Looking Ahead to Chapter 11

Focus In Chapter 11, you will find probabilities of different types of events and analyze data. You will investigate the mean, the median, the mode, and range of data sets. You will also learn several ways to represent data, such as frequency tables, histograms, stem-and-leaf plots, box-and-whisker plots, and circle graphs.

Chapter Warm-up

Answer these questions to help you review skills that you will need in Chapter 11.

Find the quotient. Then write the answer as a percent.

1. $12 \div 48$

2. $45 \div 50$

3. $21 \div 63$

Find the product.

4. $\frac{2}{3} \times \frac{4}{5}$

5. $\frac{1}{7} \times \frac{8}{3}$

6. $\frac{6}{14} \times \frac{7}{2}$

Solve the proportion.

7. $\frac{20}{30} = \frac{x}{360}$

8. $\frac{15}{20} = \frac{x}{360}$

9. $\frac{19}{152} = \frac{x}{360}$

Read the problem scenario below.

Lindsey wants to buy a new mountain bike. The cost of the bike that she wants is $250. She has 30% of the money for the bike.

10. How much money does Lindsey have?

11. What percent would Lindsey have if she had $225?

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Key Terms

outcome • p. 341
event • p. 341
probability of an event • p. 341
favorable outcome • p. 341
sample space • p. 342
random • p. 342
theoretical probability • p. 343
experimental probability • p. 343
complementary events • p. 344
compound event • p. 345
independent event • p. 346
dependent event • p. 346
mean • p. 351
median • p. 352
mode • p. 352
range • p. 352
histogram • p. 357
frequency table • p. 358
stem-and-leaf plot • p. 363
box-and-whisker plot • p. 367
upper quartile • p. 367
lower quartile • p. 367
circle graph • p. 372

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Probability and Statistics

The total number of steel and wooden roller coasters in North America is 748. In Lesson 11.6, you will use a data display called a box-and-whisker plot to analyze data about roller coasters.

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11.1 Sometimes You're Just Rained Out

Finding Simple Probabilities

Objectives

In this lesson, you will:

- Find the probability of an event.

Key Terms

- outcome
- event
- probability of an event
- favorable outcome
- sample space
- random
- theoretical probability
- experimental probability
- complementary events

Probability is a part of our daily lives. For instance, when the weather-person says that there is a 30% chance of rain, or the sportscaster says that Herman is batting 0.300, probability is involved. Because probability is used so frequently in everyday life, it is important to know how to correctly interpret questions like the following.

- If the weatherperson says that the probability of rain is 30%, should you cancel your plans to attend the baseball game?
- If Herman's batting average is 0.300, is it likely that he will get a hit?

Problem 1 A Baseball Game

Your real baseball game was rained out, so you are indoors playing a board game about baseball. In the game, you take turns rolling a number cube to move around the board. On one of your turns, you roll a 6. Rolling a 6 is an *outcome of an event*. An **outcome** is one possible result. An **event** is a collection of outcomes. For example, rolling a number cube and getting a 1, 2, 3, 4, 5, or 6 is an event. The chance that the event will happen is the **probability of the event.** You can find a probability of an event by finding the ratio of the number of **favorable outcomes** (the outcomes that you want) to the number of possible outcomes.

$$\text{Probability} = \frac{\text{Number of favorable outcomes}}{\text{Number of possible outcomes}}$$

A. In any situation, which is bigger, the number of favorable outcomes or the number of possible outcomes? Use a complete sentence to explain.

B. Can the number of favorable outcomes and the number of possible outcomes be the same? If so, what would the probability be? Use complete sentences to explain.

C. What is the largest probability? What is the smallest probability? In each case, use complete sentences to explain your reasoning.

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Investigate Problem 1

1. Work with your partner and use a single number cube marked with 1, 2, 3, 4, 5, and 6 on its faces.

Roll the cube once. How many different numbers is it possible to roll?

Take Note

Outcomes that occur by chance are said to happen at **random.** For instance, rolling a 6 on a number cube happened at random.

What is the number of possible outcomes of rolling a number cube once?

List all of the possible outcomes. The set of all possible outcomes is called the **sample space.**

You want to roll a 1. How many favorable outcomes are there?

What is the probability of rolling a 1?

What is the probability of rolling a 2?

What is the probability of rolling a 6?

How many even numbers can you roll?

What is the probability of rolling an even number?

What is the probability of rolling an odd number?

What is the probability of rolling a prime number?

What is the probability of rolling a number greater than 4?

What is the probability of rolling a number greater than or equal to 2?

Investigate Problem 1

2. Roll the number cube 30 times. In the table, record the number of times each number is rolled in the first row. The other rows will be filled out later.

Number	1	2	3	4	5	6
Number of Times the Number is Rolled (with Your Partner)						
Number of Times the Number is Rolled (in Your Group)						
Number of Times the Number is Rolled (in Your Class)						

3. Form a group with another partner team. Share the number of times each number is rolled with your group. Add the numbers of both partner teams together and record them in the table.

4. Each group should take turns sharing the number of times each number is rolled with the entire class. Add the numbers of all groups together and record them in the table.

5. **Math Path: Theoretical and Experimental Probability**

A **theoretical probability** is a probability based on knowing all of the possible outcomes that are equally likely to occur. An **experimental probability** is based on performing an experiment in the same way many times, each of which is called a trial. Each time that the desired event occurs is called a success. You can find the experimental probability by taking the ratio of the actual number of successes to the number of trials. For instance, if you rolled a 1 on the number cube seven times times, your experimental probability is

$$\text{Experimental probability} = \frac{\text{Number of successes}}{\text{Number of trials}} = \frac{7}{30}.$$

Take Note

The probabilities that you found in Question 1 are *theoretical probabilities.* The ratio of the number of times that you roll a 1 to the number of trials is the *experimental probability.*

6. Complete the table to show the theoretical and experimental probabilities of rolling each number. Base the experimental probabilities on the class results in Question 2.

Number	1	2	3	4	5	6
Theoretical Probability of Rolling the Number						
Experimental Probability of Rolling the Number						

7. Does your experimental probability match your theoretical probability? Discuss your answer with your partner.

Problem 2 Baseball Cards

In your baseball card collection, you have a total of 60 cards. You have cards from four teams—the Astros, the Cardinals, the Mets, and the Pirates. For each team, you have 5 outfielders' cards and 10 infielders' cards. Suppose that you pick a single card from the deck at random (without looking).

