Lesson 1: Chance Experiments

Student Outcomes

- Students understand that a probability is a number between and that represents the likelihood that an event will occur.
- Students interpret a probability as the proportion of the time that an event occurs when a chance experiment is repeated many times.

Classwork

Have you ever heard a weatherman say there is a chance of rain tomorrow or a football referee tell a team there is a chance of getting a head on a coin toss to determine which team starts the game? These are probability statements. In this lesson, you are going to investigate probability and how likely it is that some events will occur.

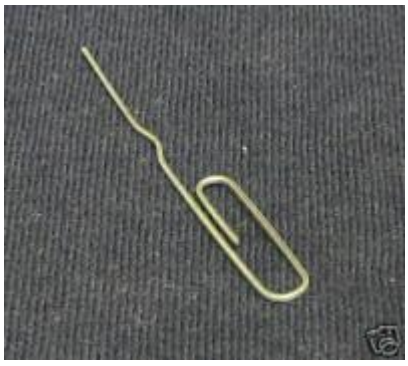
Example 1 (15 minutes): Spinner Game

Place students into groups of 2.

Hand out a copy of the spinner and a paperclip to each group. Read through the rules of the game and demonstrate how to use the paper clip as a spinner.

Here's how to use a paperclip and pencil to make the spinner:

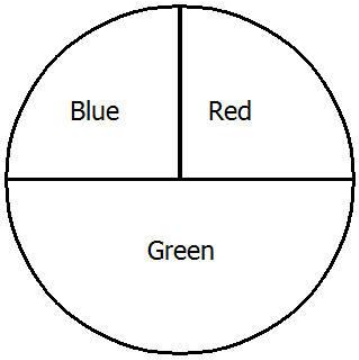
1. Unfold a paperclip to look like the paperclip pictured below. Then, place the paperclip on the spinner so that the center of the spinner is along the edge of the big loop of the paperclip.



2. Put the tip of a pencil on the center of the spinner.
3. Flick the paperclip with your finger. The spinner should spin around several times before coming to rest.
4. After the paperclip has come to rest, note which color it is pointing towards. If it lands on the line, then spin again.

Example 1: Spinner Game

Suppose you and your friend will play a game using the spinner shown here:



Rules of the game:

1. **Decide who will go first.**
2. **Each person picks a color. Both players cannot pick the same color.**
3. **Each person takes a turn spinning the spinner and recording what color the spinner stops on. The winner is the person whose color is the first to happen times.**

Play the game and remember to record the color the spinner stops on for each spin.

Students should try their spinners a few times before starting the game. Before students begin to play the game, discuss who should go first. Consider, for example, having the person born earliest in the year go first. If it's a tie, consider another option like tossing a coin. Discuss with students the following questions:

- Will it make a difference who goes first?
  - *The game is designed so that the spinner landing on green is more likely to occur. Therefore, if the first person selects green, this person has an advantage.*
- Who do you think will win the game?
  - *The person selecting green has an advantage.*
- Do you think this game is fair?
  - *No. The spinner is designed so that green will occur more often. As a result, the student who selects green will have an advantage.*

Play the game, and remember to record the color the spinner stops on for each spin.

Exercises 1–4 (5 minutes)

Allow students to work with their partners on Exercises 1–4. Then discuss and confirm as a class.

Exercises 1–4

1. **Which color was the first to occur times?**

   Answers will vary, but green is the most likely.

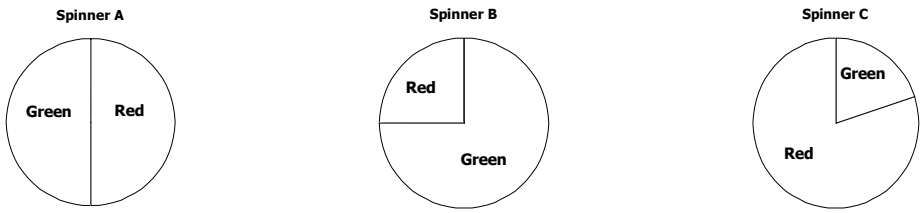
2. **Do you think it makes a difference who goes first to pick a color?**

   Yes, because the person who goes first could pick green.

