Chapter

14 Data and Probability

Dear Student,

In this chapter you will be studying probability. You will be conducting experiments, gathering data, and using probability to make predictions.

Probability is a measure of how "surprising" an event is. Chances are you have flipped a coin to decide who will go first when playing a game. Would you use this method if you did not believe that it was fair? The reason you trust this method is that you expect the chance of a coin landing on heads or landing on tails to be equal.

Sometimes we are surprised even when probability says that we should not be. If you were to flip a coin 4 times and get 4 heads, what is the probability that it will land on heads with the next flip? Is the probability the same as always, or is it higher or lower? Because 4 heads in a row is surprising, you might expect that the next flip will be tails. Still, the probability that the next flip will turn up heads is still exactly $\frac{1}{2}$. After all, the coin does not remember what happened the last 4 times! Probability helps us decide what should or should not be expected.

Chances are you will soon learn lots more about probability. And chances are it is time to get started!

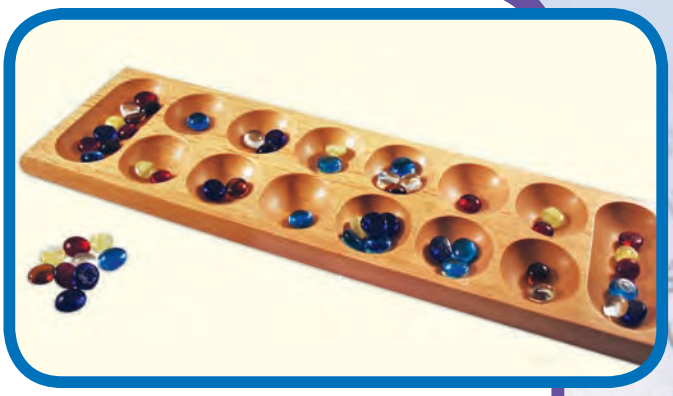
Mathematically yours,

The authors of ***Think Math!***

THE WORLD ALMANAC FOR KIDS

Probability and Data

Games using spinners, cards, number cubes, or other instruments of probability have been in existence for about 4,000 years. There are games that are based on strategy and others that are based on racing. You can learn how to play strategy games better by knowing probability.

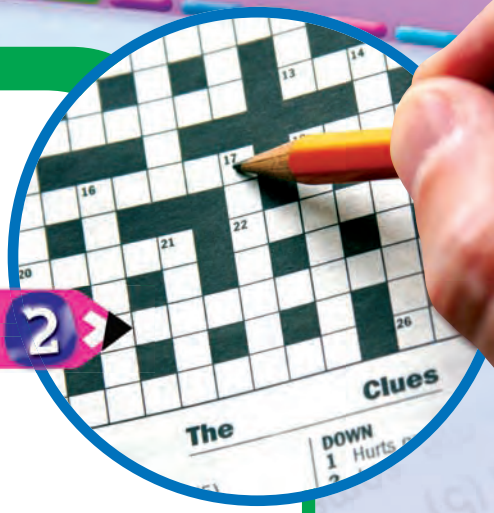


FACT·ACTIVITY 1

Afia is playing a spinner game using the spinner below. Use the spinner for 1–4.

1. Write a fraction to describe the probability of spinning a *P*; a *B*; an *E*.
2. Write a fraction to describe the probability of the spinner landing on a vowel. (Do not include *Y* as a vowel.)
3. Write a fraction to describe the probability of the spinner landing on a consonant.
4. Write a number sentence expressing the probability of the spinner landing on a vowel or the letter *B*.

The first crossword puzzle, originally known as a "word-cross," was written by Englishman Arthur Wynne. What word games do you know?



FACT·ACTIVITY 2

Suppose a word game used two 10-sided decahedra labeled with letters instead of numbers. The letters on each decahedron are shown below.