A. If you want to choose a Mets card, how many favorable outcomes are there? What is the sample space for the problem?

B. What is the probability of choosing a Mets card?

C. What is the probability of choosing an outfielders' card?

Investigate Problem 2

1. **Math Path: Complementary Events**

Two events are **complementary** when one event or the other event can occur, but both events can not occur at the same time. The sum of the probabilities of two complementary events is 1. So, to find the probability of not choosing an outfielders' card, subtract the probability of choosing an outfielders' card from 1. What is the probability of not choosing an outfielders' card?

2. A standard deck of playing cards has 52 cards in 4 suits. Clubs and spades are printed in black. Hearts and diamonds are printed in red. Each suit has 13 cards—an ace, a king, a queen, a jack, and numbered cards from 2 through 10. Suppose that you choose a single card from the deck at random.

What is the probability of choosing a diamond?

What is the probability of choosing a red card?

What is the probability of choosing a face card (king, queen, or jack)?

What is the probability of choosing a numbered card less than 7?

3. Let us now re-examine the statements from page 341.

If the weatherperson says that the probability of rain is 30%, should you cancel your plans to attend the baseball game? Use a complete sentence to explain.

If Herman's batting average (probability of getting a hit) is 0.300, is it likely that he will he get a hit? Use a complete sentence to explain.

11.2 Socks and Marbles

Finding Probabilities of Compound Events

Objectives

In this lesson, you will:

- Understand independent and dependent events.
- Find the probability of a compound event.

Key Terms

- compound event
- independent event
- dependent event

In Lesson 11.1, you found the probabilities of single events. **Compound events** consist of two or more events. For instance, flipping a coin and getting heads and rolling a number cube and getting a 4 is a compound event.

Problem 1 Socks in a Drawer

Suppose that you have a drawer of different colored individual socks. You know that there are 6 blue socks, 10 brown socks, and 4 black socks.

A. You reach in the drawer without looking and pull out a sock.

What is the probability that the sock is blue?

What is the probability that the sock is brown?

What is the probability that the sock is black?

B. Suppose you pull out a brown sock. Then you pull out another sock without putting the brown sock back.

What is the probability that the second sock is brown? Is the probability the same as or different from the probability of pulling out a brown sock in Part (A)? Explain your reasoning using a complete sentence.

C. Suppose that you pull out a brown sock. Then you pull out another sock, but this time you put the brown sock back in the drawer first.

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Investigate Problem 1

1. The process that was used in Part (B) of Problem 1 is called "sampling without replacement." The process that was used in Part (C) of Problem 1 is called "sampling with replacement." Do you see why? Use complete sentences to explain.

2. Math Path: Independent and Dependent Events

There are two types of compound events. **Independent events** are events in which the outcome of one event does not affect the outcome of the other event. **Dependent events** are events in which the outcome of one event does affect the outcome of the other event.

Decide whether the compound events are independent or dependent.

spinning a spinner and landing on blue and rolling a number cube and getting a 1

spinning two different spinners, both landing on red

choosing two cards from a standard deck without replacing the first card and getting two face cards

3. When you sample with replacement, are the events independent or dependent?

4. When you sample without replacement, are the events independent or dependent?

5. In Part (C) of Problem 1, the probability of pulling two brown socks by pulling out a sock, replacing it, and then pulling out a second sock can be found by multiplying the probabilities of the single events. Are these two events independent or dependent?

Complete the statement to find the probability.

$$\boxed{\text{Probability that both socks are brown}} = \boxed{\text{Probability that first sock is brown}} \times \boxed{\text{Probability that second sock is brown}}$$

$$= \frac{\square}{\square} \times \frac{10}{20}$$

$$= \frac{\square}{\square}$$

$$= \frac{\square}{\square}$$

6. Use the result of Question 5 to write a rule for finding the probability of two independent events.

11

Investigate Problem 1

7. In Part (B) of Problem 1, you can find the probability of pulling two brown socks out of the drawer by pulling out a sock and then pulling out a second sock without replacing the first. You need to multiply the probability of the first event by the probability of the second event, given that the first event occurred. Are these two events independent or dependent?

Complete the statement to find the probability.

$$\boxed{\text{Probability that two socks are brown}} = \boxed{\text{Probability that first sock is brown}} \times \boxed{\text{Probability that second sock is brown given that one brown sock is removed}}$$

$$= \frac{\square}{\square} \times \frac{9}{19}$$

$$= \frac{\square}{\square}$$

$$= \frac{\square}{\square}$$

8. Use the result of Question 7 to write a rule for finding the probability of two dependent events.

9. Use the results of Questions 6 and 8 to find each probability.

What is the probability of pulling two blue socks out of the drawer if you pull out a blue sock and then pull out a second sock without putting the first one back?

What is the probability of pulling two black socks out of the drawer if you pull out a black sock and then pull out a second sock without putting the first one back?

What is the probability of pulling one black sock and one blue sock out of the drawer if you sample without replacement?

What is the probability of pulling one brown sock and one blue sock out of the drawer if you sample without replacement?

Suppose that you are conducting an experiment of pulling a sock from a drawer, not replacing it, and then pulling a second sock from the drawer. Out of 38 trials, about how many times would you expect to pull a pair of brown socks?

About how many times would you expect to pull pairs of socks out of the drawer in order to pull 1 pair of brown socks? Use a complete sentence to explain.

Take Note

You can use a theoretical probability to determine a result you might get from conducting an experiment by multiplying the number of trials of the experiment by the theoretical probability.

Problem 2 Marbles in a Bag

Suppose that you have a bag of marbles containing 4 green marbles, 5 red marbles, 7 white marbles, and 9 yellow marbles.

A. You reach in the bag without looking and pull out a marble.

What is the probability that the marble is green?

What is the probability that the marble is red?

What is the probability that the marble is white?

What is the probability that the marble is yellow?

B. Suppose that you pull out a red marble from the bag and then pull out another marble without replacing the red marble.

