Bluebonnet Learning™

Secondary Mathematics

EDITION 1

Geometry

Course Guide

Welcome to the Course Guide for Secondary Mathematics, Geometry

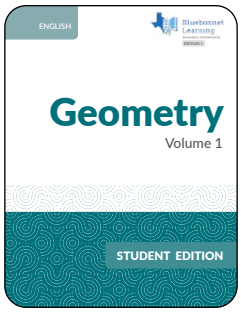
Instructional Design FM-6
Lesson Structure. FM-9
Research-Based Strategies FM-15
Thought Bubbles and Margin Notes FM-17
TEKS Mathematical Process Standards FM-18
Understanding the Problem-Solving Model. FM-21
The Problem-Solving Model Graphic Organizer FM-22
Academic Glossary. FM-23
What is Productive Struggle? FM-25
Resources for Students and Families. FM-26
Course Table of Contents FM-31

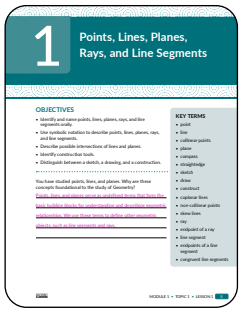
INSTRUCTIONAL DESIGN

The instructional materials help you learn math in different ways. There are two types of resources: Learning Together and Learning Individually. These resources provide various learning experiences to develop your understanding of mathematics.

Learning Together

On **Learning Together** days, you spend time engaging in active learning to build mathematical understanding and confidence in sharing ideas, listening to one another, and learning together. The Student Edition is a consumable resource that contains the materials for each lesson.





STUDENT EDITION

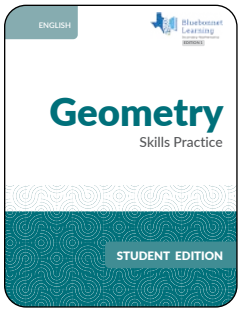
I am a record of your thinking, reasoning, and problem solving.

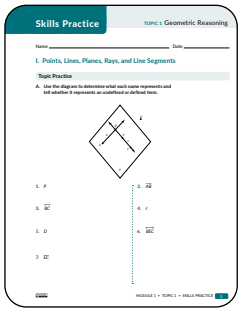
My lessons allow you to build new knowledge from prior knowledge and experiences, apply math to real-world situations, and learn together in a collaborative classroom.

My purpose is to create mathematical thinkers who are active learners that participate in class.

Learning Individually

On **Learning Individually** days, Skills Practice offers opportunities to engage with skills, concepts, and applications that you learn in each lesson. It also provides opportunities for interleaved practice, which encourages you to flexibly move between individual skills, enhancing connections between concepts to promote long-term learning. This resource will help you build proficiency in specific skills based on your individual academic needs as indicated by monitoring your progress throughout the course.





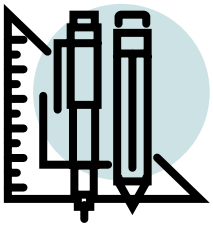
SKILLS PRACTICE

I am targeted practice of each lesson's skills, mathematical concepts, and applications for each topic in the student edition.

My purpose is to provide problem sets for additional practice, enrichment, and extension.

INSTRUCTIONAL DESIGN

The instructional materials intentionally emphasize active learning and sense-making. Deep questions ensure you thoroughly understand the mathematical concepts. The instructional materials guide you to connect related ideas holistically, supporting the integration of your evolving mathematical understanding and developing proficiency with mathematical processes.



Intentional Mathematics Design

Mathematical Coherence: The path through the mathematics develops logically, building understanding by linking ideas within and across grades so you can learn concepts more deeply and apply what you've learned to more complex problems.

TEKS Mathematical Process Standards: The instructional materials support your development of the TEKS mathematical process standards. They encourage you to experiment, think creatively, and test various strategies. These mathematical processes empower you to persevere when presented with complex real-world problems.

Multiple Representations: The instructional materials connect multiple representations of mathematical concepts. Lessons present content visually, algebraically, numerically, and verbally.

Transfer: The instructional materials focus on developing transfer. Doing A and moving on isn't the goal; being able to do A and then do B, C, and D, transferring what you know from A, is the goal.

What principles guide the design and organization of the instructional materials?

Active Learning: Studies show that learning becomes more robust as instruction moves from entirely passive to fully interactive (Chi, 2009). Classroom activities require active learning as students engage by problem solving, explaining and justifying reasoning, classifying, investigate, and analyze peer work.

Discourse Through Collaborative Learning: Collaborative problem solving encourages an interactive instructional model, and we have looked to research to provide practical guidance for making collaboration work. The collaborative activities intentionally promote active dialogue centered on structured activities.

Personalized Learning: Research has proven that problems that capture your interests are more likely to be taken seriously (Baker et. al, 2009). In each lesson, learning is linked to prior knowledge and experiences, creating valuable and authentic opportunities for you to build new understanding on the firm foundation of what you already know. You move from concrete representations and an intuitive understanding of the world to more abstract representations and procedures.