Decahedron 1:	A	B	C	D	E	F	G	H	I	K
Decahedron 2:	L	M	N	O	P	R	S	T	U	V

1. List all possible outcomes for rolling a vowel on decahedron 1 and a vowel on decahedron 2.

2. There are 100 possible outcomes for rolling the two decahedra. Copy and complete the table to the right. Write as a fraction the theoretical probability for rolling two vowels.

		Decahedron 2	
		vowel	consonant
Decahedron 1	vowel		$\frac{24}{100}$
	consonant	$\frac{14}{100}$	$\frac{56}{100}$

3. Is it possible to roll your 2 initials? Explain why or why not. What is the probability of rolling your initials?

4. Write each fraction in the table as a decimal and as a percent.

CHAPTER PROJECT

Working in small groups, determine a question you would like your classmates to answer such as, "What is your favorite board game?" Other acceptable survey topics include word games or sports games.

Survey 20 people and make a poster to present your results. Use a circle graph to display the data. Using your results, write questions for other students to answer. Then make a prediction about the favorite game of a larger group of students (such as all 5th graders).

ALMANAC Fact

At the Elliott Avedon Museum and Archives of Games in Waterloo, Canada, visitors not only see exhibits about board games, but they also get to sit down and play the games. There are more than 5,000 objects and documents at the museum.

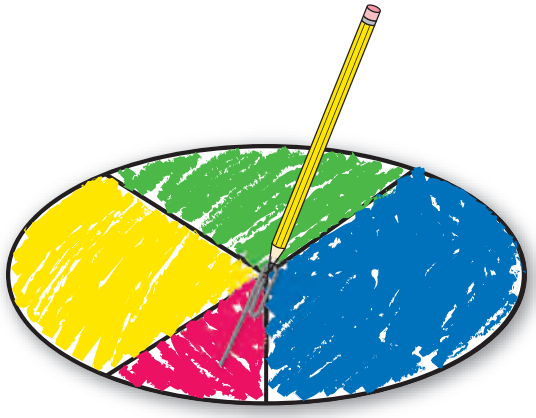
Chapter 14

Lesson 1

EXPLORE
A Probability Experiment

Imagine playing a game in which the chances of various outcomes were not all the same. You can be sure that certain outcomes are more likely than others, but HOW MUCH more likely? Here is a way to find out by doing an experiment.

1. Use Activity Master 142: Colors Spinner. Color, cut out, and assemble the spinner.



2. Make a table that lists the possible outcomes.

3. Spin the paper clip on your spinner 20 times. Record the result of each spin using tally marks.

4. How likely is each outcome?

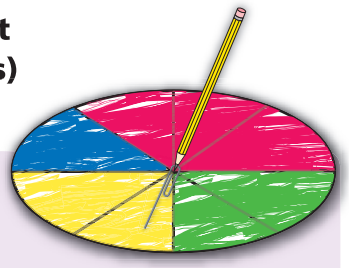
Chapter 14

Lesson 2

REVIEW MODEL
Finding Probability

Probability is the measure of the likelihood of a particular event. The probability of an event is a number from 0 to 1, where 0 means the event is never expected to occur and 1 means the event is always expected.

Probability is a comparison of the number of outcomes that are part of the event (sometimes called favorable outcomes) to the total number of possible, equally likely outcomes.



For this spinner,

- There are 8 possible *outcomes.* Each section of the spinner is a possible outcome.
- There are 4 possible *events:* red, green, yellow, blue.

The probability of the pointer landing on blue is $\frac{1}{8}$.
(number of blue sections / total number of sections)

The probability of the pointer landing on red is $\frac{3}{8}$.
(number of red sections / total number of sections)

The probability of the pointer landing on green OR yellow is $\frac{4}{8}$.
(number of green OR yellow sections / total number of sections)

Example

Erin made this set of cards.

3	6	9	12	15
18	21	24	27	30

She drew one card at random from the deck. Describe the probability for each event.

- Number is 12 $\frac{1}{10}$
- Number is less than 12 $\frac{3}{10}$
- Number is greater than 12 $\frac{6}{10}$, or $\frac{3}{5}$
- Number is less than 32 $\frac{10}{10}$, or 1

Check for Understanding

Use a fraction to describe the probability of each event.