What is the probability that the second marble is green?

What is the probability that the second marble is red?

What is the probability that the second marble is white?

What is the probability that the second marble is yellow?

C. Which probabilities in part (A) and part (B) are the same? Which probabilities are different? Use the idea of independent and dependent events to explain why. Write your explanation using complete sentences.

D. Suppose that you pull out a red marble from the bag, but this time you put the red marble back in the bag before you pull out a second marble.

What is the probability that the second marble is green?

What is the probability that the second marble is red?

What is the probability that the second marble is white?

What is the probability that the second marble is yellow?

E. Which probabilities in part (A) and part (D) are the same? Which probabilities are different? Use the idea of independent and dependent events to explain why. Write your explanation using complete sentences.

Investigate Problem 2

1. What is the probability of pulling two red marbles from the bag if you pull one red marble, put it back into the bag, and then pull a second red marble?

2. What is the probability of pulling two red marbles from the bag if you pull one red marble and then pull a second red marble without putting the first red marble back?

3. What is the probability of pulling two green marbles from the bag if you pull one green marble and then pull a second green marble without putting the first green marble back?

4. What is the probability of pulling two white marbles from the bag if you pull one white marble and then pull a second white marble without putting the first white marble back?

5. What is the probability of pulling two yellow marbles out of the bag if you pull one yellow marble and then pull a second yellow marble without putting the first yellow marble back?

6. Use the results of Questions 1–5 to write complete sentences to explain how pulling a marble without putting it back changes the probability of pulling a second marble of the same color.

7. What is the probability of pulling one yellow marble and one green marble if you sample without replacement?

8. What is the probability of pulling one red marble and one green marble if you sample without replacement?

9. If you pull three marbles, what is the probability that you pull a red marble, a green marble, and a yellow marble if you sample without replacement?

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11.3 What Do You Want to Be?

Mean, Median, Mode, and Range

Objectives

In this lesson, you will:

- Find the mean, median, mode, and range of a set of data.

Key Terms

- mean
- median
- mode
- range

There are many instances in which people need to work with large amounts of data. For example, principals work with student test scores and insurance brokers base their policy rates on the number of car accidents in different cities. In each case, someone must work with a large amount of information in the form of numbers.

Problem 1 You Want to Be a Teacher!

As a teacher, one of your responsibilities is to assess how well your students have learned the material that you have taught. Suppose that you gave a test to the 15 students in your class. The test scores for the 20-point test are listed below.

5, 14, 17, 18, 9, 11, 11, 14, 17, 8, 5, 20, 19, 5, 14

A. Did your students do well on this test? Use a complete sentence to explain why or why not.

B. One number that is often used to describe a set of data is the *mean,* or arithmetic average of the data. The **mean** is the sum of the data values divided by the number of items in the data set. What is the mean of the test scores?

C. Approximately what percent of the scores is above the mean?

D. Now that you have found the mean of the test scores, do you have a better understanding of how well the students did on the test? Explain your answer using a complete sentence.

Investigate Problem 1

Take Note

When you have an even number of items in a data set, you can find the **median** by finding the mean of the middle two numbers. For instance, for the data set 2, 3, 5, 6, 8, 9, the median is the mean of 5 and 6, which is $\frac{5 + 6}{2}$, or 5.5.

Take Note

Sometimes, a set of data will have more than one mode. For example, the data set 3, 6, 2, 5, 2, 1, 0, 6, is bimodal. The numbers 2 and 6 are the modes of the data.

1. A second number that is used to describe a set of data is the *median* of the data. The **median** is the middle score of the data, found by listing all the scores in order and finding the score exactly in the middle. What is the median test score?

2. Does the median provide you with a better understanding of how well your students did on the test? Use a complete sentence to explain why or why not.

3. A third number that is used to describe a set of data is the *mode* of the data. The **mode** is the number in the data set that appears most often. What is the mode of the scores, that is, the test score that appears the greatest number of times in the list?

4. One additional measure that is useful in analyzing data sets is the *range* of the data set. The **range** is the difference between the greatest number and the least number in the data set. What is the range of the test scores?

5. Suppose that you want to own a shoe store. You need to be able to make decisions about what sizes of shoes to order.

   To help you learn about the "average" shoe size, your teacher will find and record the shoe size of each student in your class and then divide the sizes into two groups. One group will be all of the girls' sizes and the other group will be all of the boys' sizes.

   Find the mean shoe size for all of the students in your class.

   Find the mean shoe size for the boys.

   Find the mean shoe size for the girls.

6. Find the median shoe size for all of the students in your class.

   Find the median shoe size for the boys.

   Find the median shoe size for the girls.

Investigate Problem 1

7. Find the mode of the shoe sizes for all of the students.

Find the mode of the shoe sizes for the boys.

Find the mode of the shoe sizes for the girls.

8. Find the range of the shoe sizes for all of the students.

Find the range of the shoe sizes for the boys.

Find the range of the shoe sizes for the girls.

9. What does the mean tell you about the shoe sizes?

What does the median tell you about the shoe sizes?

What does the mode tell you about the shoe sizes?

What does the range tell you about the shoe sizes?

10. If you need to order shoes at your shoe store, how could you use the mean to make decisions? How could you use the median? How could you use the mode? How could you use the range? Write your answers using complete sentences.

11. If you were to pick a student at random based on the data that were collected, what is the probability the student's shoe size is a 7?

What is the probability the student's shoe size is a 13?

12. What shoe size would have the highest probability of being the shoe size of a student selected at random? Use a complete sentence to explain.

Problem 2 You Want to Run a Large Corporation

As the Chief Executive Officer (CEO) of a large corporation, you need to make decisions about the salaries of your employees. The table shows the salaries of different categories of employees at your corporation and the number of people in each category.

Category	Salary	Number
Chief Executive Officer (CEO)	$150,000	1
Chief Financial Officer (CFO)	$125,000	1
Vice Presidents (VP)	$100,000	2
Managers	$55,000	6
Group Leaders	$30,000	10
Workers	$25,000	80

Management is considered to be the managers, the VPs, the CFO, and the CEO.

A. Find the mean salary of all of the employees.

Find the mean salary of the management.

B. Find the median salary of all of the employees.

Find the median salary of the management.