3. **Which color would you pick to give you the best chance of winning the game? Why would you pick that color?**

   Green, it has the largest section on the spinner.

4. **Below are three different spinners. If you pick green for your color, which spinner would give you the best chance to win? Give a reason for your answer.**



Spinner B, because the green section is larger for this spinner than for the other spinners.

Example 2 (10 minutes): What is Probability?

Ask the students how they would define the word *probability,* then let them read the paragraph. After they have read the paragraph, draw the probability scale on the board. You could use the bag of balls example to emphasize the vocabulary. Present the following examples, and show how the scenario relates to the probability scale below:

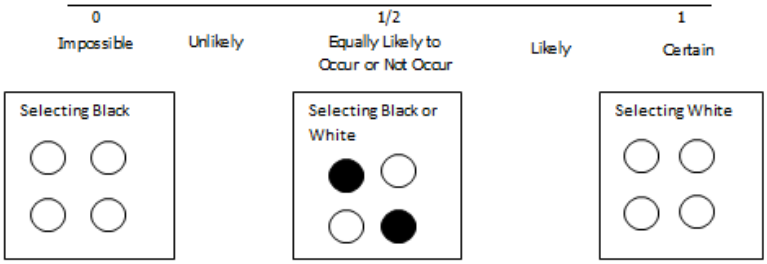
Tell the students that you have a bag with four white balls.

- Ask them what would happen if you selected one ball. Discuss with students why it is certain you would draw a white ball while it would be impossible to draw a black ball.
- Under the impossible label, draw a bag with four white balls. This bag represents a bag in which it is not possible to draw a black ball. The probability of selecting a black ball would be . On other end, draw this same bag (four white balls). This bag represents a bag in which it is certain that you will select a white ball.
- Ask the students why "impossible" is labeled with a , and "certain" is labeled with a .
- Discuss with students that, for this example, indicates that it is not possible to pick a black ball if the question is: "What is the probability of picking a black ball?" Discuss that indicates that every selection would be a white ball for the question: "What is the probability of picking a white ball?"

Tell the students that you have a bag of two white and two black balls.

- Ask the students to describe what would happen if you picked a ball from that bag. Draw a model of the bag under the – (or equally likely) to occur or not to occur.
- Ask the students why "equally likely" is labeled with –.
- Ask students what might be in a bag of balls if it was unlikely but not impossible to select a white ball.

Indicate to students that a probability is represented by a number between and . When a probability falls in between these numbers, it can be expressed in several ways: as a fraction, a decimal, or a percent. The scale below shows the probabilities , –, and , and the outcomes to the bags described above. The positions are also aligned to a description of *impossible*, *unlikely*, *equally likely*, *likely*, and *certain*. Consider providing this visual as a poster to help students interpret the value of a probability throughout this module.



Example 2: What is Probability?

Probability is about how likely it is that an event will happen. A probability is indicated by a number between and . Some events are certain to happen, while others are impossible. In most cases, the probability of an event happening is somewhere between certain and impossible.

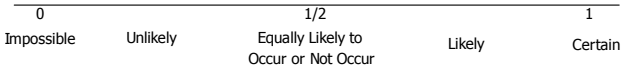
For example, consider a bag that contains only red balls. If you were to select one ball from the bag, you are certain to pick a red one. We say that an event that is certain to happen has a probability of . If we were to reach into the same bag of balls, it is impossible to select a yellow ball. An impossible event has a probability of .