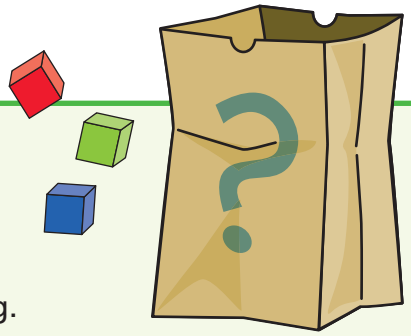
1. yellow
2. not blue
3. red OR green

4. 2 or 3
5. less than 4
6. more than 5

0	1	2	3	4

EXPLORE
A Sampling Experiment

The bag contains red, blue, and green cubes. The total number of cubes and the number of each color are secrets. Don't peek!



Follow these steps to perform an experiment.

- ☑ Without looking into the bag, pull out one cube.
- ☑ Record the color and put the cube back into the bag.
- ☑ Shake the bag a bit to mix up the contents.
- ☑ Repeat this process until you have recorded 20 pulls.

1. Summarize your experiment by assigning a fraction for each color that represents the number of pulls of that color out of the total number of pulls.

2. Explain why this does not help you know the total number of cubes in the bag.

Chapter 14

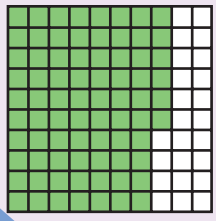
Lesson 5

REVIEW MODEL
Understanding Percent

Percent means "per hundred." A percent is a part of 100 and can be written as a fraction with 100 as the denominator.

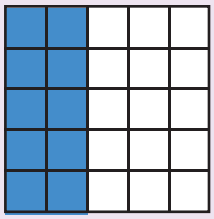
Fifty percent, or 50%, means 50 per 100 and can be written as $\frac{50}{100}$.

- 75 of the 100 squares are green.
- 75 of 100 is $\frac{75}{100}$.
- So, 75% of the grid is green.



It's easy to write percents for fractions with 100 as a denominator.

- 10 of the 25 squares are blue.
- 10 of 25 is $\frac{10}{25}$, or $\frac{40}{100}$.
- So, 40% of the grid is blue.



If the denominator is NOT 100, write an equivalent fraction with 100 as the denominator.

Examples

The Eagles won 16 of the 20 games they played. What percent of the games did they win?

They won $\frac{16}{20}$ of the games. $\frac{16}{20} = \frac{80}{100}$

So, they won 80% of the games.

Joanna got 78% of the 50 problems correct on her math quiz. How many problems did Joanna get correct?

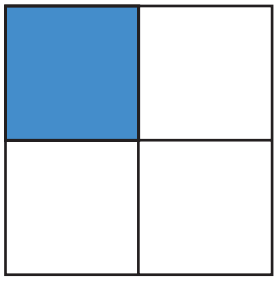
$78\% = \frac{78}{100}$ $\frac{78}{100} = \frac{39}{50}$

So, Joanna got 39 problems correct.

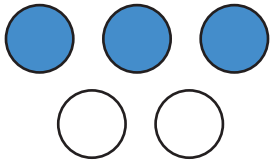
Check for Understanding

Write a percent for the blue part of each diagram.

1.

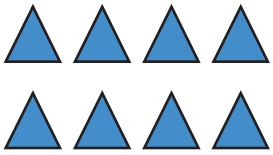


2.



3.

4.