C. Find the mode of the salaries of all of the employees.

Find the mode of the salaries of the management.

D. Find the range of the salaries of all of the employees.

Find the range of the salaries of the management.

E. What does the mean tell you about the salaries of the corporation's employees? What does the median tell you? What does the mode tell you? Write your answers using complete sentences.

Investigate Problem 2

1. If you were in charge of negotiating raises for the group leaders and workers, how could you use the mean, median, mode, or range to argue for more money? Use complete sentences to explain your reasoning.

2. If you were the CEO in charge of negotiating with the group leaders and workers, how could you use the mean, median, mode, or range to argue to keep the salaries the same? Use complete sentences to explain your reasoning.

3. If you choose an employee at random based on the information in the table, what is the probability that the person's salary is $55,000?

   What is the probability that the person's salary is more than $40,000?

   What is the probability that the person's salary is less than $35,000?

4. Compare your answers to Questions 1–3. Be sure that if you have any answers on which you do not agree, you work together to find out why. Be prepared to share your work with the rest of the class.

11.4 Get the Message?

Histograms

Objectives

In this lesson, you will:

- Interpret histograms.
- Create frequency tables and histograms.

Key Terms

- histogram
- frequency table

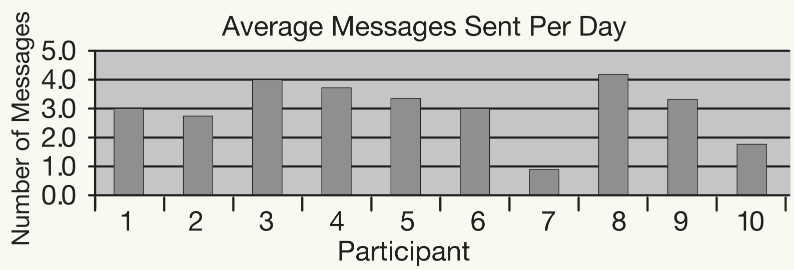
Bar graphs are useful when we observe small data sets. For large data sets or data with a wide range of values, there is another type of graph that allows us to "see" interesting trends or characteristics of the data. This graph is called a *histogram.* A **histogram** displays numerical data that has been organized into equal intervals.

Problem 1 Text Messaging

You can use a cellular phone to send and receive messages in a text format. In a recent study, ten male and female teenagers sent and received text messages. The average number of messages sent per day by each participant is shown below.

3.0, 2.8, 4.0, 3.7, 3.4, 3.0, 0.9, 4.1, 3.3, 1.7

A. The graph below is a bar graph of the data.



B. What does each bar represent? Write your answer using a complete sentence.

C. What information does the bar graph help us to "see" about the data set? What conclusions can we make based on this graph? Use complete sentences to explain.

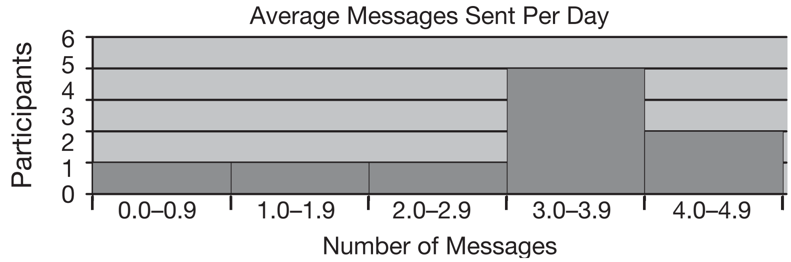
Investigate Problem 1

1. Math Path: Frequency Tables

You can use a **frequency table** to help you to organize data into intervals. The number of values that fall in the interval is the frequency of the interval. Complete the frequency table using the data in Problem 1. Make a tally mark (|) in the interval column each time that a data value falls in that interval. Then total the tally marks to find the frequency. The tally mark for the first value, 3.0, has been recorded for you.

Data Intervals	0.0–0.9	1.0–1.9	2.0–2.9	3.0–3.9	4.0–4.9
Tally				|	
Frequency					

2. Below is a histogram that displays the data in the frequency table above.



What does each bar represent?

What does the horizontal axis represent? What does the vertical axis represent?

3. What information does the histogram in Question 2 help us to "see" about the data set? What conclusions can we make based on this graph? Use complete sentences to explain.

4. Using the histogram, can you "see" in which interval the mean would be?

Can you "see" in which interval the median would be?

Can you "see" in which interval the mode would be?

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Problem 2 Length of a Phone Call

You are trying to determine how much time you spend on each call that you receive on your cellular phone. The data below are the number of minutes that you were on the phone for 25 calls that you made last week.

48, 33, 23, 28, 17, 12, 38, 43, 34, 25, 33, 37,

17, 22, 21, 39, 12, 45, 48, 17, 9, 52, 5, 17, 44

A. How many intervals of equal size do you need to represent the data? Write your answer using a complete sentence. (Remember that not all intervals must have data.)

Complete the frequency table below for the data using the intervals you chose. Use only as many columns as you need. To complete the table, use tally marks to list each occurrence in an interval. Then total the tally marks and write the frequency for each interval.

Data Intervals							
Tally							
Frequency							

B. Use the frequency table to construct a histogram below.

First, draw and label the horizontal and vertical axes.

Next, place the intervals on the horizontal scale.

Next, label the vertical scale, beginning with zero and ending with a number large enough to include all of the frequencies in the table.

Next, draw a bar to represent the frequency of each interval.

Finally, add a title to the histogram.

State or District	Number of Post Offices
AK	184
AL	558
AR	582
AZ	198
CA	1056
CO	381
CT	233
DC	1
DE	53
FL	457
GA	606
HI	72
IA	892
ID	226
IL	1225
IN	716
KS	603
KY	785
LA	468
MA	398
MD	394
ME	433
MI	822
MN	734
MO	912
MS	407
MT	312
NC	741
ND	341
NE	479
NH	227
NJ	520
NM	286
NV	85
NY	1513
OH	996
OK	576
OR	332
PA	1711
RI	51
SC	360
SD	338
TN	533
TX	1409
UT	176
VA	809
VT	270
WA	443
WI	718
WV	759
WY	176

Investigate Problem 2

1. What does each bar in your histogram in Problem 2 represent?

   What does the horizontal axis represent? What does the vertical axis represent?