Description	Example	Explanation
Some events are impossible. These events have a probability of .	**You have a bag with two green cubes, and you select one at random. Selecting a blue cube is an impossible event.**	**There is no way to select a blue cube if there are no blue cubes in the bag.**
Some events are certain. These events have a probability of .	**You have a bag with two green cubes, and you select one at random. Selecting a green cube is a certain event.**	**You will always get a green cube if there are only green cubes in the bag.**

Some events are classified as equally likely to happen or to not happen. These events have a probability of —.	You have a bag with one blue cube and one red cube and you randomly pick one. Selecting a blue cube is equally likely to happen or to not happen.	
Some events are more likely to happen than to not happen. These events will have a probability that is greater than . These events could be described as "likely" to occur.	If you have a bag that contains eight blue cubes and two red cubes, and you select one at random, it is likely that you will get a blue cube.	Even though it is not certain that you will get a blue cube, a blue cube would be selected most of the time because there are many more blue cubes than red cubes.
Some events are less likely to happen than to not happen. These events will have a probability that is less than . These events could be described as "unlikely" to occur.	If you have a bag that contains eight blue cubes and two red cubes, and you select one at random, it is unlikely that you will get a red cube.	Even though it is not impossible to get a red cube, a red cube would not be selected very often because there are many more blue cubes than red cubes.

The figure below shows the probability scale.

Probability Scale



Exercises 5–8 (10 minutes)

Let the students continue to work with their partners on Questions 5–8

Then, discuss the answers. Some answers will vary. It is important for students to explain their answers. Students may disagree with one another on the exact location of the letters in Exercise 5, but the emphasis should be on student understanding of the vocabulary, not on the exact location of the letters.

MP.2

Exercises 5–8

5. **Decide where each event would be located on the scale below. Place the letter for each event on the appropriate place on the probability scale.**

   Answers noted on probability scale below.

Event:

A. **You will see a live dinosaur on the way home from school today.**

Probability is or impossible as there are no live dinosaurs.

B. **A solid rock dropped in the water will sink.**

Probability is (or certain to occur), as rocks are typically denser than the water they displace.

C. **A round disk with one side red and the other side yellow will land yellow side up when flipped.**

Probability is –, as there are two sides that are equally like to land up when the disk is flipped.

D. **A spinner with four equal parts numbered – will land on the on the next spin.**

Probability of landing on the would be –, regardless of what spin was made. Based on the scale provided, this would indicate a probability halfway between impossible and equally likely.

E. **Your name will be drawn when a name is selected randomly from a bag containing the names of all of the students in your class.**

Probability is between impossible and equally likely, assuming there are more than two students in the class. If there were two students, then the probability would be equally likely. If there was only one student in the class, then the probability would be certain to occur. If, however, there were two or more students, the probability would be between impossible and equally likely to occur.

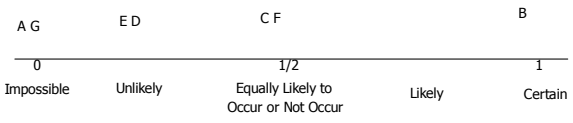
F. **A red cube will be drawn when a cube is selected from a bag that has five blue cubes and five red cubes.**

Probability would be equally likely to occur as there are an equal number of blue and red cubes.

G. **The temperature outside tomorrow will be – degrees.**

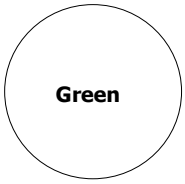
Probability is impossible (or) as there are no recorded temperatures at – degrees Fahrenheit or Celsius.

Probability Scale



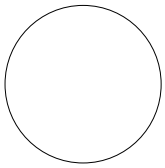
6. **Design a spinner so that the probability of green is .**

The spinner is all green.



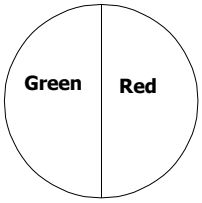
7. Design a spinner so that the probability of green is .

The spinner can include any color but green.



8. Design a spinner with two outcomes in which it is equally likely to land on the red and green parts.

The red and green areas should be equal.



