) 392/956 = 0.41 = 41%, so 41% of those pleading guilty were sent to prison.
d) 58/72 = 0.81 = 81%, so 81% of those pleading not guilty were sent to prison.

12 a) 29,015/49,437 = 0.59 = 59%, so 59% of the trials involved flipping pennies.
b) 20,422/49,437 = 0.41 = 41%, so 41% of the trials involved spinning pennies.
c) 14,709/29,015 = 0.51 = 51%, so 51% of the flips resulted in heads.
d) 9197/20,422 = 0.45 = 45%, so 45% of the spins resulted in heads.

13 a) 90% of 514 is 0.90(514) = 462.6
b) No, it is not the exact number because the number results from a count of individual respondents must be a whole number.
c) We would round the calculated value up to the nearest whole number value. The actual number would be 463 respondents.

14 If all of the plaque is removed, 100% of it is removed. It is not possible to reduce plaque by more than 100%, so the 300% figure is incorrect.

15 (1486 − 2226)/ 2226 = −33%, there is a 33% decrease from 1990 in the number of daily newspapers.

16 (256 million − 193 million)/ 193 million = 33%, there is a 33% increase from 1990 of registered passenger cars.

17 (323,447,281 - 282,171,957)/ 282,171,957 = 15%, there is a 15% increase in the U.S. population since 2000.

18 (1,038,280 - 1,276,900)/ 1,276,900 = −19%, there is a 19% decrease in bankruptcy cases filed since 2000.

19 (2.38 million − 1.87 million)/ 1.87 million = 0.27 = 27%, The *Wall Street Journal* circulation is 27% more than the *New York Times* circulation, or 127% of the *New York Times* circulation.

20 (34,781 - 10,096)/ 10,096 = 2.45 = 245%, The Toyota Camry had 245% more sales than the Ford Mustang.

21 (67 million − 95 million)/95 million = -0.29 = -29%, so O'Hare handled 29% fewer passengers than Atlanta's Hartsfield Airport.

22 (82 million − 63 million)/63 million = 0.30 = 30%, so France had 30% more international tourists than did the U.S.

23 46% of 514 = 0.46(514) = 236, so 236 human resource professionals said that body piercings and tattoos were big grooming red flags.

24 47% of 150 = 0.47(150) = 71, so 71 executives said that the most common job interview mistake is to have little or no knowledge of the company at which the interview is held.

25 61% of 703 = 0.61(703) = 429, so 429 workers said that they got their jobs through networking.

26 53% of 1002 = 0.53(1002) = 531, so 531 subjects said that they felt vulnerable to identity theft.

27 108%, the typical adult male has a height that is 100% of that of the female, plus another 8%.

28 Norway's area is 24% more than 100% of Colorado's area, so Norway's area is 124% of Colorado's area.

29 The population of Montana is 20% less than 100% of the population of New Hampshire, so Montana's population is 80% of New Hampshire's population.

30 The Vice President's salary is 42% less than 100% of the President's salary, so the Vice President's is 58% of the President's salary.

31 Yes. Reporting the error as 3% would imply that it was 3% of 89% or 0.03(0.89) = 0.0267 or 2.67 percent. The correct confidence interval is from 86% to 92%, whereas the implied confidence interval would be from 86.33% to 91.67%. In practical terms, there is not much difference in this case, but there is a very large difference when the reported percentage is small, say 11% instead of 89%.

32 The range from 14% to 18% can also be expressed as 16% ± 2%, so the margin of error is 2 percentage points.

33 The decrease in the percentage of leakage in laboratory gloves is 63% - 7% = 56% or 56 percentage points. Since (7 − 63)/63 = -0.889 = -88.9%, there has been an 88.9% decrease in leakage from vinyl to latex laboratory gloves.

34 Since 27.1% − 16.4 % = 10.7%, there has been a decrease of 10.7 percentage points in the number of people living in developed countries from 1970 to now. The relative change is (16.4 − 27.1)/27.1 = −0.395 = -39.5%. There has been a 39.5% decrease in the percentage of the world's population living in developed countries from 1970 to now.

35 The five-year survival rate for Caucasians for all forms of cancer increased 61% - 39% = 22% or 22 percentage points between the 1960s and the 1990s. This is a relative change of (new value - reference value)/ reference value = (61 - 39)/39 = 22/39 = 0.564 = 56.4% or an increase of 56.4%.

36 Since 99.3% - 72.6% = 26.7%, there is a decrease of 26.7% or 26.7 percentage points between newborns surviving the first five years of their lives compared to those of age 80 and surviving their next five years. The relative change is (72.6 - 99.3)/99.3 = −0.2699 or -26.9%.