2. What information does the histogram in Problem 2 help us to “see” about the data set? What conclusions can we make based on this graph? Use complete sentences to explain.

3. Using the histogram, can you “see” in which interval the mean would be?

   Can you “see” in which interval the median would be?

   Can you “see” in which interval the mode would be?

Problem 3 Snail Mail Messages

At the left is a table that lists of all the states and the District of Columbia and the number of primary U.S. post offices that are in the state or district.

Construct a frequency table for the data.

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Investigate Problem 3

1. Use the frequency table to construct a histogram of the data.

2. What does each bar represent?

What does the horizontal axis represent? What does the vertical axis represent?

3. What information does the histogram in Question 1 help us to "see" about the data set? What conclusions can we make based on this graph? Use complete sentences to explain.

4. Using the histogram, can you "see" in which interval the mean would be?

Can you "see" in which interval the median would be?

Can you "see" in which interval the mode would be?

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11.5 Go for the Gold!

Stem-and-Leaf Plots

Objectives

In this lesson, you will:

- Interpret stem-and-leaf plots.
- Create stem-and-leaf plots.

Key Terms

- stem-and-leaf plot

Take Note

To display data points like 175 and 5.4 in a stem-and-leaf plot, remember that the leaf is the digit with the least place value. So, 175 is displayed as 17 | 5 and 5.4 is displayed as 5 | 4.

Whenever we work with data sets, it is helpful to try to "picture" or display the data in a meaningful way in order to "see" some interesting patterns that are not obvious when the data is in a list.

Problem 1 Gold Medals

You are planning on following the next Olympics very closely on television. In order to better understand the games, you do some research and list the numbers of gold medals that the United States has won in the Summer Olympic Games in different years.

35, 40, 44, 37, 36, 83, 34, 33, 45, 36, 34, 32, 40,

38, 24, 41, 22, 45, 41, 25, 23, 12, 78, 20, 11

A. Order the data. Then find the mean, median, mode, and range of the data.

The mean is _______________. The median is _______________.

The mode is _______________. The range is _______________.

B. A **stem-and-leaf plot** is a data display that helps you to see the spread of the data. The *leaves* of the data are made from the digits with the least place value. The *stems* of the data are made from the remaining digits in the greater place values. Each data point is listed once in the plot. Complete the plot. The first data point, 11, is done for you.

0	
1	1
2	
3	
4	
5	
6	
7	
8	

1 | 1 = __________ medals

C. Be sure to include a key that indicates what the stems and leaves indicate. Complete the key in your stem-and-leaf plot.

Investigate Problem 1

1. Circle the mean of the data in the stem-and-leaf plot in Problem 1. Draw a square around the median of the data. Place a triangle around the mode of the data.

2. Does displaying the data in this form make it easier to "see" any trends or interesting patterns that were not obvious from the list in Problem 1? Use a complete sentence to explain why or why not.

3. How would you describe the number of gold medals that the United States has won over the years? Use a complete sentence to explain your answer.

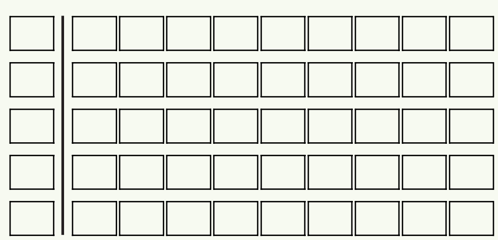
4. Form a group with another partner team. Compare your answers to Questions 1–3. Be sure that if you have any answers on which you do not agree, you work together to find out why.

Problem 2 Olympic Heights

The heights (in centimeters) of 8 female gymnasts on the U.S. Olympic team are listed below.

145, 147, 152, 152, 152, 155, 155, 170

A. Construct a stem-and-leaf plot of the data. Use only as many boxes as you need. Include a key with your plot.



B. Circle the mean of the data in the stem-and-leaf plot in Part (A). Draw a square around the median of the data. Place a triangle around the mode of the data.

C. How would you describe the gymnasts' heights? Use a complete sentence to explain your answer.

Investigate Problem 2

1. You want to understand how diving scores work in the Olympics. Judges award raw scores on a scale of 1 to 10. This score is then multiplied by the degree of difficulty of the dive. The raw scores from 5 judges for 6 different dives by a diver in an Olympic trial are shown below.

   7.8, 6.5, 6.8, 7.0, 7.5, 8.0, 7.8, 7.9, 8.2, 8.7,

   5.5, 5.9, 5.4, 5.5, 5.8, 8.7, 8.8, 8.8, 9.0, 8.9,

   7.6, 7.5, 7.0, 7.0, 7.4, 6.6, 6.9, 7.3, 7.2, 7.0

   Use the space at the left to order the data. Then construct a stem-and-leaf plot of the data. Include a key with your plot.

2. Circle the mean of the data in the stem-and-leaf plot. Draw a square around the median of the data. Place a triangle around the mode of the data.

3. Does displaying the data in this form make it easier to "see" any trends or interesting patterns that were not obvious from the list above? Use a complete sentence to explain why or why not.

4. How would you describe the scores of the diver for the six dives? Use a complete sentence to explain your answer.

5. Form a group with another partner team. Compare your answers to Questions 1–4. Be sure that if you have any answers on which you do not agree, you work together to find out why. Be prepared to share your stem-and-leaf plot with the entire class.

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11.6 All About Roller Coasters

Box-and-Whisker Plots

Objectives

In this lesson, you will:

- Interpret box-and-whisker plots.
- Create box-and-whisker plots

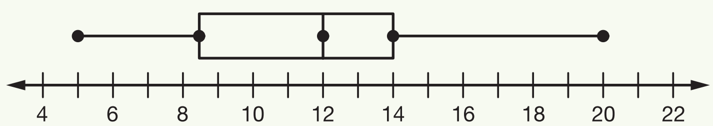
Key Terms

- box-and-whisker plot
- upper quartile
- lower quartile

We have found a number of ways to display data in an effort to "see" the data. Histograms help us to quantify large groups of data, and stem-and-leaf plots can indicate trends. We are now going to look at another data display, a box-and-whisker plot, that can help us see how spread out the data are and how much the data are clustered around the mean.

