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Mathematics Readers—Level 4

This sample includes the following:

Grade 4

Teacher Created Materials PUBLISHING

MATHEMATICS READERS

Teacher's Guide

Table of Contents

Introduction

Unit 1: Operations and Algebraic Reasoning

Unit 2: Fractions and Decimals

Unit 3: Measurement

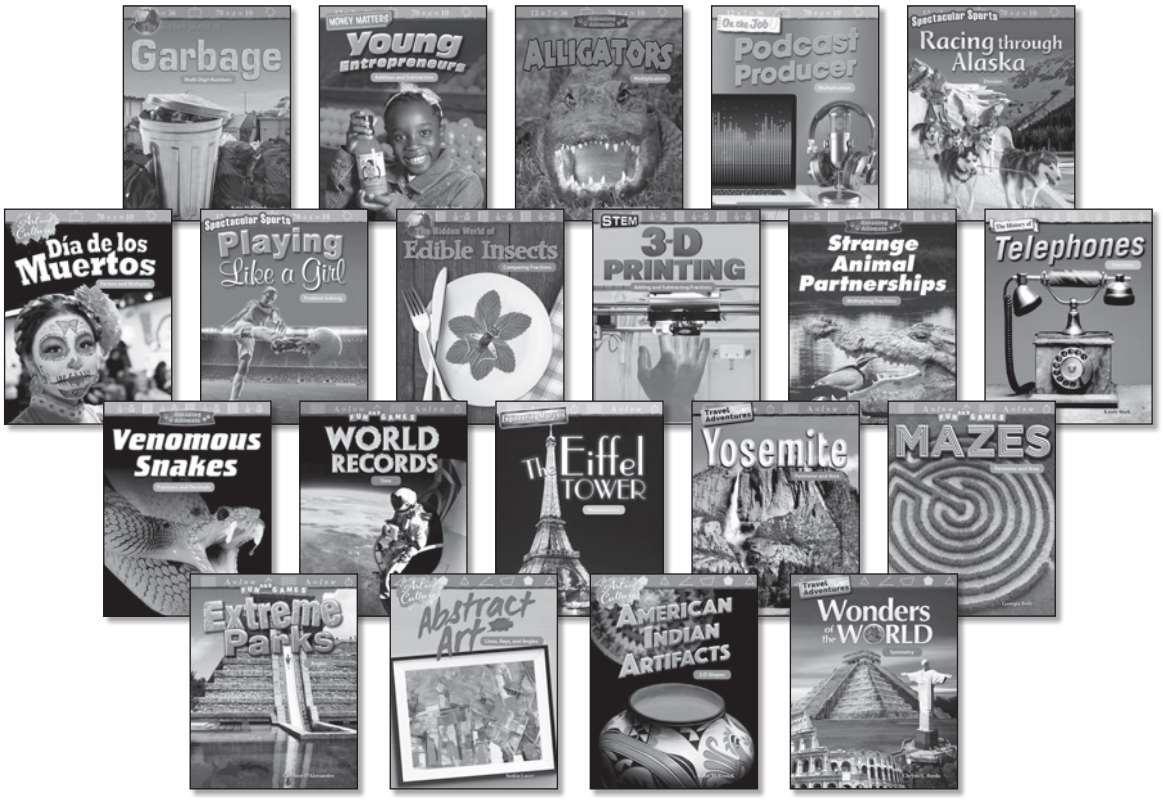
Unit 4: Geometry

Appendix

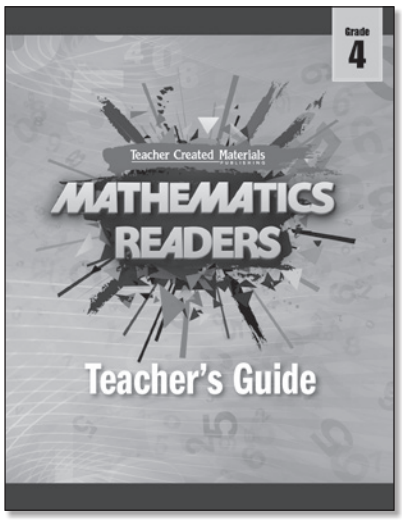
How to Use This Product

Kit Components

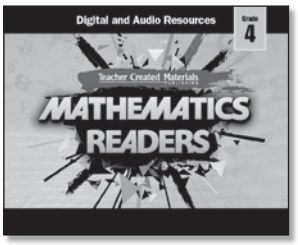
6 copies of 20 books



Teacher's Guide



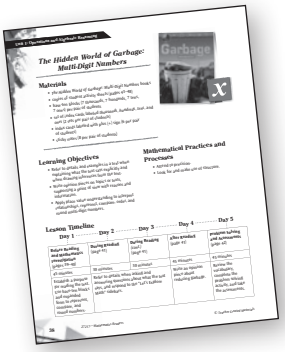
Digital and Audio Resources



How to Use This Product *(cont.)*

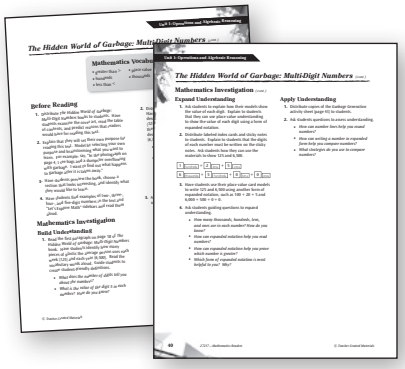
Teacher's Guide

Each five-day lesson sequence is organized in a consistent format for ease of use.



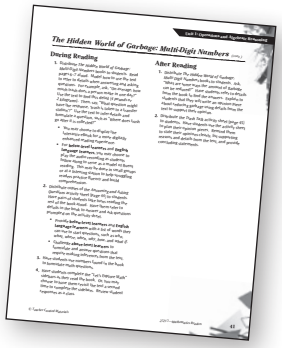
Overview

- The overview page includes learning objectives, a materials list, and a suggested timeline for the lesson.



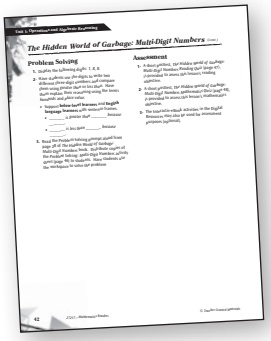
Day 1

- Students are introduced to the book and the math concept or skill.
- Students build, expand, and apply understanding of the math concept or skill with concrete, representational, and abstract activities.



Days 2, 3, and 4

- Students complete reading and writing activities, as well as the "Let's Explore Math" sidebars.



Day 5

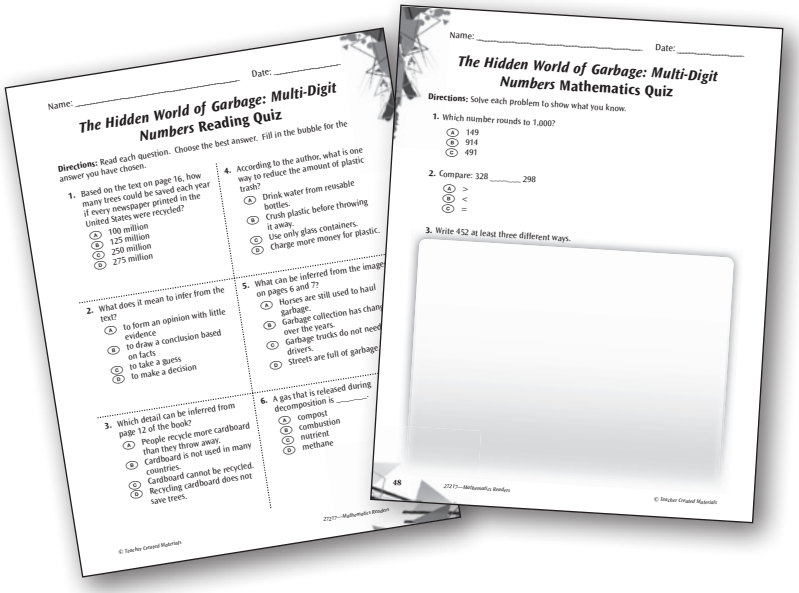
- Students take what they've learned and apply it in context in the Problem Solving activity.
- Students take the reading and mathematics assessments.