Exercises 9–10 (5 minutes)

Have a classroom discussion about the probability values discussed in the exercises. Discuss with students that an event that is impossible has a probability of and will never occur, no matter how many observations you make. This means that in a long sequence of observations, it will occur of the time. An event that is certain has a probability of and will always occur. This means that in a long sequence of observations, it will occur of the time. Ask students to think of other examples in which the probability is or .

Exercises 9–10

An event that is impossible has probability and will never occur, no matter how many observations you make. This means that in a long sequence of observations, it will occur of the time. An event that is certain, has probability and will always occur. This means that in a long sequence of observations, it will occur of the time.

9. What do you think it means for an event to have a probability of –?

In a long sequence of observations, it would occur about half the time.

10. What do you think it means for an event to have a probability of –?

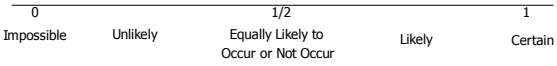
In a long sequence of observations, it would occur about of the time.

Closing

Lesson Summary

- **Probability is a measure of how likely it is that an event will happen.**
- **A probability is a number between and .**
- **The probability scale is:**

Probability Scale



Exit Ticket (5 minutes)

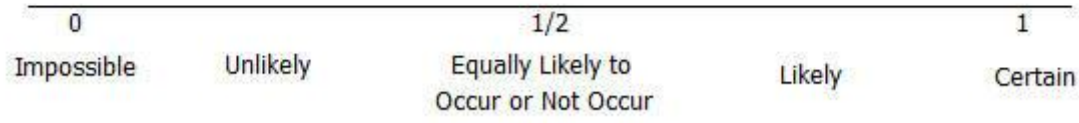
Name _____ Date_____

Lesson 1: Chance Experiments

Exit Ticket

Decide where each of the following events would be located on the scale below. Place the letter for each event on the appropriate place on the probability scale.

Probability Scale



The numbers from to are written on small pieces of paper and placed in a bag. A piece of paper will be drawn from the bag.

A. A piece of paper with a is drawn from the bag.

B. A piece of paper with an even number is drawn.

C. A piece of paper with a is drawn.

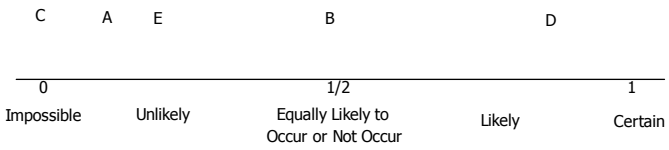
D. A piece of paper with a number other than is drawn.

E. A piece of paper with a number divisible by is drawn.

Exit Ticket Sample Solutions

Decide where each of the following events would be located on the scale below. Place the letter for each event on the appropriate place on the probability scale.

Probability Scale



The numbers from to are written on small pieces of paper and placed in a bag. A piece of paper will be drawn from the bag.

A. A piece of paper with a is drawn from the bag.

B. A piece of paper with an even number is drawn.

C. A piece of paper with a is drawn.

D. A piece of paper with a number other than is drawn.

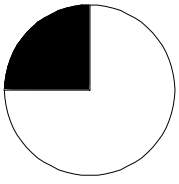
E. A piece of paper with a number divisible by is drawn.

Problem Set Sample Solutions

1. Match each spinner below with the words Impossible, Unlikely, Equally likely to occur or not occur, Likely, and Certain to describe the chance of the spinner landing on black.