Focus on Problem Solving: Solving problems is an essential life skill that you need to develop. The problem-solving model provides a structure to support you as you analyze and solve problems. It is a strategy you can continue to use as you solve problems in everyday life.

1 Constructing a Coordinate Plane

1 OBJECTIVES

- Construct a perpendicular line segment and bisector using paper folding and using a compass and straightedge.
- Use construction tools to duplicate a line segment and construct a square.
- Use constructions and rigid motions to create a coordinate plane.
- Identify rigid motions that can be used to create shapes on a coordinate plane.
- Identify the coordinates of vertices of shapes on a coordinate plane orally and in writing.

3 KEY TERMS

- arc
- midpoint
- segment bisector
- perpendicular bisector
- transformation
- rigid motion

2

You have recalled and investigated two-dimensional shapes on a plane. How can you construct a coordinate plane to help you analyze geometric objects?

LESSON STRUCTURE

1 Objectives

Objectives are stated for each lesson to help you take ownership of the objectives.

2 Essential Question

Each lesson begins with a statement connecting what you have learned with a question to ponder.

Return to this question at the end of this lesson to gauge your understanding.

3 Key Terms

The mathematical terms for each lesson are identified to help you connect your everyday and mathematical language.

4 Getting Started

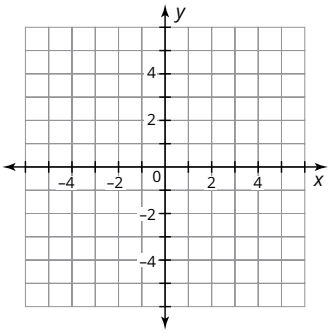
Each lesson begins with a Getting Started. When working on the Getting Started, use what you know about the world, what you have learned previously, or your intuition. The goal is just to get you thinking and ready for what's to come.

4 Getting Started

Constructing a Perpendicular Line Using Patty Paper

A compass is a tool used to create arcs and circles.
A straightedge is a ruler with no numbers.
An **arc** consists of two points on a circle and the curved line that connects the two points.

Remember, when you construct geometric figures, you create exact figures without measurements, using paper folding or a *compass* and a *straightedge*.



A coordinate plane is composed of two intersecting lines—the *x*-axis and *y*-axis.

You can also think of a coordinate plane as being composed of squares. Each square is 1 unit long and 1 unit wide, with the definition of "1 unit" up to the person who constructs the coordinate plane.

In this lesson, you will consider how a coordinate plane is constructed using squares. To construct a square, you will first need to be able to construct perpendicular lines.

Let's start by experimenting with patty paper to construct a line perpendicular to a given line segment.

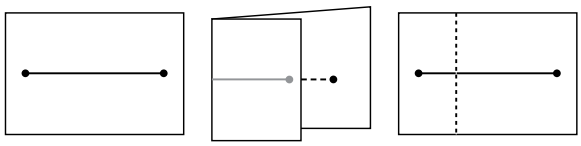
You can represent a plane with a piece of paper since paper is a flat surface. Remember a geometric plane extends infinitely in all directions, unlike a physical piece of paper which has boundaries.

WORKED EXAMPLE

Draw a line segment on a piece of patty paper.

Fold the line segment so that it lies on top of itself.

Open the patty paper. The crease represents a line perpendicular to the given line segment.



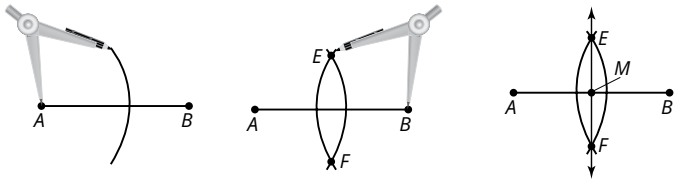
ACTIVITY 1.1

Constructing a Perpendicular Line Using a Compass and a Straightedge

You can also construct segment bisectors using a compass and straightedge. To do this construction, you will draw arcs, making use of the fact that all the radii of a circle have an equal length.

WORKED EXAMPLE

You can construct the segment bisector of $\overline{AB}$.



Construct an Arc

Open the radius of the compass to more than half the length of $\overline{AB}$. Use endpoint A as the center and construct an arc.

Construct Another Arc

Keep the compass radius and use point B as the center as you construct an arc. Label the points formed by the intersection of the arcs point E and point F.

Construct a Line

Connect points E and F. Line segment EF is the segment bisector of $\overline{AB}$. The point M represents the midpoint of $\overline{AB}$.

Line EF bisects $\overline{AB}$. Point M is the midpoint of $\overline{AB}$.

A **perpendicular bisector** is a line, line segment, or ray that bisects a line segment and is also perpendicular to the line segment.

Though the statement "all perpendicular bisectors are segment bisectors, but not all segment bisectors are perpendicular bisectors is true," the construction for a segment bisector is the same.

5 Activities

You are going to build a deep understanding of mathematics through a variety of activities in an environment where collaboration and conversations are important and expected.

You will learn how to solve new problems, but you will also learn why those strategies work and how they are connected to other strategies you already know.

Remember:

- It's not just about getting the answer. The process is important.
- Making mistakes is a critical part of learning, so take risks.
- There is often more than one way to solve a problem.