5. Jake spelled 46 of the 50 words on the spelling test correctly. What percent of the words were spelled correctly?

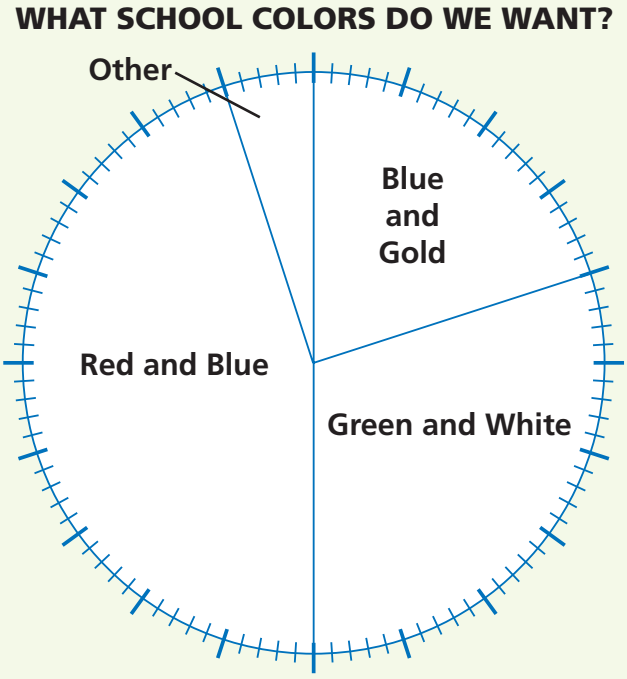
6. $\frac{1}{4}$ of the students in the fifth-grade class bought pizza for lunch. What percent of the students bought pizza?

Chapter 14

Lesson 6

EXPLORE
A Circle Graph

The students at the Hilltop School voted for new school colors. This graph shows the results.



- ☑ Make up 3 questions that can be answered by reading the graph.
- ☑ Make up 2 questions about this situation that cannot be answered by reading the graph.

Chapter 14

Lesson 6

REVIEW MODEL
Making Circle Graphs

A circle graph is an appropriate graph to use when you want to show how the parts relate to the whole.

If you think of a complete circle as 100%, you can express parts of a circle graph, as percents.

The table shows the results of a survey of fifth-grade students.

In all, 50 students were surveyed.

$10 + 8 + 18 + 6 + 8 = 50$

OUR FAVORITE SPORTS				
Baseball	Golf	Soccer	Tennis	Other
10	8	18	6	8

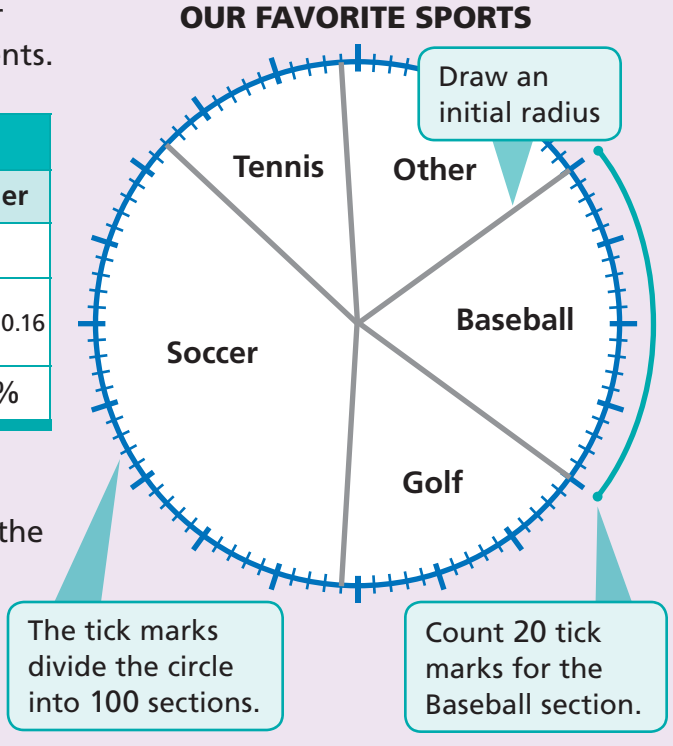
The steps below show a way to make a circle graph of the data.

Step 1 Write the data as fractions or decimals. Then write the data as percents.