How to Use This Product *(cont.)*

Student Activity Sheets and Assessments

clear directions and activities that promote higher-order thinking skills

reading and math quizzes with text-dependent questions



How to Use This Product *(cont.)*

Pacing and Instructional Setting Options

The following pacing and instructional setting options show suggestions for how to use this product. *Mathematics Readers* is flexibly designed and can be used in tandem with a core curriculum within a mathematics block, literacy block, or both. Teachers should customize pacing according to student need (instruction may need to be extended over more days) and the teacher's preferred instructional frameworks, such as Guided Math or Guided Reading. This suggestion reflects one lesson per book for each of the 20 books. Each lesson spans 5 instructional days and requires 30–45 minutes, for a total of approximately 65 hours over the course of 100 days.

Day	**1**	**2**	**3**	**4**	**5**
Activity	Before Reading and Mathematics Investigation	During Reading	During Reading *(cont.)*	After Reading	Problem Solving and Assessments
Instructional Time	45 minutes	30 minutes	30 minutes	45 minutes	45 minutes

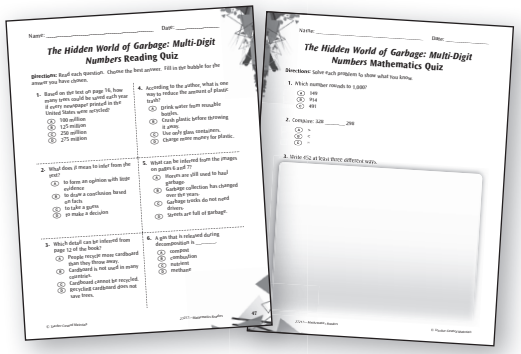
***Mathematics Readers* within the Guided Math and Balanced Literacy Frameworks**
Classroom Environment of Numeracy and Literacy—The books in *Mathematics Readers* contribute to an environment of numeracy and literacy by immersing students in real-world connections to mathematics and by giving students the opportunity to learn outside of content-area silos.
Whole-Class Instruction—The Before Reading activity in each *Mathematics Readers* lesson is a great opportunity to activate students' prior knowledge and capture their interest in a topic.
Small-Group Instruction—The lessons in *Mathematics Readers* offer flexibility that allows students to complete Before Reading, Mathematics Investigation, During Reading, and After Reading activities in small groups or any other preferred instructional setting, depending on student need. These activities have differentiation suggestions and targeted objectives and give students time to work with manipulatives and models.
Workshop—The During Reading, After Reading, and Problem Solving activities in each *Mathematics Readers* lesson can be completed during Math or Reading Workshop, in centers or at workstations, depending on students' previous learning experiences and their need for teacher support.
Conferencing—The Problem Solving activity and assessments in each *Mathematics Readers* lesson offer multiple opportunities for teachers and students to confer about concepts and ideas.
Assessment—*Mathematics Readers* offers multiple formative and summative assessment opportunities. Teachers can gain insight into student learning through reading and mathematics quizzes, small-group observations, analysis of written assignments, and a culminating activity.

How to Use This Product *(cont.)*

Assessment

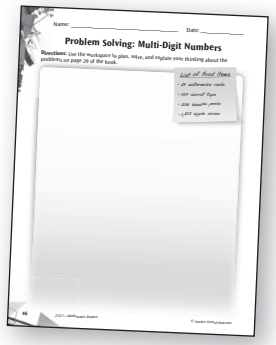
Mathematics Readers offers multiple assessment opportunities. You can gain insight into student learning through reading and mathematics quizzes, small-group observations, analysis of written assignments, and a culminating activity. These formal and informal assessments provide you with the data needed to make informed decisions about what to teach and how to teach it. This is the best way for you to know who is struggling with various concepts and how to address difficulties that students are experiencing with the curriculum.

Mathematics and Reading quizzes—At the end of each lesson in this Teacher's Guide are two quizzes—one to assess the reading objective and one to assess the mathematics objective. These short assessments include text-dependent questions and may be used as open-book evaluations.



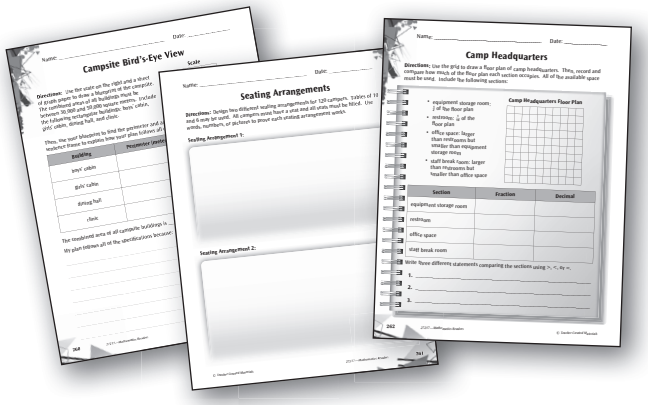
Mathematics and Reading Quizzes

Problem Solving activity—Each lesson includes a multistep problem solving activity that can be used to assess understanding of the mathematical concepts or skills.



Problem Solving Activity

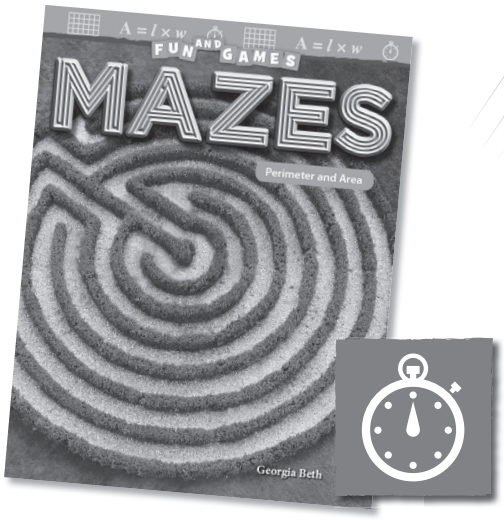
Culminating activity—The culminating activity asks students to apply what they have learned throughout the units in an engaging and interactive way. Students use what they have learned to create new ideas in a real-life context.



Culminating Activity

Progress monitoring—There are several points throughout each lesson when useful evaluations can be made. These evaluations can be made based on group, paired, and individual discussions and activities.

Fun and Games: Mazes: Perimeter and Area



Materials

- *Fun and Games: Mazes: Perimeter and Area* books
- copies of student activity sheets (pages 208–213)
- square tiles (16 per student)
- *The Maze* (themaze.pdf)
- *Graph Paper* (graphpaper.pdf)

Learning Objectives

- Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a grade-appropriate topic or subject area.
- Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences.
- Solve real-world mathematical problems related to the perimeter and area of rectangles where dimensions are whole numbers.

Mathematical Practices and Processes

- Reason abstractly and quantitatively.
- Model with mathematics.
- Attend to precision.
- Look for and express regularity in repeated reasoning.

Lesson Timeline

Day 1	Day 2	Day 3	Day 4	Day 5
Before Reading and Mathematics Investigation (pages 204–205)	**During Reading** (page 206)	**During Reading** *(cont.)* (page 206)	**After Reading** (page 206)	**Problem Solving and Assessments** (page 207)
45 minutes	30 minutes	30 minutes	45 minutes	45 minutes
Identify unknown or unusual words and math terms in the text. Solve problems involving area and perimeter.	Use strategies to determine the meanings of unknown words, and respond to the "Let's Explore Math" sidebars.		Write a fictional narrative about a walk through a maze.	Review the vocabulary, complete the problem solving activity, and take the assessments.

Fun and Games: Mazes: Perimeter and Area *(cont.)*

Mathematics Vocabulary

- area
- length
- perimeter
- width

Before Reading

1. Distribute copies of *The Maze* (themaze.pdf) to students. Allow time for students to solve it.
2. Ask students to describe the strategies they used to solve the maze. Tell students that just like there are strategies that help people complete mazes, there are strategies that help readers determine the meanings of unknown words and phrases. Explain that synonyms, antonyms, examples, and definitions are all helpful in-text context clues.
3. Distribute the *Fun and Games: Mazes: Perimeter and Area* books and copies of the *Unusual Words* activity sheet (page 208) to students. Have students preview the text and record unknown or unusual words and math terms on their activity sheets. Save students' activity sheets for later use.