Activities may include real-world problems, sorting activities, Worked Examples, or analyzing sample student work.

Be prepared to share your solutions and methods with your classmates.

6 Talk the Talk

Talk the Talk gives you an opportunity to reflect on the main ideas of the lesson.

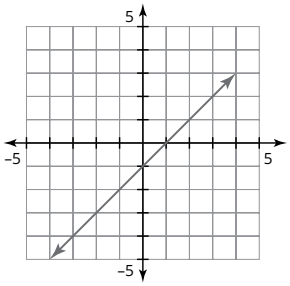
- Be honest with yourself.
- Ask questions to clarify anything you don't understand.
- Show what you know!

Don't forget to revisit the question posed on the lesson opening page to gauge your understanding.

Talk the Talk 6

Walking on a Thin Line

Consider the line shown on the coordinate plane.



1. Suppose the line was constructed using rigid motions, starting with any line segment constructed in one square. Describe one possible sequence of translations that could produce the line.

2. How is the sequence of translations related to the slope of the line?

3. What is the equation for the line in slope-intercept form?

Remember . . .

The equation for a line can be written in in slope-intercept form, $y = mx + b$, where m represents the slope of the line, and b represents the y-intercept.

Lesson 1 Assignment

Write 7

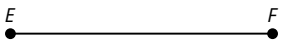
Describe the similarities and differences of a segment bisector and a perpendicular bisector.

Remember 8

A perpendicular bisector is a line, line segment, or ray that bisects a line segment and is also perpendicular to the line segment.
A translation "slides" a figure up, down, left, or right. A reflection "flips" a figure across a line. A rotation "spins" a figure about a point.

Practice 9

1. Locate the midpoint of the line segment using construction tools and label it point *M*. Then, explain how you know that point *M* is the midpoint of $\overline{EF}$.



ASSIGNMENT

7 Write
Reflect on your work and clarify your thinking.

8 Remember
Take note of the key concepts from the lesson.

9 Practice
Use the concepts learned in the lesson to solve problems.

Lesson 1 Assignment

ASSIGNMENT

10 Prepare

Get ready for the next lesson.

Prepare 10

Determine the reciprocal of each value.

1. 3

2. -10

3. $\frac{1}{5}$

4. $-c$

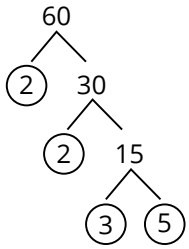
5. $\frac{a}{b}, b \neq 0$

Research-Based Strategies

WORKED EXAMPLE

You can use prime factorization to rewrite radicals in simplest radical form.

Rewrite $\sqrt{60}$ in simplest radical form.



Write the prime factorization of 60.

$60 = 2^2 \cdot 3 \cdot 5$

Extract the perfect squares

$\sqrt{60} = 2 \cdot \sqrt{3 \cdot 5}$

Rewrite the radicand.

$\sqrt{60} = 2 \cdot \sqrt{15}$

Ask Yourself . . .

- What is the main idea?
- How would this work if I changed the numbers?
- Have I used these strategies before?

WORKED EXAMPLE

When you see a Worked Example:

- Take your time to read through it.
- Question your own understanding.
- Think about the connections between steps.

THUMBS UP

When you see a Thumbs Up icon:

- Take your time to read through the correct solution.
- Think about the connections between steps.

THUMBS DOWN

When you see a Thumbs Down icon:

- Take your time to read through the incorrect solution.
- Think about what error was made.

WHO'S CORRECT?

When you see a Who's Correct icon:

- Take your time to read through the situation.
- Question the strategy or reason given.
- Determine whether the work is correct or incorrect.

Sebastian and Mason described the probability of a heads up result for the first coin or a tails up result for the second coin.

Sebastian

I circled 2 outcomes and drew a rectangle around 2 outcomes, and there are 4 possible outcomes. So, the probability of flipping a heads on the first coin or a tails on the second is $\frac{2+2}{4} = \frac{4}{4} = 1$.

Mason

I marked 4 outcomes, and there are 4 possible outcomes. But, I marked 1 of the outcomes twice. So, I have to subtract one of the outcomes and the probability of a heads up result for the first coin or a tails up result for the second coin is $\frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} - \frac{1}{4} = \frac{3}{4}$.

Ask Yourself . . .

- Why is this method correct?
- Have I used this method before?

Ask Yourself . . .

- Where is the error?
- Why is it an error?
- How can I correct it?

14. Calculate the distance between the points $(-1, -2)$ and $(-3, -7)$. Notice the similarity between these points and and Question 13, part (a).

    Samuel says that the solution must be the opposite of the solution of part (a). Harper disagrees and says that the solution will be the same as the solution of part (a). Who is correct? Explain your reasoning and state the correct solution.

Ask Yourself . . .

- Does the reasoning make sense?
- If the reasoning makes sense, what is the justification?
- If the reasoning does not make sense, what error was made?

Thought Bubbles and Margin Notes

Look for these margin notes as you journey through this course. Sometimes, they will remind you about things you already learned. Sometimes, they will ask you questions to help you think about different strategies. Sometimes, they will share fun facts. They are here to help and guide your learning.