37
a) 73% to 81%, the possible range of values is 77% - 4% = 73% to 77% + 4% = 81%.
b) 4% of 77% = 0.04(0.77) = 0.0308 or 3.08%, so the possible range of values is 77% - 3.08% = 73.92% to 77% + 3.08% = 80.08%.

38 The statement incorrectly implies that the error can be up to 1.2% of 5%, which is 0.06%. This means that the actual result could be up to 0.06% away from 5% (from 4.94% to 5.06%), but it really can be up to 1.2% away from 5% (from 3.8% to 6.2%).

Section 2.4
Statistical Literacy and Critical Thinking

1 An index number provides a simple way to compare measurements made at different times or in different places. The value at one particular time (or place) must be chosen as the *reference value* (or *base value*). The index number for any other value is then calculated by dividing that value by the reference value and multiplying by 100.

2 The CPI is an index number computed from prices for a sample of more than 60,000 goods, services, and housing costs. It is intended to track inflation.

3 Because prices tend to rise with time, the only fair way to compare prices at different times is by adjusting them for the effects of inflation. The CPI allows us to do that by adjusting prices based on the CPI values for the times being compared.

4 No, wages do not automatically increase if the CPI increases. The CPI is based on prices of goods, services, and housing, so wages can rise or fall independent of the CPI.

5 This statement does not make sense. The prices from 1982 to 1984 are used as the reference value for the CPI values, but the index number for 2016 correctly reflects the prices in 2016.

6 This statement does not make sense. The CPI is based on a large sample of prices, so we don't expect any single product (such as gasoline) to track it perfectly.

7 This statement does make sense. If your wages don't keep up with inflation, then your standard of living falls.

8 This statement does make sense. Based on the CPI, inflation has raised typical prices by more than double since 1980, so a price that has only doubled will be lower than the 1980 price when adjusted for inflation.

Concepts and Applications

9 $Index = \frac{CPI\ for\ 2000}{CPI\ for\ 2015} = \frac{172.2}{237} = 0.727$, Based on the CPI, typical prices in 2000 were 0.727 times what they were in 2015. So, 0.727($12,250) = $8906 would be the cost of the housing in 2000.

10 $Index = \frac{CPI\ for\ 2015}{CPI\ for\ 2000} = \frac{237}{172.2} = 1.376$, Based on the CPI, typical prices in 2015 were 1.376 times what they were in 2000. So, 1.376($12,250) = $16,856 would be the cost of the housing in 2015.

11 $Index = \frac{CPI\ for\ 1980}{CPI\ for\ 2014} = \frac{82.4}{236.7} = 0.348$, Based on the CPI, typical prices in 1980 were 0.348 times what they were in 2014. So, 0.348($23,875) = $8309 would be the cost of the housing in 1980.

12 $Index = \frac{CPI\ for\ 2010}{CPI\ for\ 1985} = \frac{218.1}{107.6} = 2.027$, Based on the CPI, typical prices in 2010 were 2.027 times what they were in 1985. So, 2.027($14,222) = $28,828 would be the cost of the housing in 2010.

13 The CPI increased from 82.4 in 1980 to 237.0 in 2015. $Index = \frac{CPI\ for\ 2015}{CPI\ for\ 1980} = \frac{237}{82.4} = 2.87$, so the CPI in 2015 was 2.9 times the CPI in 1980. The college cost grew from $5600 in 1980 to $43,921 in 2015. $Index = \frac{Cost\ for\ 2015}{Cost\ for\ 1980} = \frac{\$43{,}921}{\$5600} = 7.84$, so the college cost in 2015 was 7.8 times the college cost in 1980. The college cost for four-year private colleges rose much more than the cost of typical goods, services, and housing.

14 The CPI increased from 82.4 in 1980 to 237.0 in 2015. $Index = \frac{CPI\ for\ 2015}{CPI\ for\ 1980} = \frac{237}{82.4} = 2.87$, so the CPI in 2015 was 2.9 times the CPI in 1980. The college cost grew from $2550 in 1980 to $19,548 in 2015. $Index = \frac{Cost\ for\ 2015}{Cost\ for\ 1980} = \frac{\$19{,}548}{\$2550} = 7.67$, so the college cost in 2015 was 7.7 times the college cost in 1980. The college cost for four-year public colleges rose much more than the cost of typical goods, services, and housing.