Mathematics Investigation

Build Understanding

1. Have students examine the mazes on pages 7 and 10 of the *Fun and Games: Mazes: Perimeter and Area* books. Point out that although these mazes have twisting paths inside, the outer shapes are rectangles. Read the vocabulary words aloud. Guide students to create student-friendly definitions.
   - *What mathematical words can you use to describe the rectangles?*
   - *How is describing the space covered by the mazes different from describing the distance around the mazes?*
2. Distribute square tiles to each student. Ask students to use all 16 of their tiles to build rectangles that could hold a maze, and find the perimeters. (**Note:** Squares are valid solutions and can present rich discussion opportunities as to how they are special rectangles.)
   - Challenge **above-level learners** to build all the possible rectangles with a perimeter of 16.
   - Provide **below-level learners** and **English language learners** with a diagram of a rectangle with labels indicating length, width, area, and perimeter. Encourage them to refer to this diagram when solving area and perimeter problems to clarify their descriptions.
3. Ask students guiding questions to build understanding:
   - *What strategy did you use to find the perimeter and area of your rectangle? Are there different strategies that could be used?*
   - *How does knowing the length and width of the rectangle help you to find the perimeter and area?*
   - *How many different rectangles can be built using 16 square tiles? Will the perimeters and areas change?*

Fun and Games: Mazes: Perimeter and Area *(cont.)*

Mathematics Investigation *(cont.)*

Expand Understanding

1. Ask students to explain how square tiles can help problem solvers find perimeter and area. Explain to students that diagrams can also be useful to find perimeter and area.
2. Distribute two copies of *Graph Paper* (graphpaper.pdf) from the Digital Resources to each student. Tell students they will draw rectangles for mazes. On the first sheet of graph paper, have students draw a rectangle with an area of 32 square units. On the second sheet of graph paper, have students draw a rectangle with a perimeter of 32 units. Ask students to label the length, width, area, and perimeter of each rectangle.
    - Provide **below-level learners** with square tiles to build rectangles before they draw them on graph paper.
3. Ask students guiding questions to expand understanding:
    - *What do you know about each rectangle? How can you use what you already know to help you solve the problem?*
    - *How can you confirm the area of the first rectangle is 32 square units and the perimeter of the second rectangle is 32 units?*
    - *What units are used to describe the dimensions of the rectangle? What units are used to describe the area and perimeter?*
    - *Is there more than one possible solution for each rectangle?*

Apply Understanding

1. Distribute copies of the *Missing Measures* activity sheet (page 209) to students. Explain to students that different measures are given for each rectangle.
2. Ask students questions to assess understanding:
    - *How do you find the area of a rectangle?*
    - *How do you find the perimeter of a rectangle?*
    - *Is there another way to find area and perimeter?*
    - *How can you find the missing length or width when you know the area or perimeter?*

Fun and Games: Mazes: Perimeter and Area *(cont.)*

During Reading

1. Distribute the *Fun and Games: Mazes: Perimeter and Area* books to students. As a class, conduct a Fade In/Fade Out read aloud. Tell students you will start the read aloud by tapping a student's shoulder. That student will gradually increase his or her volume to a normal reading voice. As the first student reads, you will tap the shoulder of another student who will start reading, gradually increasing volume to a normal level. The first student will gradually fade out as the second student fades in. Repeat this process until the reading is complete. If you come across words that may be unfamiliar to students, pause to define the word, give an example, and give a nonexample if applicable.
    - You may choose to display the Interactiv eBook for a more digitally enhanced reading experience.
    - For **below-level learners** and **English language learners**, you may choose to play the audio recording as students follow along to serve as a model of fluent reading. This may be done in small groups or at a listening station. The recording will help struggling readers practice fluency and build comprehension.
2. Have students revisit the *Unusual Words* activity sheet from the Before Reading activity. Discuss different types of context clues, such as synonyms, antonyms, in-text definitions, and examples. Discuss other strategies such as referencing glossaries and text features. Have students complete the activity sheet by using context clues from the text to define the words. Discuss students' strategies as a class.
3. Have students complete the "Let's Explore Math" sidebars as they read the book. Or, you may choose to have them revisit the text a third time to complete the sidebars. Review student responses as a class.

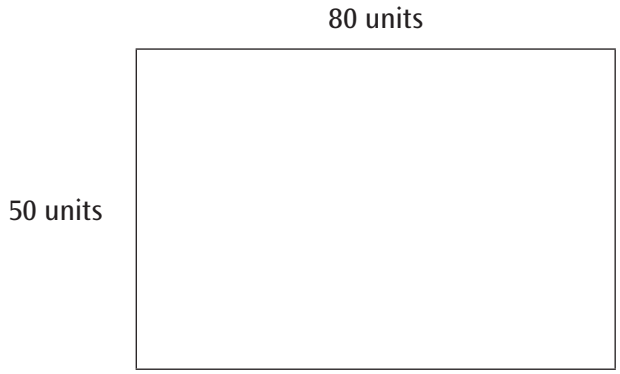
After Reading

1. Distribute the *Fun and Games: Mazes: Perimeter and Area* books to students. Have students find examples of how the author's use of context clues helped readers determine the meanings of unusual words and phrases.
2. Explain to students that they will write stories about imagined walks through a maze, using context clues to help the reader determine the meaning of a mathematical term.
3. Distribute copies of the *A-MAZE-ing Story* activity sheet (page 210) to students. Have them use their activity sheets to plan their narratives. Then, have students write their narratives on separate sheets of paper. Have students share their narratives in small groups.
    - Challenge **above-level learners** to use at least two of the words they identified on their *Unusual Words* activity sheets from the Before Reading activity in their stories.

Fun and Games: Mazes: Perimeter and Area *(cont.)*

Problem Solving

1. Display a rectangle similar to the one below.



2. Have students describe the rectangle to partners using the terms *length, width, perimeter*, and *area*.
   - Support **below-level learners** and **English language learners** with sentence frames.
     - *The length of the rectangle is* _____.
     - *The width of the rectangle is* _____.
     - *The perimeter of the rectangle is* _____ *because* _____.
     - *The area of the rectangle is* _____ *because* _____.
3. Read the Problem Solving prompt aloud from page 28 of the *Fun and Games: Mazes: Perimeter and Area* book. Distribute copies of the *Problem Solving: Maze Design* activity sheet (page 211) to students. Have students use the workspace to solve the problem.

Assessment

1. A short posttest, *Fun and Games: Mazes: Perimeter and Area Reading Quiz* (page 212), is provided to assess this lesson's reading objective.
2. A short posttest, *Fun and Games: Mazes: Perimeter and Area Mathematics Quiz* (page 213), is provided to assess this lesson's mathematics objective.
3. The Interactiv-eBook activities in the Digital Resources may also be used for assessment purposes (optional).

Name: _____ Date: _____

Unusual Words

Directions: Write five unusual words from the text. Make sure one of the words is a math word. Then, write the meanings of the words and the strategies you used to determine the meanings.

Word	Meaning	Strategy
1.		
2.		
3.		
4.		
5. Math word:		

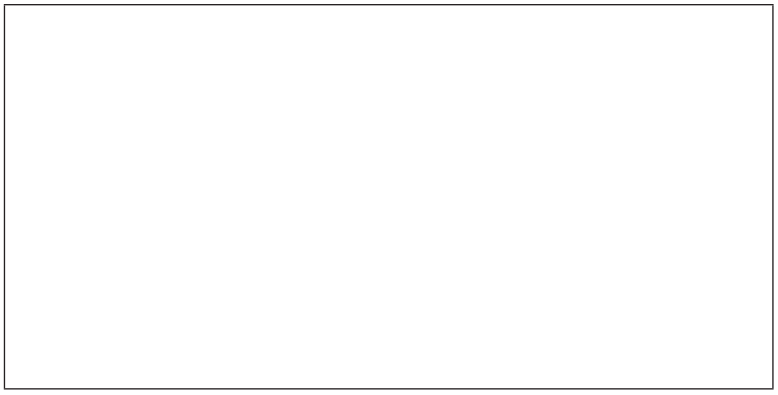
Name: _____ Date: _____

Missing Measures

Directions: Find the missing measures for the rectangles. Then, answer the questions about area and perimeter. Remember to label your answers using correct units.

1.

20 units



width = _____

perimeter = _____

area = 200 square units

2. Draw a rectangle with a length of 15 units and a width of 4 units. What is the area? Explain your thinking.

3. Draw a rectangle with a length of 9 units and a width of 2 units. What is the perimeter? Explain your thinking.

Name: _____ Date: _____

A-MAZE-ing Story

Directions: Use the chart to plan a narrative about walking through a maze. Then, write your story on a separate sheet of paper.

Characters	Setting

Problem

Sequence of Events

1.

2.

3.