Problem 1 Ride 'Til You Drop

Your class visits an amusement park for a day. Each class member rides only the roller coasters. Each of you keeps track of the number of times that you ride. In a **box-and-whisker plot,** a number line is used to show how data are distributed. The box-and-whisker plot below represents the number of times that each class member rode a roller coaster that day.



A. What is the lowest number in the data set?

What is the highest number in the data set?

B. The vertical line inside the box represents the median of the data. What is the median of the data?

C. The point in the box directly to the right of the median represents the median of the upper half of the data. The median of the upper half of the data is called the **upper quartile.** What is the value of the upper quartile?

D. Similarly, the point in the box directly to the left of the median represents the median of the lower half of the data. The median of the lower half of the data is called the **lower quartile.** What is the value of the lower quartile?

E. The horizontal lines on both ends of the box are called whiskers. What do the dots at the end of the whiskers represent?

Investigate Problem 1

1. The box-and-whisker plot divides the data set into how many parts? Use a complete sentence to explain how you know.

2. Can you tell how many numbers are in the data set? Use a complete sentence to explain.

3. What do you know about the fraction of the data set that is represented by each of the parts of the box-and-whisker plot? Use a complete sentence to explain.

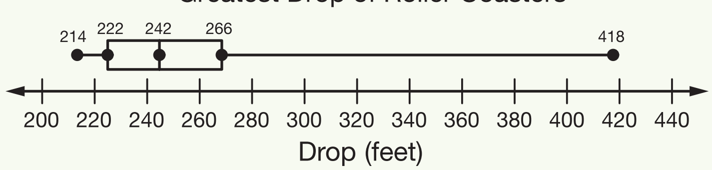
4. Look at the box-and-whisker plot again. Use complete sentences to write any conclusions that you can make about the data in the data set.

5. Form a group with another partner team. Compare your answers to Parts (A)–(E) in Problem 1 and Questions 1–4. Be sure that if you have any answers on which you do not agree, you work together to find out why.

Problem 2 Coasters with the Greatest Drop

The drop of a roller coaster is the biggest drop in height experienced on the roller coaster. The box-and-whisker plot represents the drop of the 10 roller coasters in the United States that hold the record for the greatest drop.

Greatest Drop of Roller Coasters



A. Look at the box-and-whisker plot. Each whisker represents about what fraction of the data?

B. About what fraction of the data is represented by the large box?

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Problem 3 Upside Down!

On a roller coaster, an inversion is when a rider is turned completely upside down. The numbers of inversions of the top 30 roller coasters with inversions are listed below.

14, 13, 11, 20, 11, 17, 13, 13, 26, 11, 13, 19, 13, 31, 17,
19, 11, 11, 15, 18, 12, 17, 16, 15, 14, 13, 12, 11, 13, 11

A. List the numbers of inversions from least to greatest.

Find the median.

Find the upper quartile by finding the median of the upper half of the data (all of the numbers above the median).

Find the lower quartile by finding the median of the lower half of the data (all of the numbers below the median).

Into how many parts has the data been divided?

B. What is the highest number of inversions?

What is the lowest number of inversions?

Create a number line on the line at the bottom of the page that includes numbers in the range of the data (the highest and lowest number of inversions).

C. Locate the median on the number line. About an inch above the number line, draw a dot for the median and label its value.

Locate the upper quartile on the number line. About an inch above the number line, draw a dot for the upper quartile and label its value.

Locate the lower quartile on the number line. About an inch above the number line, draw a dot for the lower quartile and label its value.

D. Locate the lowest data value on the number line. About an inch above the number line, draw a dot for the lowest data value and label its value.

Locate the highest data value on the number line. About an inch above the number line, draw a dot for the highest data value and label its value.

E. Draw a box with sides at both quartiles.

Draw a vertical line through the median.

Draw a "whisker" to the highest data value and a "whisker" to the lowest data value.

Take Note

Recall that when there is an even number of data points, you find the median by finding the mean of the two middle numbers.

Investigate Problem 3

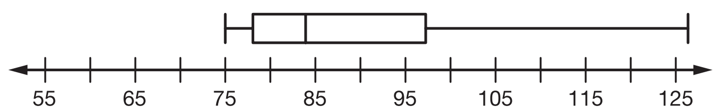
1. Is the box-and-whisker plot you constructed in Problem 3 similar to the one in Problem 1? Use a complete sentence in your answer.

2. Look at the box-and-whisker plot that you made. Use complete sentences to write any conclusions that you can make about the data in the data set.

3. Form a group with another partner team. Compare your box-and-whisker plots. Be sure that if the plots do not look similar that you work together to find out why. Be prepared to share your box-and-whisker plot with the rest of the class.

4. The box-and-whisker plots below show the speeds of the top 10 fastest wooden roller coasters and the top 10 fastest steel roller coasters.

Speed of wooden coasters (miles per hour)



Speed of steel coasters (miles per hour)

5. About what fraction of the steel roller coasters have speeds that are greater than 100 miles per hour? Write your answer using a complete sentence.

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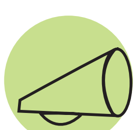
6. Three-fourths of the wooden roller coasters are slower than approximately what speed? Write your answer using a complete sentence.



7. Are any of the wooden roller coasters as fast as the steel roller coasters? Use a complete sentence to explain.

11.7

What's Your Favorite Flavor?

Circle Graphs

Objectives

In this lesson, you will:

- Interpret circle graphs.
- Create circle graphs.

Key Terms

- circle graphs

Besides histograms, stem-and-leaf plots, and box-and-whisker plots, there are several other ways of displaying data in order to "see" the data. One way of displaying data that you may already know is a bar graph.