Ask Yourself . . .
Can distance be negative?

Remember . . .
When you sketch a geometric figure, you create the figure without tools. Accuracy is not important. When you draw geometric figures, you can use tools such as rulers, protractors, or a coordinate plane to draw exact lengths and areas.

Think About . . .
The endpoint is where the ray *begins?* Why isn't it called the "begin-point" instead?

TEKS Mathematical Process Standards

Effective communication and collaboration are essential skills of a successful learner. With practice, you can develop the habits of mind of a productive mathematical thinker. The "I Can" expectations listed below align with the TEKS mathematical process standards and encourage students to develop their mathematical learning and understanding.

Apply mathematics to problems arising in everyday life, society, and the workplace.

I CAN:

- use the mathematics that I learn to solve real-world problems.
- interpret mathematical results in the contexts of a variety of problem situations.

Use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying a solution, and evaluating the problem solving process and reasonableness of the solution.

I CAN:

- explain what a problem "means" in my own words.
- create a plan and change it if necessary.
- ask useful questions in an attempt to understand the problem.
- explain my reasoning and defend my solution.
- reflect on whether my results make sense.

Select tools, including real objects, manipulatives, paper and pencil, and technology as appropriate; and techniques including mental math, estimation, and number sense as appropriate, to solve problems.

I CAN:

- use a variety of different tools that I have to solve problems.
- recognize when a tool that I have to solve problems might be helpful and when it has limitations.
- look for efficient methods to solve problems.
- estimate before I begin calculations to inform my reasoning.

Communicate mathematical ideas, reasoning, and their implications using multiple representations including symbols, diagrams, graphs, and language, as appropriate.

I CAN:

- communicate and defend my own mathematical understanding using examples, models, or diagrams.
- use appropriate mathematical vocabulary in communicating mathematical ideas.
- make generalizations based on results.
- apply mathematical ideas to solve problems.
- interpret my results in terms of various problem situations.

Create and use representations to organize, record, and communicate mathematical ideas.

I CAN:

- consider the units of measure involved in a problem.
- label diagrams and figures appropriately to clarify the meaning of different representations.
- create an understandable representation of a problem situation.

Analyze mathematical relationships to connect and communicate mathematical ideas.

I CAN:

- identify important relationships in a problem situation.
- use what I know to solve new problems.
- analyze and organize information.
- look closely to identify patterns or structure.
- look for general methods and more efficient ways to solve problems.

Display, explain, and justify mathematical ideas and arguments using precise mathematical language in written or oral communication.

I CAN:

- work carefully and check my work.
- distinguish correct reasoning from reasoning that is flawed.
- use appropriate mathematical vocabulary when I talk with my classmates, my teacher, and others.
- specify the appropriate units of measure when I explain my reasoning.
- calculate accurately and communicate precisely to others.

Understanding the Problem-Solving Model

Productive mathematical thinkers are problem solvers. These instructional materials include a problem-solving model to help you develop proficiency with the TEKS mathematical process standards. An opportunity to use the problem-solving model is present every time you see the problem-solving model icon.

The problem-solving model represents a strategy you can use to make sense of problems you must solve. The model provides questions you can use to guide your thinking and the graphic organizer provides a place for you to show and organizer your work.

Using the Problem-Solving Model

Notice | Wonder

Understand the situation by asking these questions.

- What do I notice?
- What do I wonder?
- How do I analyze the given information to identify what is important?
- Do I have enough information to formulate a plan and determine a solution?

Organize | Mathematize

Devise a plan for your mathematical approach by asking these questions.

- What mathematical relationships exist between this problem and similar problems I have solved?
- What plan or strategy can I use to solve this problem?
- How can I efficiently solve this problem?
- How can I organize, record, and communicate my mathematics?

Predict | Analyze

Carry out your plan to determine a solution. Then, ask yourself the following questions.

- Did I display my work using multiple representations?
- Did I explain my reasoning in terms of the problem situation?
- Did I communicate the strategy used to determine the solution?
- Did I justify my mathematical argument clearly using precise mathematical language?
- Can I use my mathematical reasoning to make any predictions?

Test | Interpret

Look back at your work and ask these questions.

- Does my solution clearly and completely answer the original question/problem?
- Is my solution reasonable?
- Does my solution make sense in terms of the problem situation?
- Can I solve the problem using a different strategy? Would another strategy be more efficient?
- Can I justify my solution?

Report

As you share your mathematical reasoning with others, ask these questions.

- Did you use multiple representations to represent your mathematics?
- Did you justify your mathematical reasoning?
- Can others understand my process and solution?

The Problem-Solving Model Graphic Organizer

Understand the Problem

Devise a Plan

Carry Out the Plan

Look Back

Report

Academic Glossary

Knowing what these terms mean and using them will help you demonstrate proficiency with the TEKS mathematical process standards as you think, reason, and communicate your ideas.

Analyze

Definition

Study or look closely for patterns. Analyzing can involve examining or breaking a concept down into smaller parts to gain a better understanding of it.

Ask Yourself

- Do I see any patterns?
- Have I seen something like this before?
- What happens if the shape, representation, or numbers change?