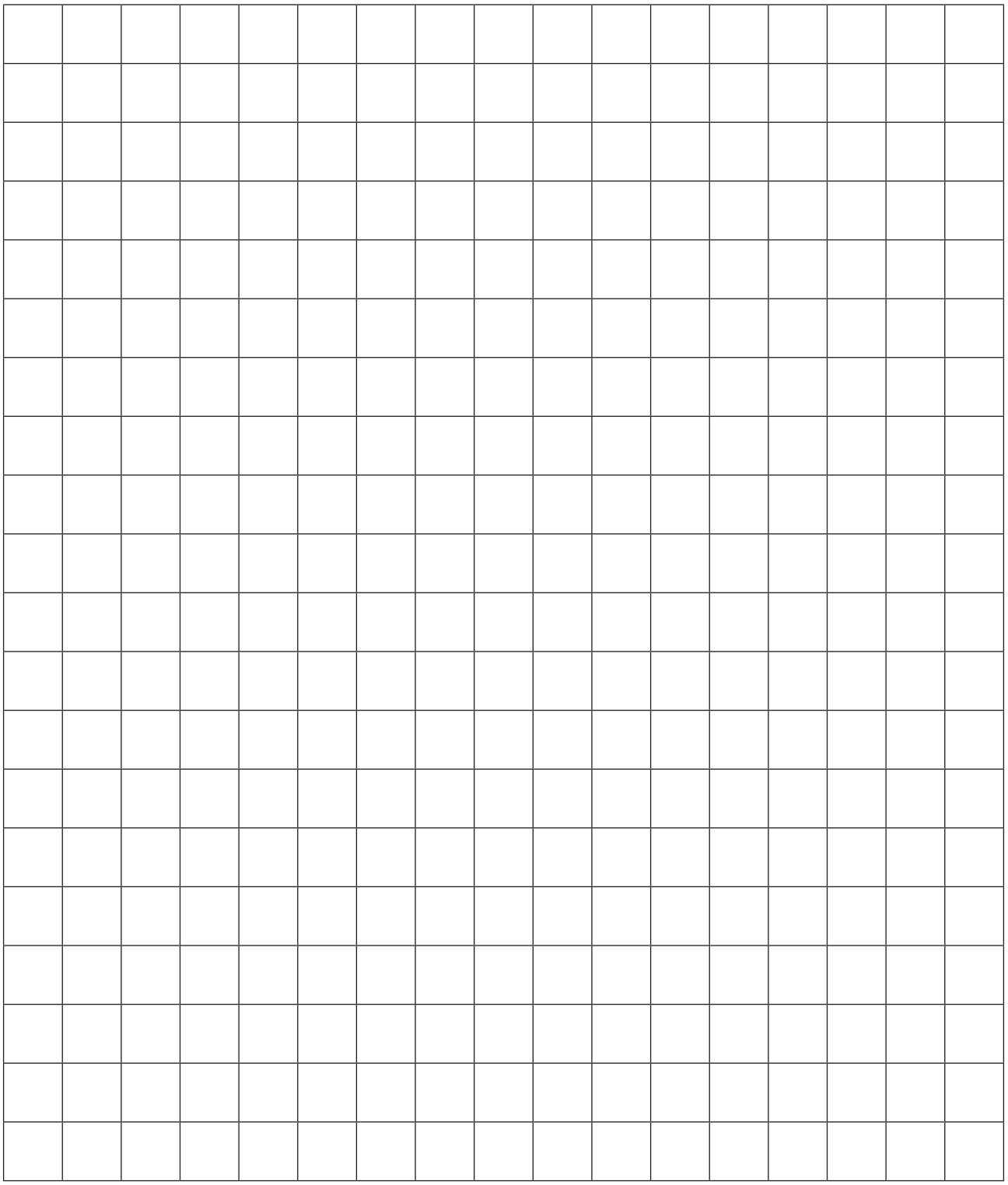
Math Word with Context Clue

Solution

Name: _____ Date: _____

Problem Solving: Maze Design

Directions: Use the workspace to plan, solve, and explain your thinking about the problems on page 28 of the book.



Name: _____ Date: _____

Fun and Games: Mazes: Perimeter and Area
Reading Quiz

Directions: Read each question. Choose the best answer. Fill in the bubble for the answer you have chosen.

1. How are labyrinths different from mazes?

- (A) Labyrinths and mazes are two words for the same thing.
- (B) Pencils must be used on labyrinths.
- (C) Labyrinths have only one path leading to the center.
- (D) There are many ways to solve labyrinths.

2. How is seeing a maze from a bird's-eye view helpful to designers?

- (A) There are no dead ends with this view.
- (B) This view shows all of the materials that will be used to build the maze.
- (C) Viewing from the side, the designer can be sure the walls are high enough.
- (D) The view from above makes the maze simpler to visualize.

3. What do quests mean in the following sentence? *Some video games rely on mazes to take players on digital quests.*

- (A) journeys
- (B) hiding places
- (C) computers
- (D) plans

4. Why do maze makers need budgets?

- (A) Budgets provide a plan for using money.
- (B) Good sites for mazes are identified in budgets.
- (C) Maze-making crews get their directions from budgets.
- (D) Budgets show drawings of mazes.

5. What does *strategic* mean in the following sentence? *Solving a maze is about staying calm and being strategic.*

- (A) fast
- (B) slow
- (C) well planned
- (D) quiet

6. Groups of winding passages that make mazes more challenging are _____.

- (A) junctions
- (B) exits
- (C) vortexes
- (D) dead ends

Name: _____ Date: _____

Fun and Games: Mazes: Perimeter and Area
Mathematics Quiz

Directions: Solve each problem to show what you know.

1. If a rectangle has an area of 24 square feet and a width of 4 feet, what is the length?

(A) 8 feet
(B) 6 feet
(C) 10 feet

2. If a rectangle has a perimeter of 40 inches and a length of 15 inches, what is the width?

(A) 5 inches
(B) 10 inches
(C) 25 inches

3. How can you use length and width to find the perimeter and area of rectangles?

_____

_____

_____

_____

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_____

_____

_____

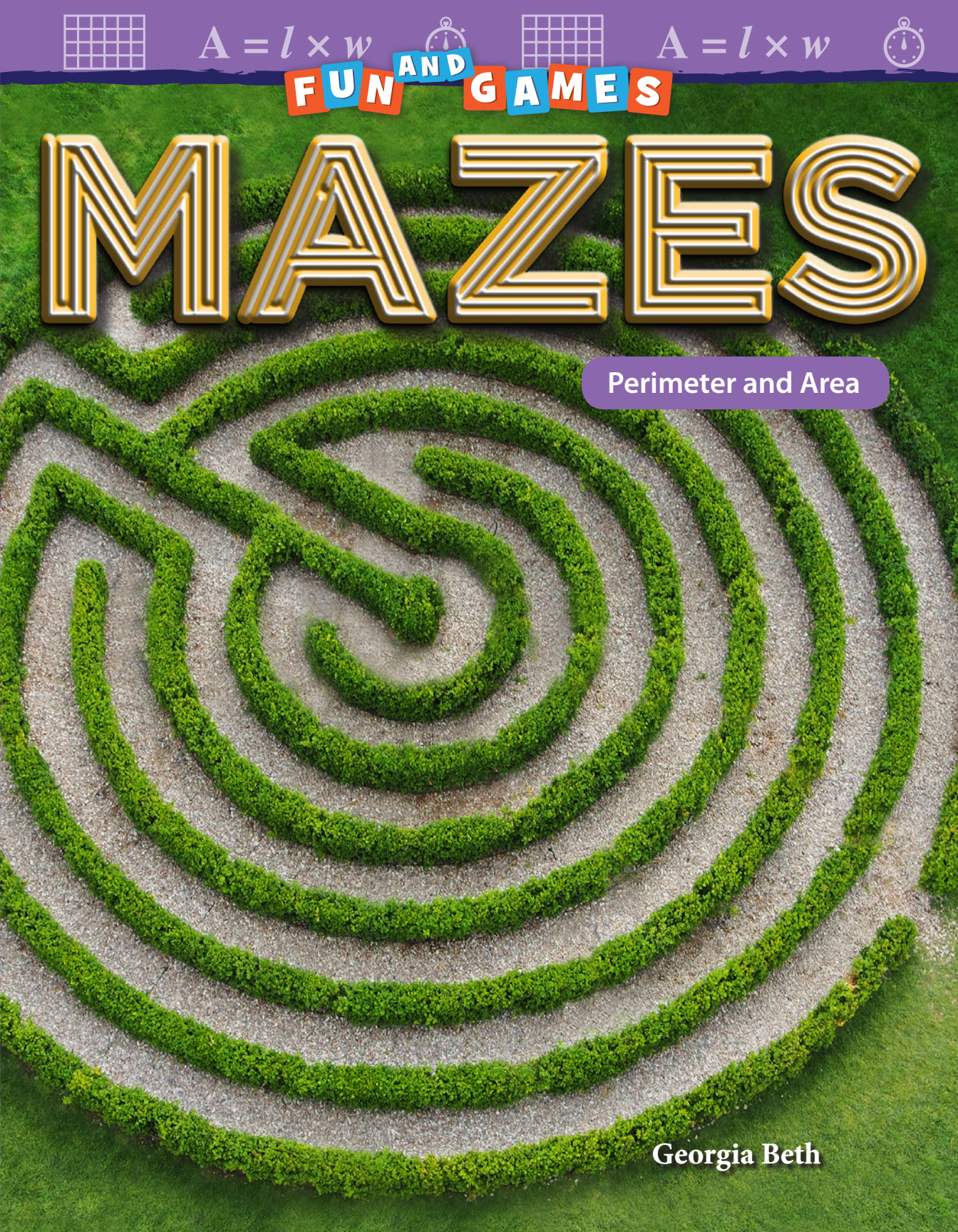
A = l × w
A = l × w
FUN AND GAMES
MAZES
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Table of Contents