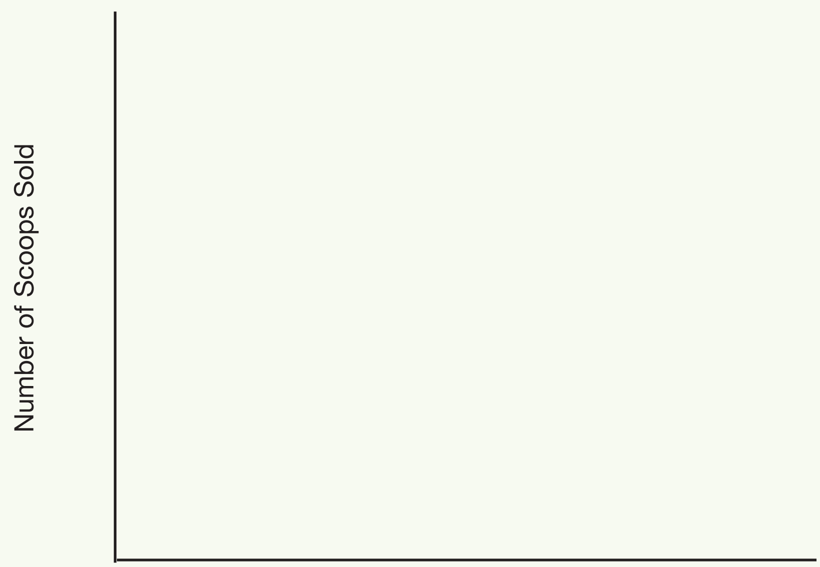
Problem 1 One Scoop or Two?

The table shows the most popular ice cream flavors sold at a local ice cream shop.

Ice Cream Flavors	Cookie Dough	Chocolate	Vanilla	Peach	Other
Number of Scoops Sold	200	300	340	120	40

A. Construct a bar graph of this information in the space provided.

Most Popular Ice Cream Flavors



B. Which was the most popular flavor?

Which was the least popular flavor?

Use a complete sentence to write any conclusions you can make using the bar graph.

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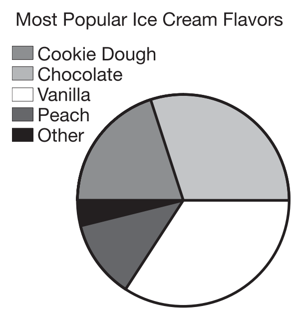
Investigate Problem 1

1. Complete the table below. First, for each flavor, write the amount of the flavor as a fraction of the total number of scoops sold. Then write the fraction as a decimal and then as a percent.

Ice Cream Flavors	Cookie Dough	Chocolate	Vanilla	Peach	Other
Number of Scoops Sold	200	300	340	120	40
Fraction of Total					
Fraction of Total as a Decimal					
Percent of Total					

2. At the right is a *circle graph* of the most popular ice cream flavors. A **circle graph** is a data display that represents data as parts of a whole. Label each section with the percent that the section represents.



3. How does the circle graph enable you to "see" the data differently than the bar graph? Use a complete sentence to explain your answer.

4. When you construct a circle graph, the area of the sections of the circle are based on the percents of each category of data. Remember that there are 360 degrees in a circle. For each flavor, write and solve a proportion to find the number of degrees in each section that will represent the flavor. The first one is done for you.

Cookie dough: $\frac{200}{1000} = \frac{x}{360}$ $x = 72$ degrees

Chocolate:

Vanilla:

Peach:

Other:

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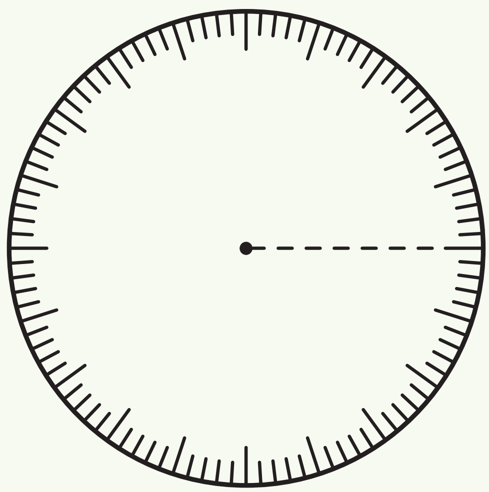
Problem 2 How Much is Enough Ice Cream?

The table below shows the average amount of ice cream eaten per person per year in the top six countries that eat the most ice cream.

A. Complete the table below. First, for each country, write the amount of ice cream eaten per person as a fraction of the total amount eaten by all countries. Then write the fraction as a decimal and then as a percent.

Country	New Zealand	U.S.	Australia	Finland	Sweden	Canada
Amount Eaten per Person (liters)	27	19	18	14	12	10
Fraction of Total Amount Eaten						
Fraction of Total as a Decimal						
Percent of Total						

B. Use the percents from your table to construct a circle graph below. Be sure to include a key to the graph or label each section with the name of a country.



Looking Back at Chapter 11

Key Terms

Summary

Finding Probabilities of Events (p. 341)

To find the probability of an event, find the ratio of the number of favorable outcomes to the number of possible outcomes.

Example To find the probability that if a coin is flipped, it will land heads up, find the ratio of the number of heads on a coin to the number of faces on a coin.

$$\text{Probability} = \frac{\text{Number of heads}}{\text{Number of faces}} = \frac{1\text{ head}}{2\text{ faces}} = \frac{1}{2}$$

So, the probability that if a coin is flipped, it will land heads up is $\frac{1}{2}$.

Finding Probabilities of Complementary Events (p. 344)

Two events are complementary if one event or the other can occur, but not both. The sum of the probabilities of two complementary events is 1.

Example To find the probability of pulling an ace from a standard deck of cards, find the ratio of the number of aces in a deck to the number of cards in a deck.

$$\text{Probability} = \frac{\text{Number of aces}}{\text{Number of cards}} = \frac{4\text{ aces in a deck}}{52\text{ cards in a deck}} = \frac{4}{52} = \frac{1}{13}$$

So, the probability of pulling an ace from a standard deck of cards is $\frac{4}{52}$, or $\frac{1}{13}$. You can use this to find the probability of not pulling an ace from a standard deck by subtracting the probability of pulling an ace from 1. So, the probability of not pulling an ace is $1 - \frac{1}{13} = \frac{12}{13}$.

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Finding Probabilities of Independent Events (p. 346)

To find the probability of independent events, multiply the probability of the first event by the probability of the second event.