OUR FAVORITE SPORTS				
Baseball	Golf	Soccer	Tennis	Other
10	8	18	6	8
$\frac{10}{50}$, or 0.20	$\frac{8}{50}$, or 0.16	$\frac{18}{50}$, or 0.36	$\frac{6}{50}$, or 0.12	$\frac{8}{50}$, or 0.16
20%	16%	36%	12%	16%

Step 2 Use a ruler to draw an initial radius from the center to the edge of the circle. Use the tick marks to help you draw a radius to show each section.

Step 3 Label the sections and write a title for the graph.



Check for Understanding

The table shows the results of a survey of fifth-grade students. Use the data in this table to make a circle graph.

OUR FAVORITE VACATIONS				
Beach	Famous City	National Park	Camping	Other
8	4	3	5	5

Chapter 14

Lesson 7

REVIEW MODEL

Problem Solving Strategy

Make a Table

Below is a list of the 18 students in Ms. Sweetland's class. They each told their busiest school day of the week.

Jon	Mon	Patrick	Thu	Isacc	Thu	Drew	Mon	Lauren	Wed	Emily	Thu
Colin	Fri	Sierra	Mon	Kirin	Mon	Hassan	Thu	Mike	Mon	Weston	Thu
Ray	Wed	Amy	Tue	Jasmine	Wed	Sammy	Fri	Judy	Tue	Grant	Mon

What fraction of the class has their busiest school day on Monday?

Strategy: Make a Table

Read to Understand

What do you know from reading the problem?

I know which school day is the busiest day for each of the 18 students in Ms. Sweetland's class.

What do you need to find out?

the fraction of the class that has their busiest school day on Monday

Plan

How can you solve this problem?

You can make a table to help solve the problem.

Solve

How can you use a table to solve the problem?

You can list the days of the week and write a tally mark for each student who chose that day. Then, count the number of tally marks for Monday. Write that number as a fraction of 18.

So, the fraction of Ms. Sweetland's class that has their busiest school day on Monday is $\frac{6}{18}$, or $\frac{1}{3}$.

Check

Look back at the problem. Did you answer the question that was asked? Does the answer make sense?

Problem Solving Practice

Use the strategy *make a table* to solve.

Below is a list of the students in the math club and their ages.

Wilson	9	Alexandra	11	Paul	11	Alison	10
Julie	10	Miles	10	Kristin	9	Lynn	8
Matthew	9	Bradley	8	Haley	10	Avi	11
Brooke	11	Corey	10	Mike	10	Brenda	9
Ryan	10	Kaitlin	9	Adele	8	Faith	10

1. What fraction of the students in the math club are 9 years old?

2. What age are the most students in the math club?

Problem Solving Strategies

- ✔ Act It Out
- ✔ Draw a Picture
- ✔ Guess and Check
- ✔ Look for a Pattern
- ✔ Make a Graph
- ✔ Make a Model
- ✔ Make an Organized List
- ✔ **Make a Table**
- ✔ Solve a Simpler Problem
- ✔ Use Logical Reasoning
- ✔ Work Backward
- ✔ Write an Equation

Mixed Strategy Practice

Use any strategy to solve. Explain.

3. Scott has 1 cup of milk in his refrigerator. He uses $\frac{1}{3}$ cup for some pancakes and drinks $\frac{1}{2}$ cup. How much milk is left?

4. Mr. Silva's class can go to the Book Fair on Monday, Tuesday, Wednesday, or Friday. They can go in the morning or afternoon. How many choices do they have?

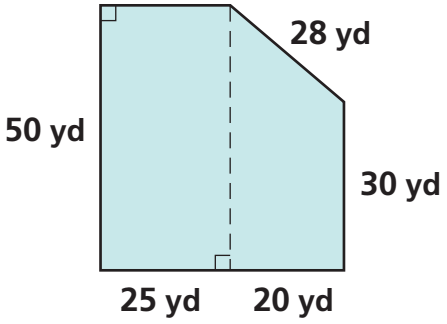
5. Lily is at a football game. On the first play her team moved the ball forward 12 yards from the 20 yard line. On the second play, they lost 6 yards. On the third play, they gained 5 yards. What yard line were they on after the third play?