Daring to Enter

The moon shines overhead. A wall of ivy beckons. A mysterious gate greets you. Do you dare to enter? Once you cross through, there is no turning back. And there is no way to know how or when you will escape. The only thing that is certain is that you are sure to return transformed.

Some people call it a **labyrinth** (LAH-buh-rinth). Others call it a **maze**. The words are often used in the same way. But, labyrinths have only one curving path leading to the center. It may take a long time to walk it, but no one gets lost in a labyrinth. Mazes, on the other hand, are filled with many passages. There are unexpected turns and dead ends. Getting lost is a very real possibility. The first mazes may have been designed to help visitors think deeply and walk slowly. But the mazes of today are more active, fast-paced adventures. Visitors are called "maze runners" for a reason!

When inside a maze, runners may feel like they are trapped inside a giant knot or spider's web. But they are really trapped inside the creative, mathematical minds of the maze makers. Maze makers build passages that twist and turn so many times that it is impossible to see where the path leads. Now, the maze makers have the runners right where they want them—totally lost!

A boy searches for the exit in a hedge maze.

Plan It and Pay for It!

Being inside a maze can be intimidating. The walls hide the exit, and escape is uncertain. But, fly high above to get a **bird's-eye view**, and mazes look much simpler. The way out is clear. This is how **designers** visualize mazes before they are built.

Every maze starts as a sketch on paper. Builders work out where to place the edges of mazes. Each line is a wall or dead end that forces people to make a decision. Left or right? Forward or backward?

Designers use their imaginations to create places that interest visitors. After planning the size and shape of a maze, materials are chosen. There are living mazes made of corn, hay, or other plants. Wood, cardboard, and stone have all been used to build mazes. There are also mazes of mirrors, which make escape really hard!

Designers use materials in creative ways. They form some mazes in interesting shapes. They make others look like they are made out of desserts, such as cake and ice cream. The materials are not real, so the pieces do not melt. But the effect is still totally sweet!

LET'S EXPLORE MATH

Many people rent inflatable mazes for parties. The maze shown is a rectangle with a length of 30 feet. Its **area** is 1,080 square feet.

1. What is the width of the maze?
2. What is the **perimeter** of the maze?

Along with size and materials, maze makers look at location. It is important to choose a **site** that is easy for people to find. And it helps when the land is flat enough for walking.

It can take anywhere from a few hours to a few years to build a maze. So, builders want to be sure the work will be worth it. A **budget** shows how much the process will cost. Expensive materials and workers' wages can add up. But, a great maze can bring in thousands of people each year. That can mean a lot of money for the owners!

After the design and budget are finalized, it is time to build the maze. Workers post flags or lay down patterns to mark a maze's location. This is the outline. It's like a map showing workers where to create passages. The crew works together to build the walls. Gary Roberson, a professor from North Carolina State University, says the process is like "connecting the dots."

LET'S EXPLORE MATH

Some companies sell patterns for corn mazes to farmers. Imagine that a farmer wants to plant a corn maze in a field. The field is a rectangle with a length of 90 meters and a width of 60 meters. The farmer hopes to use a maze pattern with an area of 6,000 square meters. Will the maze pattern fit in the field? Why or why not?

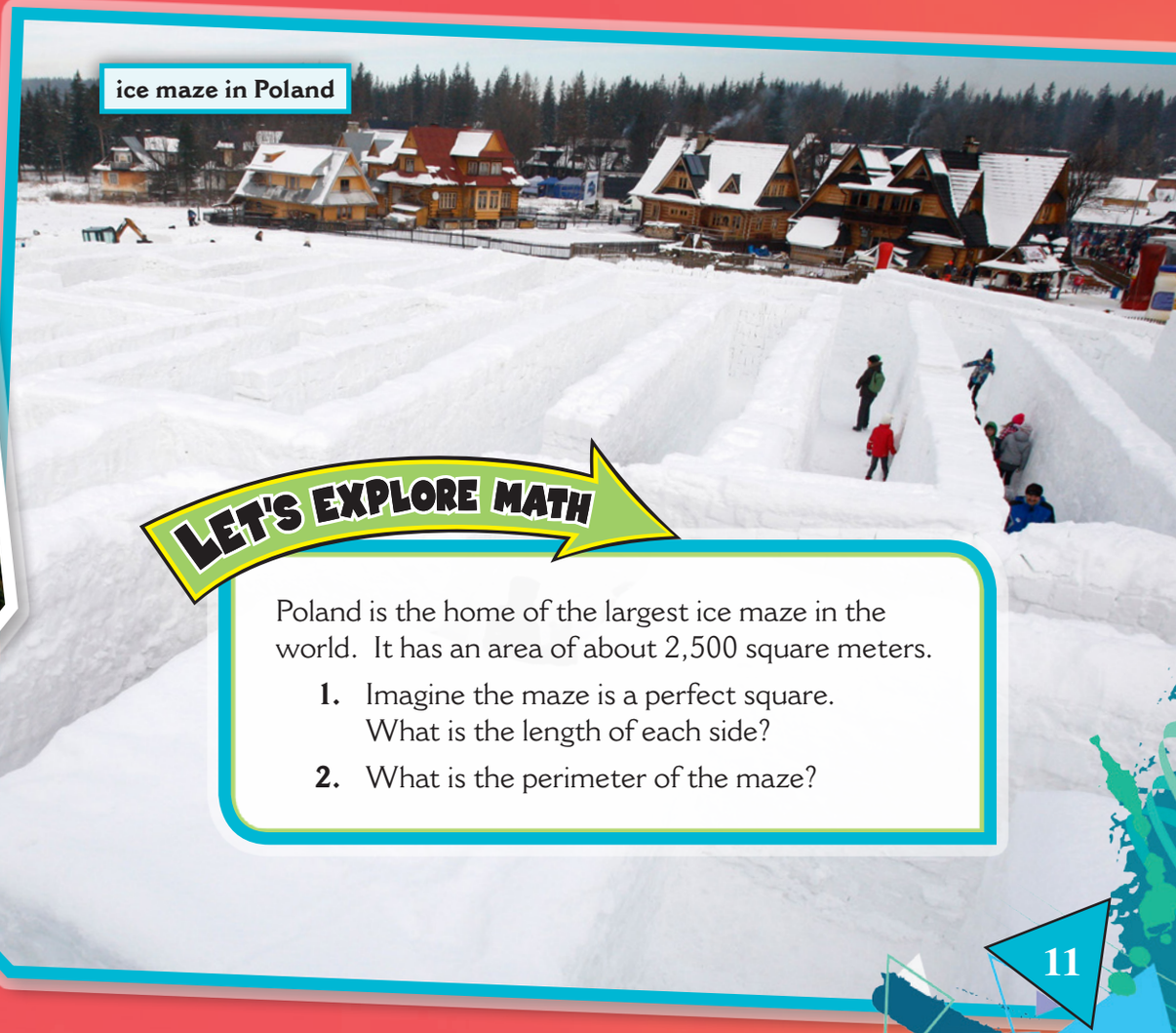
Workers build a maze out of straw bales.

bird's-eye view of a corn maze

Bigger and Better?