- Examine
- Evaluate
- Determine
- Observe
- Consider
- Investigate
- What do you notice?
- What do you think?
- Sort and match

Explain Your Reasoning

Definition

Give details or describe how to determine an answer or solution. Explaining your reasoning helps justify conclusions.

Ask Yourself

- How should I organize my thoughts?
- Is my explanation logical?
- Does my reasoning make sense?
- How can I justify my answer to others?

- Show your work
- Explain your calculation
- Justify
- Why or why not?

- Show
- Sketch
- Draw
- Create
- Plot
- Graph
- Write an equation
- Complete the table

Represent

Definition

Display information in various ways. Representing mathematics can be done using words, tables, graphs, or symbols.

Ask Yourself

- How should I organize my thoughts?
- How do I use this model to show a concept or idea?
- What does this representation tell me?
- Is my representation accurate?

- Predict
- Approximate
- Expect
- About how much?

Estimate

Definition

Make an educated guess based on the analysis of given data. Estimating first helps inform reasoning.

Ask Yourself

- Does my reasoning make sense?
- Is my solution close to my estimation?

- Demonstrate
- Label
- Display
- Compare
- Determine
- Define
- What are the advantages?
- What are the disadvantages?
- What is similar?
- What is different?

Describe

Definition

Represent or give an account of in words. Describing communicates mathematical ideas to others.

Ask Yourself

- How should I organize my thoughts?
- Is my explanation logical?
- Did I consider the context of the situation?
- Does my reasoning make sense?

What is Productive Struggle?

Imagine you are trying to beat a game or solve a puzzle. At some point, you are not sure what to do next. You don't give up; you keep trying repeatedly until you accomplish your goal. You call this process *productive struggle*. Productive struggle is when you choose to persist, think creatively, and try various strategies to accomplish your goal. Productive struggle supports you as you develop characteristics and habits that you will use in everyday life.

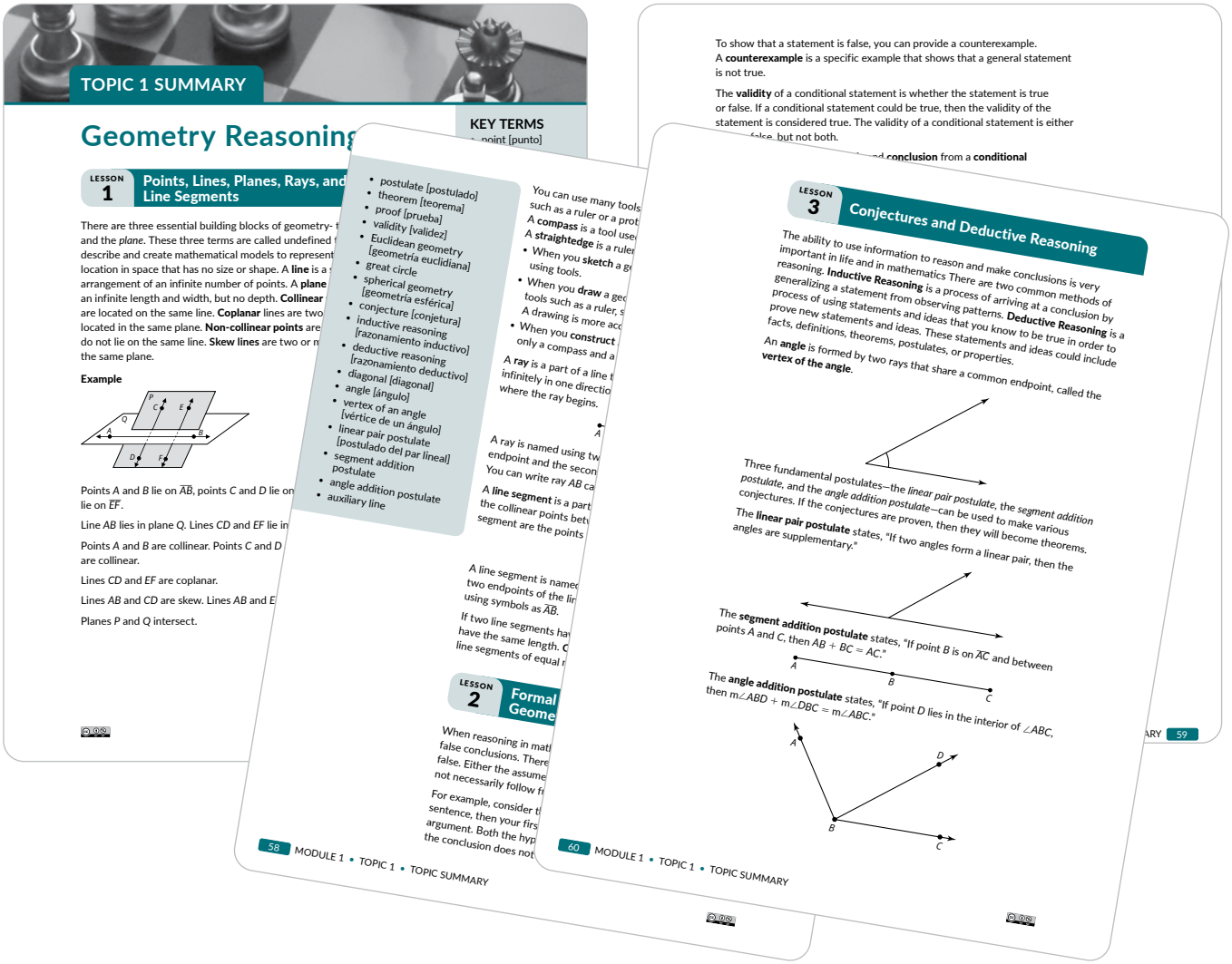
Things to do:	Things not to do:
• Persevere. • Think creatively. • Try different strategies. • Look for connections to other questions or ideas. • Ask questions that help you understand the problem. • Help your classmates without telling them the answers.	• Get discouraged. • Stop after trying your first attempt. • Focus on the final answer. • Think you have to make sense of the problem on your own.