15 The CPI increased from 82.4 in 1980 to 237.0 in 2015. $Index = \frac{CPI\ for\ 2015}{CPI\ for\ 1980} = \frac{237}{82.4} = 2.87$, so the CPI in 2015 was 2.9 times the CPI in 1980. The price of a gallon of gasoline rose from \$1.22 in 1980 to \$2.52 in 2015. $Index = \frac{Cost\ for\ 2015}{Cost\ for\ 1980} = \frac{\$2.52}{\$1.22} = 2.07$, so the price of a gallon of gas in 2015 was 2.07 times the price in 1980. The price of a gallon of gasoline rose at a lower rate than the prices of typical goods, services, and housing.

16 The CPI increased from 195.3 in 2005 to 237.0 in 2015. $Index = \frac{CPI\ for\ 2015}{CPI\ for\ 2005} = \frac{237}{195.3} = 1.21$, so the CPI in 2015 was 1.2 times the CPI in 2005. The price of electricity grew from 10.0 cents per kWh in 2005 to 13.8 cents per kWh in 2015. $Index = \frac{Cost\ for\ 2015}{Cost\ for\ 2005} = \frac{\$0.138}{\$0.10} = 1.38$, so the price of electricity in 2015 was 1.4 times the price in 2005. The price of electricity rose at a slightly higher rate than the prices of typical goods, services, and housing.

17 The price of coffee in 2010 is the 2015 price multiplied by the comparison of coffee indices from 2010 and 2015 expressed as a decimal. $\frac{2010\ Coffee\ Index}{2015\ Coffee\ Index} = \frac{101.6}{107.8} = 0.94$, \$4.75(0.94) = \$4.47 per pound.

18 The price of coffee in 2015 is the 2005 price multiplied by the comparison of coffee indices from 2015 and 2005 expressed as a decimal. $\frac{2015\ Coffee\ Index}{2005\ Coffee\ Index} = \frac{107.8}{78.1} = 1.38$, \$2.90(1.38) = \$4.00 per pound.

19 The price of coffee in 2007 is the 2012 price multiplied by the comparison of coffee indices from 2007 and 2012 expressed as a decimal. $\frac{2007\ Coffee\ Index}{2012\ Coffee\ Index} = \frac{91.4}{101.6} = 0.90$, \$5.62(0.90) = \$5.06 per pound.

20 The price of coffee in 2012 is the 2006 price multiplied by the comparison of coffee indices from 2012 and 2006 expressed as a decimal. $\frac{2012\ Coffee\ Index}{2006\ Coffee\ Index} = \frac{101.6}{87.5} = 1.16$, \$3.19(1.16) = \$3.70 per pound.

21 The cost of pizza in 2010 is the 1986 price multiplied by the comparison of the CPI from 2010 and 1986 from Table 2.2. $\frac{CPI\ for\ 2010}{CPI\ for\ 1986} = \frac{218.1}{109.6} = 1.99$, so \$1.00(2.0) = \$2.00, this is lower than what pizza actually cost in either 2009 (\$2.25) or 2013 (\$2.30), telling us that actual pizza prices increased more than the CPI would suggest.

22 The cost of pizza in 2014 is the 1995 price multiplied by the comparison of the CPI from 2014 and 1995 from Table 2.2. $\frac{CPI\ for\ 2014}{CPI\ for\ 1995} = \frac{236.7}{152.4} = 1.55$, so \$1.35(1.6) = \$2.16, this is lower than what pizza actually cost in either 2013 (\$2.30) or 2015 (\$2.75), telling us that actual pizza prices increased more than the CPI would suggest.

23 The subway fare in 2006 is the 2013 fare multiplied by the comparison of the CPI from 2006 and 2013 from Table 2.2. $\frac{CPI\ for\ 2006}{CPI\ for\ 2013} = \frac{201.6}{233.0} = 0.87$, so \$2.50(0.9) = \$2.25, the table suggests that the actual subway fare at the time was either \$2.00 (in 2003) or \$2.25 (in 2009), so the change in subway fare was generally consistent with what we would expect from the CPI.

24 The subway fare in 1990 is the 2015 fare multiplied by the comparison of the CPI from 1990 and 2015 from Table 2.2. $\frac{CPI\ for\ 1990}{CPI\ for\ 2015} = \frac{130.7}{237.0} = 0.55$, so \$2.75(0.6) = \$1.65, the table suggests that the actual subway fare at the time was between \$1.00 (in 1986) and \$1.35 (in 1995), so subway fares appear to have increased by more than the CPI since 1990.