When maze makers decide to build a maze, they do not just want to build any maze. They want to build a better, bolder maze! They set out to create the best maze ever built. But before they begin building, it helps to measure the length and width of the maze's planned location. This lets the designers know how much space they have for the design. The bigger the space, the better it is for designers to create their masterpieces.

But for runners trying to solve a maze, bigger may not always be better. When they are lost, walking the length of a maze can feel like an eternity. Maze designers often visit the sites where they build mazes so they can walk around to get a feel for the size. That way, they know how perimeter will affect the design. They also know how it will affect the maze runners.



ice maze in Poland

Let's Explore Math

Poland is the home of the largest ice maze in the world. It has an area of about 2,500 square meters.

1. Imagine the maze is a perfect square. What is the length of each side?
2. What is the perimeter of the maze?

Still, the biggest mazes draw people from around the world. It feels good for runners to say that they have conquered these puzzles!

The Dole Plantation in Hawaii has the world's largest permanent hedge maze, made from 14,000 Hawaiian plants. The Pineapple Garden Maze covers more than 137,000 sq. ft. (12,700 sq. m). And the path is almost 2 $\frac{1}{2}$ miles (4 kilometers) long!

The Pineapple Garden Maze has fresh flowers along the path, and a sculpture of a golden pineapple lies at the center. It takes most people less than an hour to solve the maze. The fastest maze runners win a juicy prize. And, their names are recorded for all to see.

Pineapple Garden Maze

Masone Labyrinth

The world's largest bamboo maze is in Italy. The Masone Labyrinth was created on a dare. It took about 30 years to create. This maze covers about 860,000 sq. ft. (80,000 sq. m). That is about the same size as 15 football fields! A perfect square sits in the middle of a star. Hundreds of thousands of bamboo plants form the walls. The builder wanted to create a place that would fill people with wonder—done!

Filling in the Blanks

Remember that bird's-eye view? People can see the outline or perimeter of a maze by looking down at it. It is important for maze makers to know the distance around the maze. But that is not where the action is. The adventure takes place in the space between the outer walls of the maze.

Maze makers are mathematicians who see the world in square units. Seeing the world this way makes it possible for maze makers to imagine mazes everywhere they look. They might see small, simple mazes on sheets of paper. They might see large mazes in fields of corn.

corn maze in France

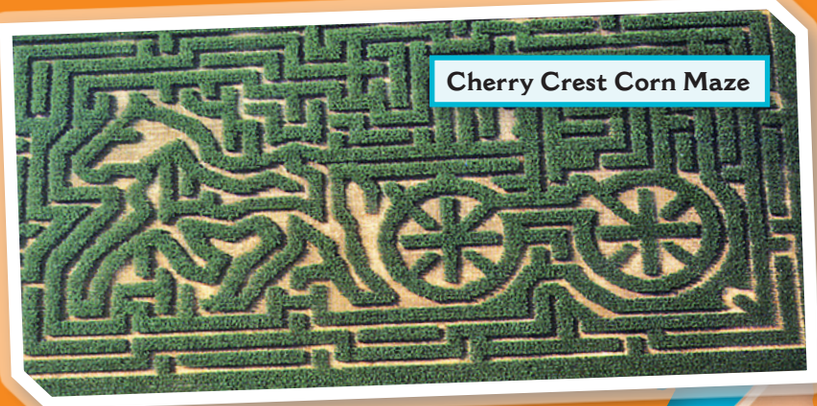
Ian Anderson and his six-story maze

Maze maker Ian Anderson sees mazes in places other people don't. He even saw a maze on the walls of a stairwell. He drew a maze in the stairwell of the Cartoon Network building. Although Anderson came across some dead ends and went in circles at times, it only took him a few hours to solve his six-story maze!

A space's area determines the possible area of a maze. Area is the amount of space covered by square units inside shapes. It is the space surrounded by perimeter. But area isn't just something that is found in squares on a sheet of graph paper. It is what designers use to bring mazes to life.

In Queens, New York, maze makers created a see-through maze made of twine. The maze was harder to solve than it looked! So, musicians and dancers were invited to perform in the center of the maze. The performances encouraged maze runners to keep going.

If a twine maze seems too easy, the Cherry Crest Corn Maze in Ronks, Pennsylvania, is sure to test even the best maze runners. First, runners are given a game board and instructions. Then, they begin winding their way to the middle. Along the way, runners have to find clues, play games, and solve puzzles to move forward. It takes most people about an hour to complete the $2\frac{1}{2}$ mi. (4 km) pathway. Two staff members wander through the maze all day to keep people from getting lost. Think you can memorize the route for next year? Think again. The designers change the maze's shape and clues every year to keep people guessing.



Cherry Crest Corn Maze

This twine maze in Queens, New York was created by artists Sam Hillmer and Laura Paris.

LET'S EXPLORE MATH

Some mazes aren't outside. The twine maze was built inside of a 50,000 square foot room. The BIG Maze was another indoor maze. This square maze measured 60 feet on each side. If there was nothing else inside of it, would the BIG Maze have fit in the room that the twine maze was in? Why or why not?

the BIG Maze in Washington, DC

Getting Lost

The word *maze* comes from an old word that means "**delirium**" (dih-LEER-ee-uhm). So, it's no wonder that mazes can cause confusion and fear. When escape seems uncertain, people may start to envision the worst. When the sun goes down, panic can really set in. Maze runners often underestimate how long it will take to escape. When it takes more than an hour, they might become anxious.

Today, people can use their phones to call for help when they think they are lost. At a corn maze in Massachusetts, a family thought they were lost and called for help. They were found about 25 ft. (8 m) from the exit!

Cool Patch Pumpkins in California has the biggest corn maze in the world. The sheriff's office gets calls every year from people who are lost in the maze and have started to panic. But, there is no real reason to worry. The owner of the maze always finds the confused maze runners. So far, the police have never had to rescue anyone from the maze!

A father leads his daughters through a corn maze.

Some maze runners like the feeling of getting lost. The Mirror Maze in London used more than its walls to disorient visitors. Curving halls, tunnels, dead ends, and staircases to nowhere added to the drama. Maze runners solved the tricky maze while seeing their reflections everywhere and finding the oval doors that led to other rooms.

The best mazes are difficult to solve. But they are not impossible. A maze with a lot of dead ends is actually one of the easiest to solve because there are fewer paths to test. If runners have to retrace their steps more often, solving the maze becomes more difficult. There is a greater chance of getting lost.

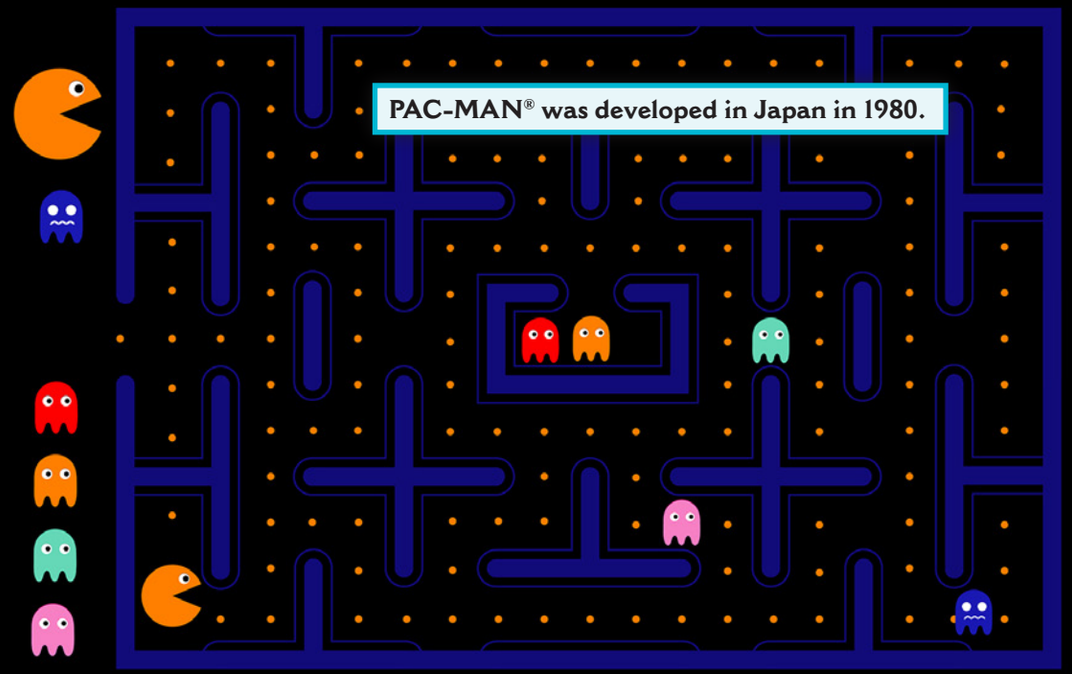
Many maze runners try to avoid getting lost by only taking right turns. Another tactic is to keep one hand on the maze's wall at all times. The trick to this method is to remember to put a hand on the wall as soon as you enter. And whatever you do, don't let go! If you take a wrong turn and then try this approach, you'll just keep going in circles!