This course will challenge you by providing you with opportunities to solve problems that apply the mathematics you know to the real-world. As you work through these problems, your first approach may not work. This is okay, even when your initial strategy does not work, you are learning. In addition, you will discover multiple ways to solve a problem. Looking at various strategies will help you evaluate the problem-solving process and identify an efficient approach. As you persist in problem-solving, you will better understand the math.

Resources for Students and Families

Topic Summary

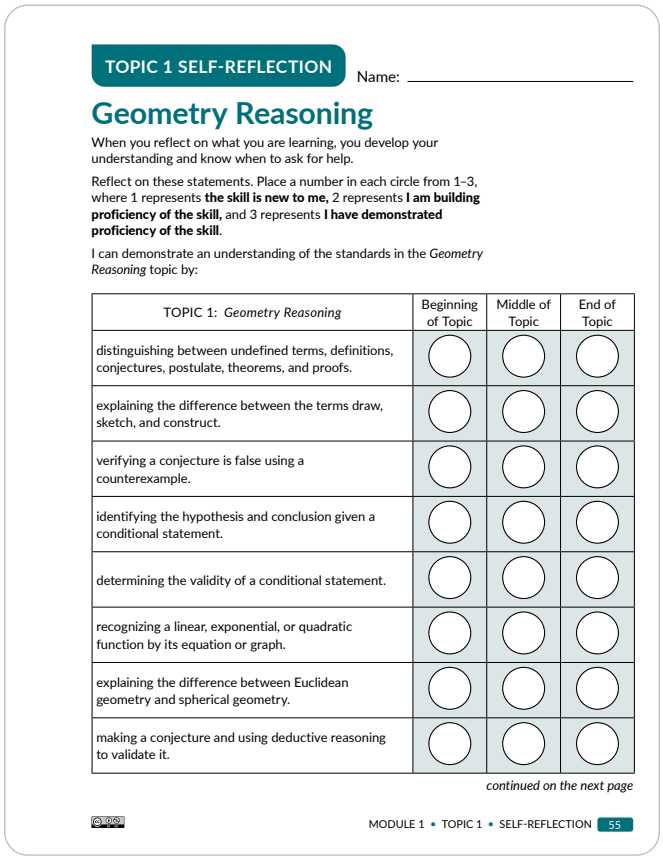
Each topic includes a Topic Summary. The Topic Summary contains a list of all key terms addressed in the topic and a summary of each lesson, including worked examples and key term definitions. Use the Topic Summary to review each lesson's major concepts and strategies as you complete assignments and/or share your learning outside of class.



Topic Self-Reflection

The Topic Self-Reflection, provided at the end of each topic, empowers you to develop confidence in your mathematical understanding and monitor your own learning processes. Taking the time for self-reflection helps you identity your strengths and where you want to focus efforts to improve.

Use the Topic Self-Reflection throughout the topic to monitor your progress toward the mathematical goals for the topic.



TOPIC 1 SELF-REFLECTION Name: _____

Geometry Reasoning

When you reflect on what you are learning, you develop your understanding and know when to ask for help.

Reflect on these statements. Place a number in each circle from 1–3, where 1 represents **the skill is new to me,** 2 represents **I am building proficiency of the skill,** and 3 represents **I have demonstrated proficiency of the skill**.

I can demonstrate an understanding of the standards in the *Geometry Reasoning* topic by:

TOPIC 1: *Geometry Reasoning*	Beginning of Topic	Middle of Topic	End of Topic
distinguishing between undefined terms, definitions, conjectures, postulate, theorems, and proofs.	○	○	○
explaining the difference between the terms draw, sketch, and construct.	○	○	○
verifying a conjecture is false using a counterexample.	○	○	○
identifying the hypothesis and conclusion given a conditional statement.	○	○	○
determining the validity of a conditional statement.	○	○	○
recognizing a linear, exponential, or quadratic function by its equation or graph.	○	○	○
explaining the difference between Euclidean geometry and spherical geometry.	○	○	○
making a conjecture and using deductive reasoning to validate it.	○	○	○