25 $Price\ in\ Los\ Angeles = \frac{Index\ in\ Los\ Angeles}{Index\ in\ Chicago} x\ Price\ in\ Chicago = \frac{190}{105}(940{,}000) = \$1{,}700{,}952$

26 $Price\ in\ Chicago = \frac{Index\ in\ Chicago}{Index\ in\ Los\ Angeles} x\ Price\ in\ Los\ Angeles = \frac{105}{190}(940{,}000) = \$519{,}474$

27 $Price\ in\ Miami = \frac{Index\ in\ Miami}{Index\ in\ Denver} x\ Price\ in\ Denver = \frac{161}{136}(400{,}000) = \$473{,}529$

28 $Price\ in\ Phoenix = \frac{Index\ in\ Phoenix}{Index\ in\ Boston} x\ Price\ in\ Boston = \frac{122}{146}(650{,}000) = \$543{,}151$

29 $Price\ in\ SF = \frac{Index\ in\ SF}{Index\ in\ Las\ Vegas} x\ Price\ in\ Las\ Vegas = \frac{172}{115}(375{,}000) = \$560{,}870$

30 $Price\ in\ Las\ Vegas = \frac{Index\ in\ Las\ Vegas}{Index\ in\ SF} x\ Price\ in\ SF = \frac{115}{172}(375{,}000) = \$250{,}727$

31 $Price\ in\ Dallas = \frac{Index\ in\ Dallas}{Index\ in\ Denver.} x\ Price\ in\ Denver. = \frac{121}{136}(835{,}000) = \$742{,}904$

32 $Price\ in\ Denver = \frac{Index\ in\ Denver}{Index\ in\ Dallas} x\ Price\ in\ Dallas = \frac{136}{121}(835{,}000) = \$938{,}512$

Chapter 2 Review Exercises

1
- a) 41.0% of 1003 is the same as 0.410(1003) = 411 respondents
- b) 24 out of 1003 is 24/1003 = 0.02 or 2%
- c) The data would be considered qualitative and since the responses, "yes", "no" and "not sure" cannot be meaningfully ordered, they are at the nominal level of measurement.
- d) Because the sponsor has a financial interest in the results, there is a possibility that the results were somehow manipulated to be favorable to the sponsor.

2 The CPI increased from 44.4 in 1973 to 236.7 in 2014. $Index = \frac{CPI\ for\ 2014}{CPI\ for\ 1973} = \frac{236.7}{44.4} = 5.33$, so the CPI in 2014 was 5.3 times the CPI in 1973. The total spending on health care in the U.S. rose from \$80 million in 1973 to \$3.0 trillion in 2014. $Index = \frac{Spending\ in\ 2014}{Spending\ in\ 1973} = \frac{\$3000\ \text{mil}}{\$80\ \text{mil}} = 37.5$, so the total spending on health care in the U.S. in 2014 was 37.5 times more than in 1973. Health care spending grew at a dramatically higher rate than the overall rate of inflation.

3
- a) 106%, The typical adult female has a pulse rate that is 100% of that of the typical adult male, plus another 6%.
- b) 95% of 80 beats per minute is 0.95(80) = 76 beats per minute
- c) 10% of 80 beats per minute is 0.10(80) = 8 beats lower, 80 – 8 = 72 beats per minute

4
- a) According to the table \$0.25 in 1938 dollars is worth \$3.98 in 2012 dollars.
- b) According to the table \$1.00 in 1956 dollars is worth \$8.29 in 2012 dollars.
- c) $\frac{CPI\ for\ 2012}{CPI\ for\ 1978} = \frac{229.6}{65.2} = 3.52$, so the CPI in 2012 was 3.5 times the CPI in 1978. If the minimum wage increased at this same rate, the minimum wage in 2012 would be 3.52(2.65) = \$9.33. The actual minimum wage in 2012 was \$7.25, so it did not keep up with the increases in the costs of goods, services, and housing.

Chapter 2 Quiz

1 The data are quantitative and continuous, since time can take on any value in a given interval.

2 The data are at the ratio level of measurement is a natural zero associated with the braking time.

3 The absolute error is 2.4 seconds – 1.9 seconds = 0.5 seconds.

4 The relative error = absolute error / reference value = 0.5/1.9 = 0.26 or 26%.

5 20 of 36 = 20/36 = 0.56 = 56% of reaction times were greater than 1.9 seconds.

6 The data would be qualitative since it is descriptive label of their state. The data is at the nominal level of measurement since there is no meaningful order.

7 5% of 1038 is 0.05 x 1038 = 52, so 52 of the respondents said that second-hand smoke is not at all harmful.

8 The first student makes an absolute error of -0.44 cm, while the second student makes an error of 0.74 cm. The first student makes a smaller error and is therefore more accurate. The second student's measurement is more precise because it is recorded to more decimal places.

9 The index number for the second year is the ratio, in percent, of the second year net profit to that of the first year or 14,237/10,008 = 1.423 or 142.3%. Thus the index number for the second year is 142.3.

10 The projected profit for the sixth year is $81,565 – (0.05)($ 81,565)= $77,487.