Designer Es Devlin stands near an oval door in the Mirror Maze.

Es Devlin and her Mirror Maze

LET'S EXPLORE MATH

Imagine that the Mirror Maze is in the shape of a rectangle with an area of about 1,000 square meters. Find the dimensions of a rectangle with this area. Then, find the perimeter of your rectangle.

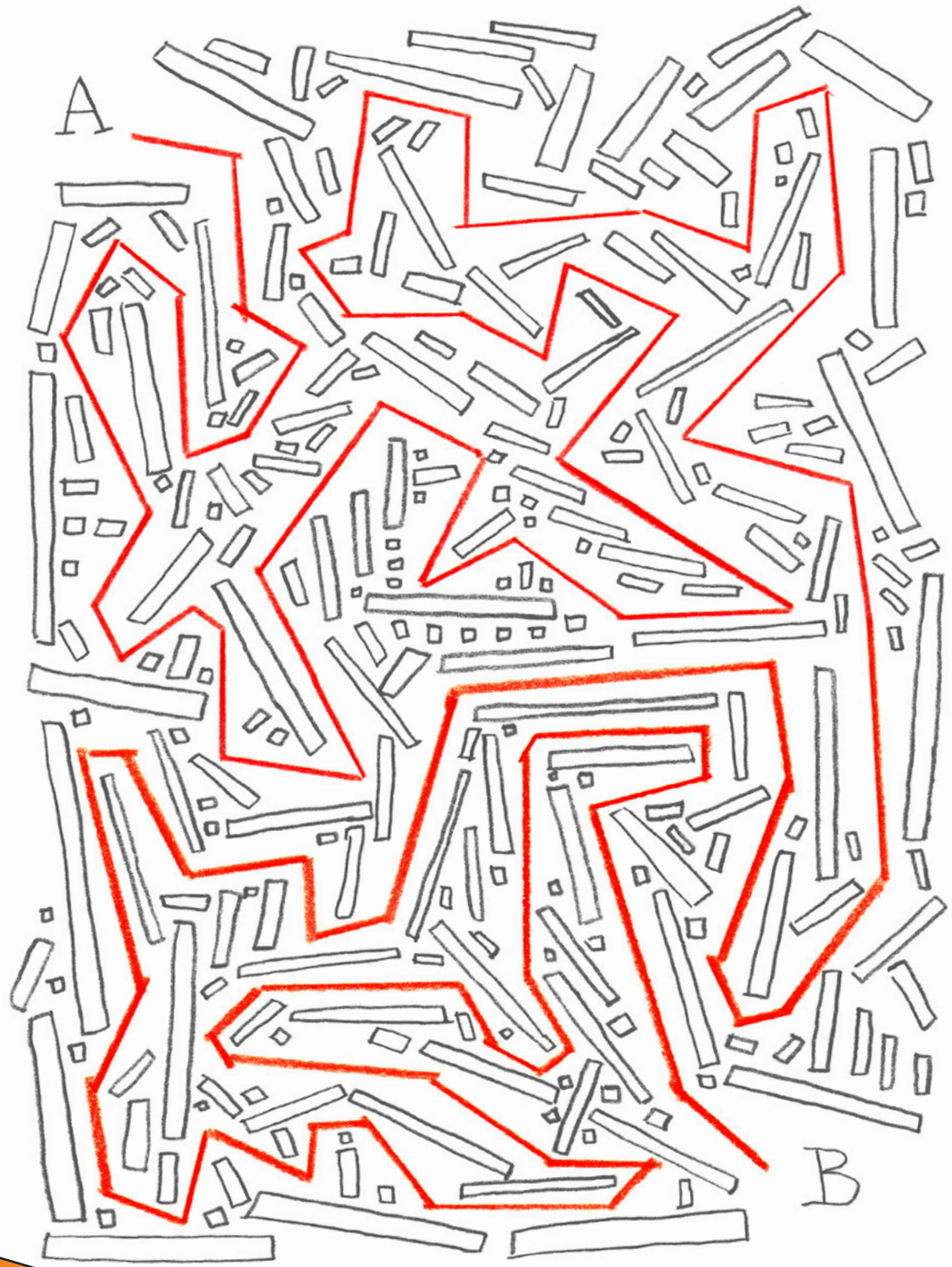


Other Maze Experiences

Some mazes are large enough to walk through. But, walking is not the only way to experience a maze. Some video games rely on mazes to take players on digital **quests**.

Of course, not all mazes use technology. But, don't count them out just yet. These mazes can still be very difficult. *Maze: Solve the World's Most Challenging Puzzle* is a 96-page picture book published in the 1980s. It is filled with riddles, puzzles, and a giant maze. There was a $10,000 prize for the first person to solve the riddle hidden within the maze. But after two years, no one had solved it! Finally, the money was split between the people who were closest to the end.

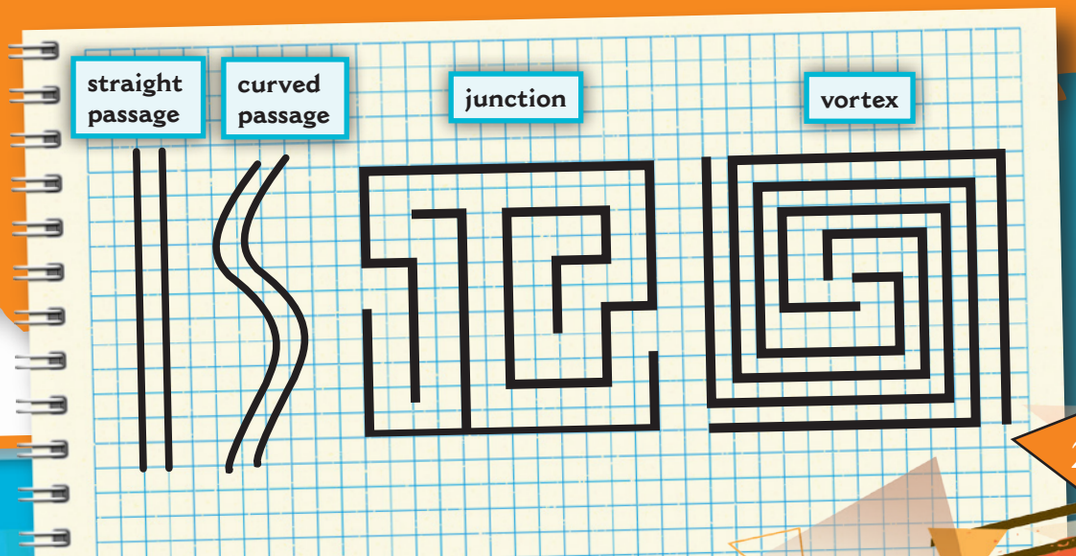
Another maze from the 1980s was released on social media in 2013. The **intricate** maze was 30 years old and drawn by hand. Photographs show layers and layers of tiny pathways. So far, no one has solved this maze. All that is known for sure is that a janitor in Japan created it. He secretly drew for seven years.



Want to have total control over the maze experience? Try your hand at making your own maze. There are websites that help people generate mazes quickly. But it might be more fun to draw one by hand. Maze makers can lose themselves in the process, just like solvers do.

Following a few guidelines can help you make a maze that intrigues people. First, grab a ruler and graph paper. Do your best to make the width of the passages the same throughout. Start by drawing straight passages. Then, try drawing curved routes. Next, practice drawing **junctions**. At these points where passages meet, you force the maze solver to make a decision. So, avoid drawing junctions that lead to obvious dead ends. Keep it surprising. Balance the turns that lead to dead ends and the passages that backtrack to earlier parts of the maze. Linking groups of winding passages, called **vortexes**, can also make a maze more difficult.