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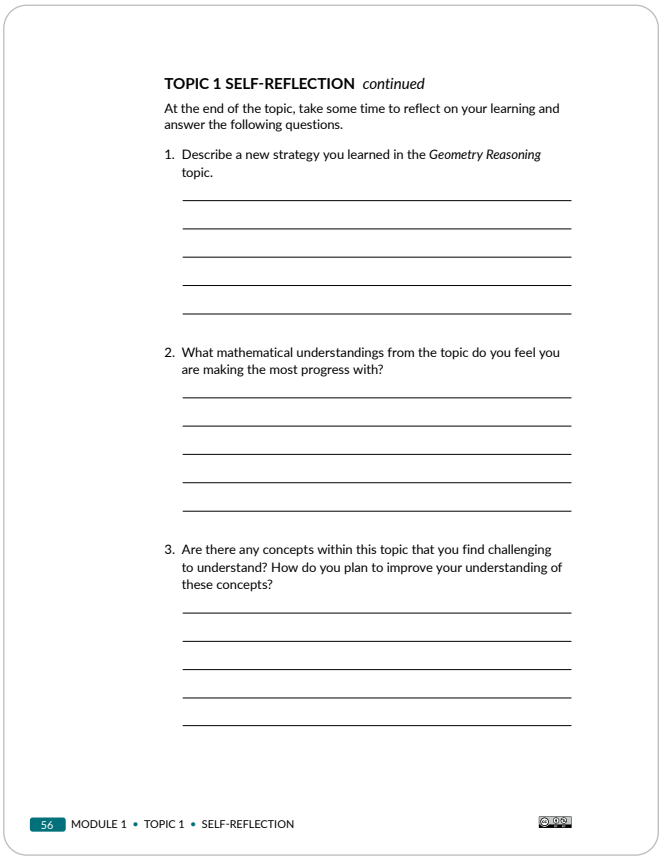


TOPIC 1 SELF-REFLECTION *continued*

At the end of the topic, take some time to reflect on your learning and answer the following questions.

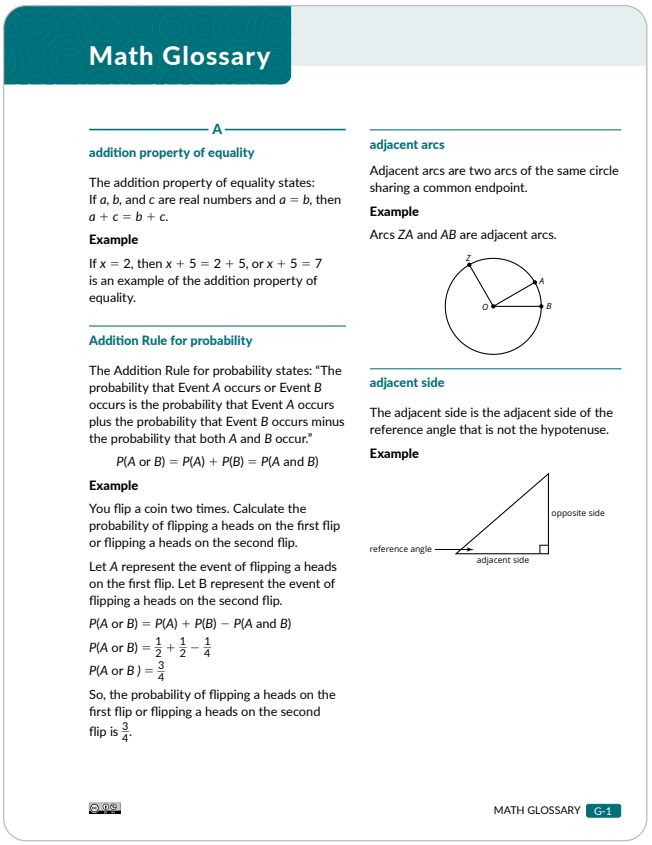
1. Describe a new strategy you learned in the *Geometry Reasoning* topic.

2. What mathematical understandings from the topic do you feel you are making the most progress with?

3. Are there any concepts within this topic that you find challenging to understand? How do you plan to improve your understanding of these concepts?

Math Glossary

A course-specific Math Glossary is available to utilize and reference while you are learning. Use the glossary to locate definitions and examples of math key terms.



Math Glossary

A

addition property of equality

The addition property of equality states: If a, b, and c are real numbers and $a = b$, then $a + c = b + c$.

Example

If $x = 2$, then $x + 5 = 2 + 5$, or $x + 5 = 7$ is an example of the addition property of equality.

Addition Rule for probability

The Addition Rule for probability states: "The probability that Event A occurs or Event B occurs is the probability that Event A occurs plus the probability that Event B occurs minus the probability that both A and B occur."

$$P(A \text{ or } B) = P(A) + P(B) = P(A \text{ and } B)$$

Example

You flip a coin two times. Calculate the probability of flipping a heads on the first flip or flipping a heads on the second flip.

Let A represent the event of flipping a heads on the first flip. Let B represent the event of flipping a heads on the second flip.

$P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$

$P(A \text{ or } B) = \frac{1}{2} + \frac{1}{2} - \frac{1}{4}$

$P(A \text{ or } B) = \frac{3}{4}$

So, the probability of flipping a heads on the first flip or flipping a heads on the second flip is $\frac{3}{4}$.

adjacent arcs

Adjacent arcs are two arcs of the same circle sharing a common endpoint.