Example A bag of markers contains 5 red, 9 orange, and 6 yellow markers. You can find the probability of choosing a red marker, replacing it, and then choosing an orange marker by multiplying the probability of choosing a red marker by the probability of choosing an orange marker.

Probability = probability of choosing red × probability of choosing orange

$$= \frac{5}{20} \times \frac{9}{20}$$

$$= \frac{45}{400} = \frac{9}{80}$$

So, the probability of first choosing a red marker, replacing it, and then choosing an orange marker is $\frac{9}{80}$.

Finding Probabilities of Dependent Events (p. 347)

To find the probability of dependent events, multiply the probability of the first event by the probability of the second event, given that the first event occurred.

Example To find the probability of choosing a red marker, then choosing an orange marker, without replacing the red marker, multiply the probability of choosing a red marker by the probability of choosing an orange marker, given that a red marker had already been removed.

$$\text{Probability} = \frac{5}{20} \times \frac{9}{19} = \frac{45}{380} = \frac{9}{76}$$

So, the probability of choosing a red marker, then an orange marker is $\frac{9}{76}$.

Finding the Mean and Median (pp. 351, 352)

To find the mean of a set of data, add all of the data values and divide by the number of items in the data set. To find the median of a set of data, arrange the items in order from smallest to largest and find the item that is exactly in the middle of the list.

Example The scores of your class on a 25-point math quiz are listed below.

20, 13, 16, 24, 25, 19, 17, 11, 18, 22, 24, 23, 16, 20, 16

To find the mean, add the scores and divide by 15.

$$\text{mean} = \frac{20 + 13 + 16 + 24 + 25 + 19 + 17 + 11 + 18 + 22 + 24 + 23 + 16 + 20 + 16}{15} = \frac{284}{15} = 18\frac{14}{15}$$

So, the mean, or score of the class is $18\frac{14}{15}$.

Example To find the median quiz score, arrange the numbers in order from smallest to largest. Then find the number in the middle.

11, 13, 16, 16, 16, 17, 18, (19), 20, 20, 22, 23, 24, 24, 25

The median score is 19.

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Finding the Mode and Range (p. 352)

To find the mode of a set of data, find the number that appears most often in the data set.

Example To find the mode of the quiz scored from above, find the number that appears most often.

11, 13, 16, 16, 16, 17, 18, 19, 20, 20, 22, 23, 24, 24, 25

The number 16 appears three times, more than any other. So the mode is 16.

To find the range of a set of data, find the difference between the greatest number and the least number in the data set.

Example To find the range of the quiz scores, find the greatest score and least score and subtract.

Range = greatest – least = 25 – 11 = 14

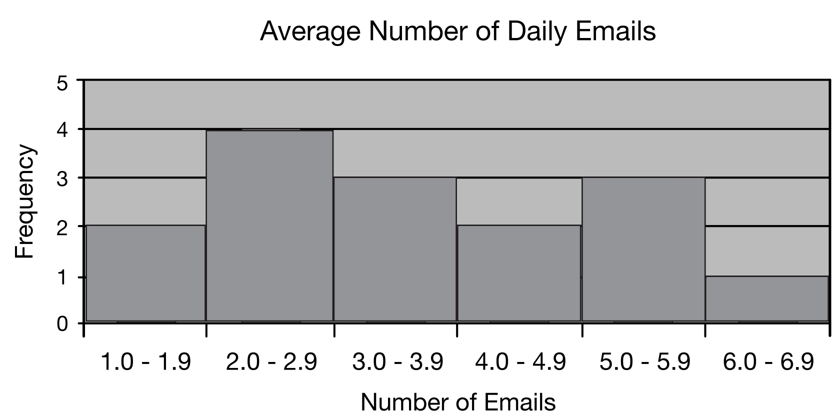
So, the range of the quiz scores is 14.

Creating Histograms (p. 359)

To create a histogram, first make a frequency table. Then place intervals along the horizontal axis and number the vertical axis. Draw a bar at each interval to represent the frequency at that interval. Be sure to add a title to the histogram.

Example A group of 15 people recorded the average number of emails that they receive per day, listed below.

4.0, 3.2, 5.0, 2.5, 4.0, 5.3, 2.0, 6.2, 1.8, 2.0, 4.5, 3.0, 1.7, 3.1, 2.6



11

Creating a Stem-and-Leaf Plot (p. 363)

To create a stem-and-leaf plot, use the digits with the least place value as the leaves and the remaining digits with greater place values as the stem. Be sure to include a key that indicates what the stems and leaves represent.

Example Everyone in your class reaches into their pockets to see how much change they have. The amounts, in cents, are 15, 48, 92, 72, 50, 75, 70, 18, 85, 95, 42, 25, 63, 59, 87, 13, 55, 75, 99, and 25. A stem-and-leaf plot of the data is shown.

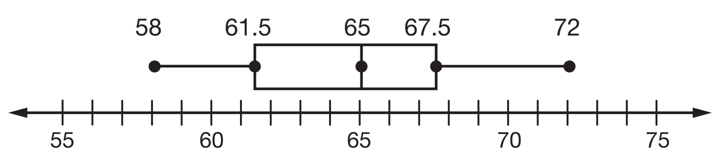
1	3	5	8		
2	5	5			
3					
4	2	8			
5	0	5	9		
6	3				
7	0	2	5	5	
8	5	7			
9	2	5	9		2 | 5 = 25 cents

Creating a Box-and-Whisker Plot (p. 367)

A box-and-whisker plot uses a number line to show how data are distributed.

Example The heights of each of your classmates in inches are 62, 58, 67, 68, 68, 72, 66, 65, 60, 61, 64, 67, and 64.

To create the box-and-whisker plot, find the median, the upper quartile, and the lower quartile. Then plot these points on a number line, and draw a box between the upper quartile and the lower quartile.



Creating Circle Graphs (p. 372)

To create a circle graph, first find the percents of each of the data items. Then, find how many degrees each data item will represent.

Example To see what pizza toppings are your town's favorites, you gather information from the local pizzeria. Of the total pizzas that the pizzeria sells, 27.5% are cheese, 37.5% are pepperoni, 20% are mushroom, 7.5% are sausage, and 7.5% are other.

To find the number of degrees in the circle graph needed to represent each topping, write and solve a proportion. A circle graph is shown.