As you draw, be sure to check that the maze works. It is very easy to mistakenly create a maze with no solution. If the maze still feels too easy, you can always change exit routes to dead ends.



Looking for a Way Out

Creating a maze requires a balance of logic, math, and art. Solving a maze is about staying calm and being **strategic**. But, humans are not the only ones with those skills! Scientists use mazes to learn how animals think. Lab rats search for food and show how well they remember a path when tested again. Lizards wind their way through mazes looking for sunlight. Even simple, brainless slime molds can escape a maze. Their trail of goo marks where they have been. Then, they avoid sliding across those paths later. Just like human maze runners, these animals are always looking for a new way out.

The magic of making a maze and trying to solve one is the feeling that comes from not knowing the solution. It is the mystery that draws people in. Is this the way out? Or, is that? A feeling of accomplishment makes designers and solvers crave more.

Whether you draw a maze, look at one from above, or find your way deep inside a vortex, you may find that mazes are a-*maze*-ing!

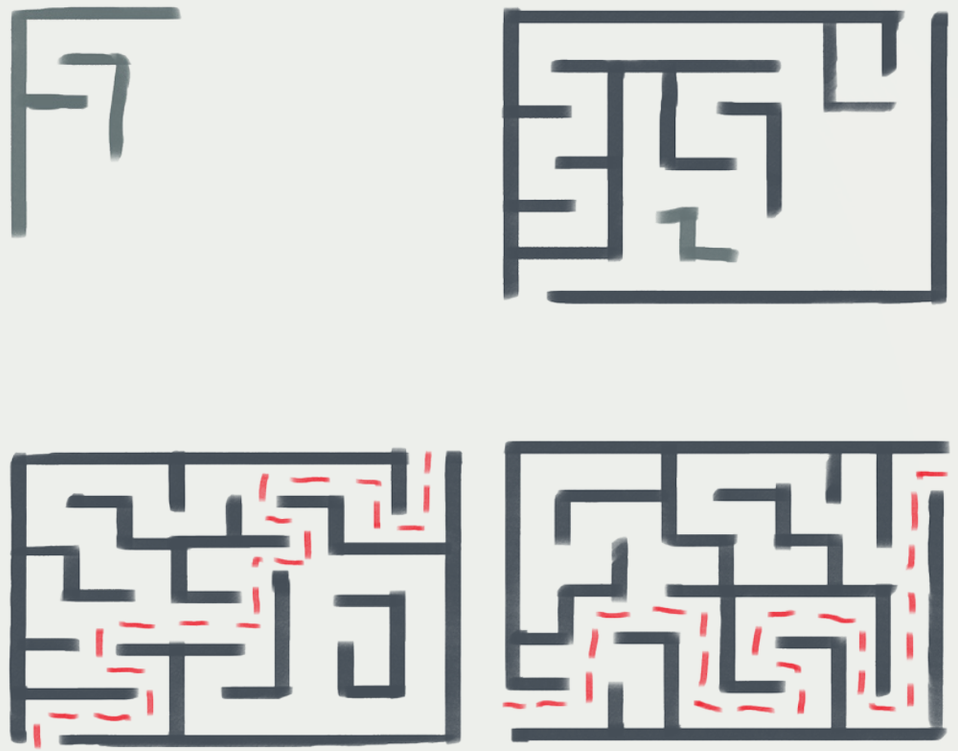
A slime mold solves a maze.

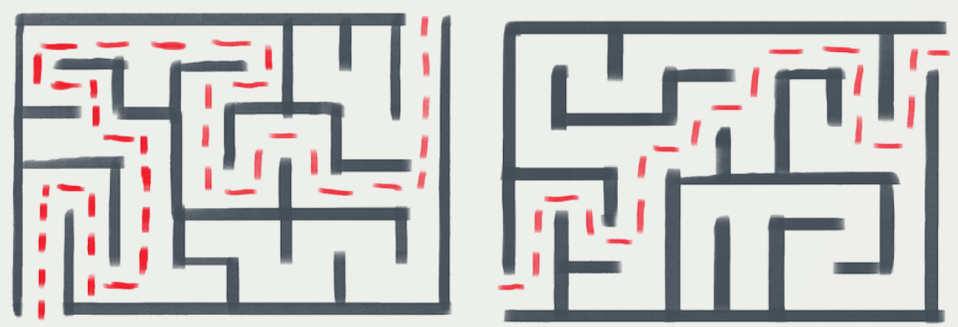
A lab rat finds its way through a maze in search of food.

Problem Solving

Now, it is your turn to design a maze! Use 1-centimeter graph paper to draw a rectangular maze. Be sure to follow the guidelines on page 25.

1. What will you call your maze? Where will your maze be located? What material will you use to build it?
2. What is the area of your maze design? What is the perimeter?
3. Draw a rectangle that has half of the area of your maze design. What is the perimeter of the rectangle? Show your thinking.
4. Draw a rectangle that has double the area of your maze design. What is the perimeter of the rectangle? Show your thinking.





Glossary

area—the amount of space covered by square units inside a two-dimensional shape

bird's-eye view—a view from above

budget—a plan for using money over a period of time

delirium—a mental state of wild excitement, happiness, and often confusion

designers—people who plan how something will look and be made

intricate—having many complex parts

junctions—places where two things come together

labyrinth—a place with a curved pathway that winds toward the center before the exit

maze—a complicated and confusing system of pathways that twist, turn, and form dead ends in surprising ways

perimeter—the distance around the outside of a shape

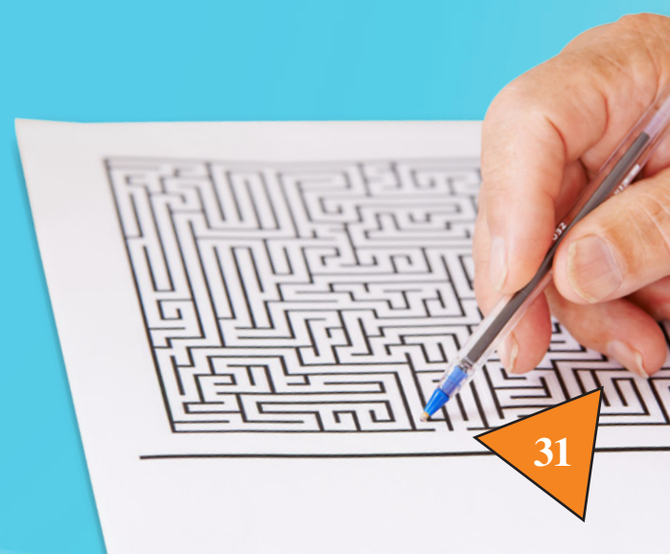
quests—journeys made in search of something

site—the location of something

strategic—relating to a careful method for achieving a particular goal

vortexes—pathways that wind around a central location

Index



Answer Key

Let's Explore Math

page 7:

1. 36 ft.
2. 132 ft.

page 9:

No; The field has an area of 5,400 sq. m, so the area of the pattern is greater than the area of the field.

page 11:

1. 50 m
2. 200 m

page 17:

Yes; The BIG Maze had an area of 3,600 sq. ft., so it had an area less than 50,000 sq. ft.

page 21:

Answers will vary, but the length and width of the rectangle must have an area of 1,000 sq. m and a perimeter accurate for the dimensions given. Example: a 40 m by 25 m rectangle has a perimeter of 130 m.

Problem Solving

1. Answers will vary, but should include a title of the maze design, a location, and materials.
2. Answers will vary, but should show the area as the number of sq. cm and the perimeter as the sum of side lengths in cm.
3. Answers will vary, but the area of the rectangle should be half of the number of sq. cm of the original maze design and the perimeter should be the sum of side lengths in cm.
4. Answers will vary, but the area of the rectangle should be double the number of sq. cm of the original maze design and the perimeter should be the sum of side lengths in cm.

Math Talk

1. How can knowing the length and width of a rectangle help you calculate its area and perimeter?
2. What is the difference between the units used to measure area and the units used to measure perimeter?
3. Find all the possible rectangles with whole number side lengths that have an area of 36 square units. How can you be sure that you have found them all?
4. Nika finds the perimeter of a rectangle by adding all four of the sides together. Miguel finds the perimeter of a rectangle by adding one length with one width, and then doubling the sum. Who is correct? Why do you think so?
5. Laura thinks that all rectangles with the same area must also have the same perimeter. Do you agree with her? Why or why not?
6. Draw a rectangle that has an area that is the same number as its perimeter.