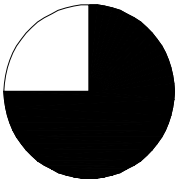
Spinner A: ***Unlikely***

Spinner A



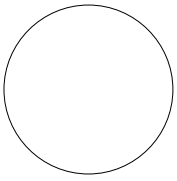
Spinner B: ***Likely***

Spinner B



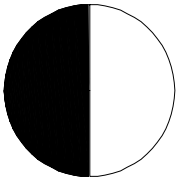
Spinner C: ***Impossible***

Spinner C



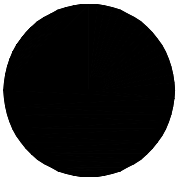
Spinner D: ***Equally Likely***

Spinner D



Spinner E: ***Certain***

Spinner E



2. Decide if each of the following events is Impossible, Unlikely, Equally likely to occur or not occur, Likely, or Certain to occur.

   a. A vowel will be picked when a letter is randomly selected from the word "lieu."

   Likely; most of the letters of the word lieu are vowels.

   b. A vowel will be picked when a letter is randomly selected from the word "math."

   Unlikely; most of the letters of the word math are not vowels.

   c. A blue cube will be drawn from a bag containing only five blue and five black cubes.

   Equally likely to occur or not occur; the number of blue and black cubes in the bag is the same.

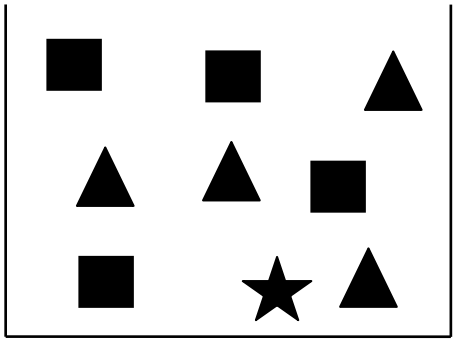
   d. A red cube will be drawn from a bag of red cubes.

   Certain; the only cubes in the bag are red.

   e. A red cube will be drawn from a bag of red and blue cubes.

   Unlikely; most of the cubes in the bag are blue.

3. A shape will be randomly drawn from the box shown below. Decide where each event would be located on the probability scale. Then, place the letter for each event on the appropriate place on the probability scale.



Event:

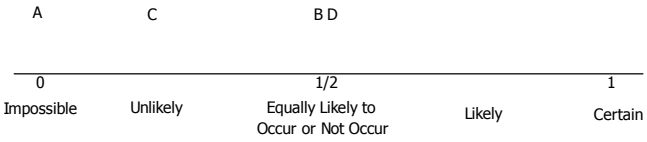
A. A circle is drawn.

B. A square is drawn.

C. A star is drawn.

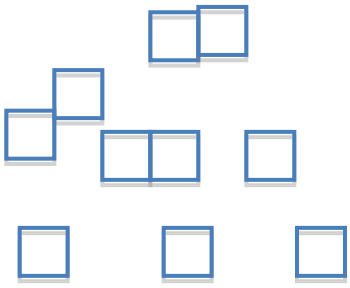
D. A shape that is not a square is drawn.

Probability Scale



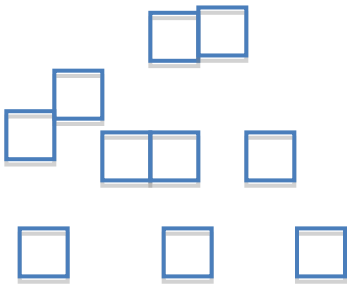
4. Color the cubes below so that it would be equally likely to choose a blue or yellow cube.

Color five blue and five yellow.



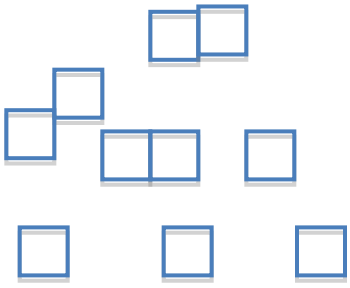
5. Color the cubes below so that it would be likely but not certain to choose a blue cube from the bag.

, , or blue, and the rest any other color.



6. Color the cubes below so that it would be unlikely but not impossible to choose a blue cube from the bag.

, , or blue, and the others any other color.



7. Color the cubes below so that it would be impossible to choose a blue cube from the bag.

Any color but blue.