6. A science camp had a total of 350 campers during the summer. The camp had two sessions. If the second session had 10 more campers than the first session, how many campers were at each session?

For 7–8, use the diagram of the playground.

7. What is the perimeter of the playground?

8. What is the area of the playground?



Chapter 14 Vocabulary

Choose the best vocabulary term from Word List A for each sentence.

1. A set of outcomes is called a(n) ___?___.
2. A(n) ___?___ outcome is one that is sure to happen.
3. A possible result of an experiment is called a(n) ___?___.
4. A(n) ___?___ outcome is an unlikely outcome.
5. A(n) ___?___ experiment is an experiment used to make predictions about a population.
6. The ___?___ is the likelihood that an event will happen.
7. The ___?___ is the full set in a sampling experiment.
8. To tell the number of hundredths, you can use a(n) ___?___.
9. A(n) ___?___ is a part of a population.
10. Every member of a population has equal chance of being selected in a(n) ___?___ selection.

Word List A

- probability
- outcome
- event
- certain
- probable
- improbable
- sampling
- population
- random
- sample
- percent

Complete each analogy using the best term from Word List B.

11. Part is to whole as ___?___ is to population.
12. Yes is to no as ___?___ is to impossible.

Word List B

- certain
- event
- sample

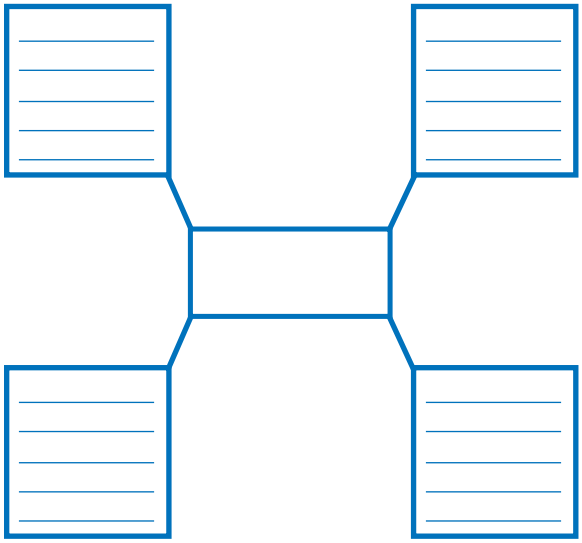
Talk Math

Discuss with a partner what you have learned about probability. Use the vocabulary terms *outcome* and *probability*.

13. How can you use a fraction to describe the results of a probability experiment?
14. How can you use an experiment to make a prediction?
15. How does the number of trials affect the results of a probability experiment?

Word Web

16 **Create a word web for the term *event*.**



Word Line

17 **Create a word line using the terms *certain, impossible, improbable,* and *probable*.**

Words:

Sequence:

SECTOR *Sector* comes from a Latin word, *secare.* It means "to cut." You can see that if you cut something, you might end up with a section of it. In math, a *sector* is a section of a circle. It is shaped like a slice of pie.

In everyday life, a *sector* can be a section of other things as well. It can be a section of the population, such as the public *sector* or the urban *sector.* It can be a section of a town, such as the business *sector.* It can even be a section of a track on a computer disk. But even though a computer disk is in the shape of a circle, its *sector* is not shaped like a slice of pie.

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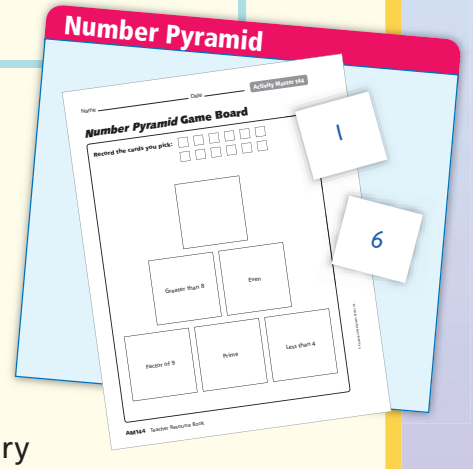
Number Pyramid

Game Purpose

To practice categorizing numbers while generating a random data set

Materials

- Activity Master 143: Blank Cards
- Activity Master 144: *Number Pyramid Game* Board
- scissors



How To Play The Game

1. This is a game for 2 players.
   - Each player will need a set of blank cards. Write the numbers 1 through 12 on the blank cards. Cut them out. Combine both sets of cards. Mix them up. Place them face down in a stack.
   - Each player will need a game board. Label the one empty square in the pyramid with any category that includes at least one of the numbers on the cards. For example, you could write "Not 2 or 3" or "Less than 9."
   - Decide who will go first, and then take turns.

2. Pick a number card. Record the number in a blank box at the top of your game board. Decide whether the number matches any of the categories on the pyramid.
   - If the number matches a category, put a check mark in the box for that category.
   - If the number matches more than one category, choose one of them. Put a check mark next to that category.
   - If the number does not match a category, that is the end of your turn.

   Put the card back in the stack. Mix up the cards again.

3. When you have matched at least one number to each category, you have completed your pyramid. You win!

GAME

Matching Quantities

Game Purpose

To practice converting between fractions, decimals, and percents

Materials

- Activity Masters 149–150: *Matching Quantities Cards*
- scissors

How To Play The Game

1. This is a game for 2 players. Cut out all the *Matching Quantities* Cards. Mix them up. Place them face down in a stack. Each player takes 4 cards from the top of the stack. Then put 4 more cards face up on a the table. Decide who will go first, and then take turns. The goal is to collect more cards than the other player.

2. Look at your cards. Decide whether any of them has an expression that is equivalent to an expression on a card on the table.
   - If you have a matching card, place it on top of its match so the other player can see the match. Then take both cards, and put them aside in your own stack. Take a new card so that you will have 4 cards in your hand and place a new card on the table.
   - If you do not have a matching card, put one of your cards at the bottom of the face down stack. Pick another card from the top. You must wait until your next turn to use that card.

3. When all of the cards in the face down stack are gone, you can still try to match cards on the table with cards in your hand. The game ends when all of the cards in the face down stack are gone and no matches can be made with the cards on the table. Whoever has more cards in his or her stack wins.

CHALLENGE

Theoretical and Experimental Probabilities

Try a probability experiment.

PART 1: Count the number of boys and girls in your class, including yourself. Tear a sheet of paper into the same number of pieces as the number of boys and girls. On each small piece of paper, write a B for each boy or a G for each girl in your class. Put the pieces into a bag.

- If you pick one paper, is it more likely to have a *B* or *G* on it?
- What is the probability that you will pick *B?* a *G?*

That is the theoretical probability. You know the number of boys and girls, and each paper has a fair chance of being chosen, so you can find this probability mathematically.

PART 2: Now pick 20 times. Record B or G for each pick. Put the paper back in the bag after each pick. Copy the table below. Keep a tally of your results.

Boy/Girl	Number of Picks	Totals
B		
G		

Write these two fractions.

$$\frac{\text{number of boys picked}}{\text{total number of picks}} \text{ and } \frac{\text{number of girls picked}}{\text{total number of picks}}$$

Those are experimental probabilities.

- Do you think the experimental probabilities are close to the theoretical probabilities?

PART 3: Work in a group of 4 students. Each student should do the experiment 30 more times. Then, combine your results. Write the new experimental probabilities. The denominator of each fraction will be 200. That includes the 20 original trials plus the 30 more.

- How do the group's results compare to the theoretical probabilities?
- Did the experimental probabilities with 200 trials come closer to the theoretical probabilities than the experiment with 20 trials?

If you did 2,000 trials, the results would be very close to the theoretical probabilities. The greater the number of trials, the closer you will get.