Example

Arcs ZA and AB are adjacent arcs.

adjacent side

The adjacent side is the adjacent side of the reference angle that is not the hypotenuse.

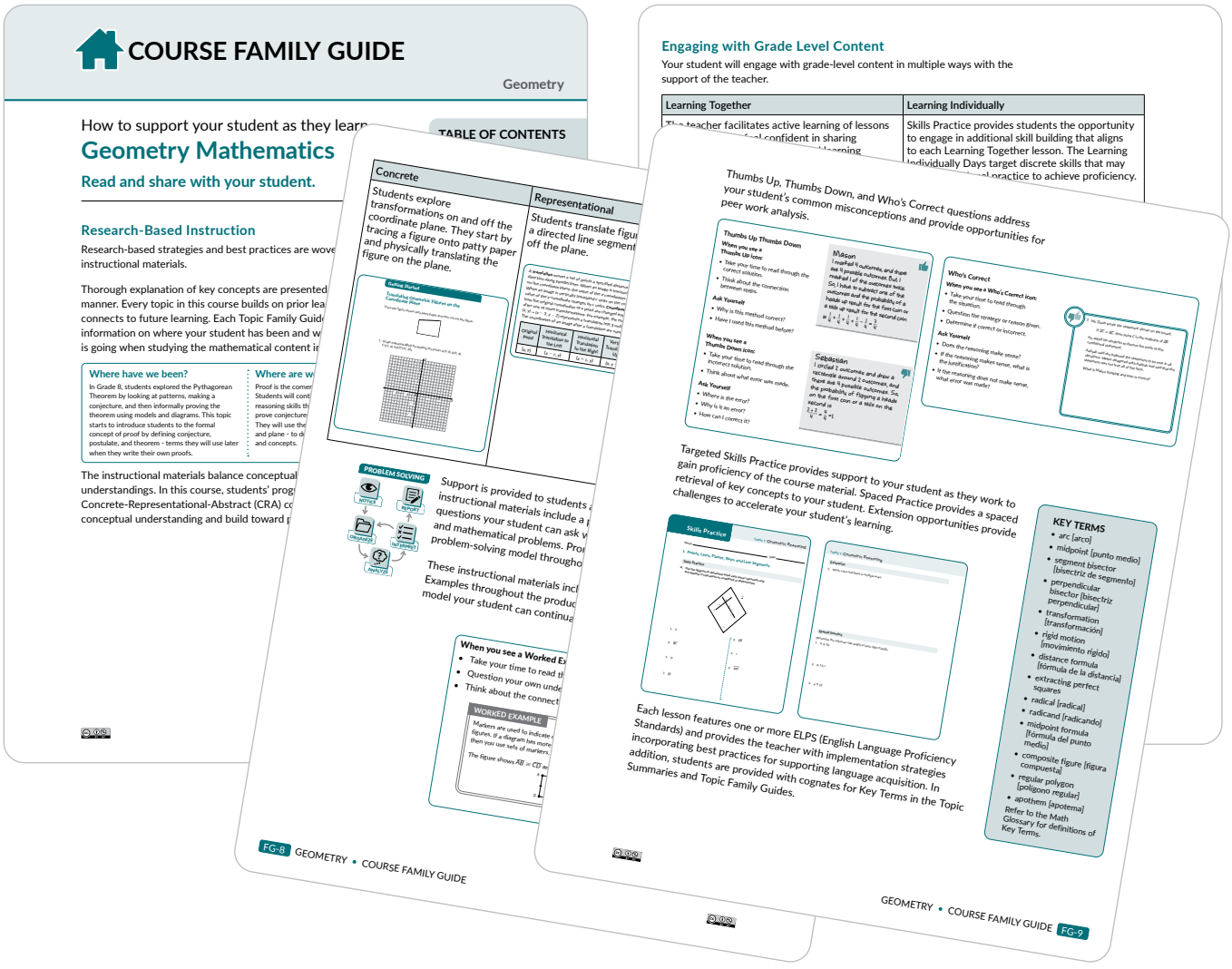
Example

MATH GLOSSARY G-1

Course Family Guide

The Course Family Guide provides you and your family an overview of the course design. The guide details the resources available to support your learning, such as the Math Glossary, the Topic Family Guide, the Topic Self-Reflection, and the Topic Summaries.

The purpose of the Course Family Guide is to bridge your learning in the classroom to your learning at home. The goal is to empower you and your family to understand the concepts and skills learned in the classroom so that you can review, discuss, and solidify the understanding of these key concepts together.



Topic Family Guides

Each topic contains a Topic Family Guide that provides an overview of the math of the topic and answers the questions, “Where have we been?” and “Where are we going?” Additional components of the Topic Family Guide are an example of a math model or strategy taught in the topic, definitions of key terms, applying math in the real world, and questions family members can ask you to support your learning.

Learning outside of the classroom is crucial to student success at school. The Topic Family Guide serves to assist families in talking to students about the learning that is happening in the classroom.

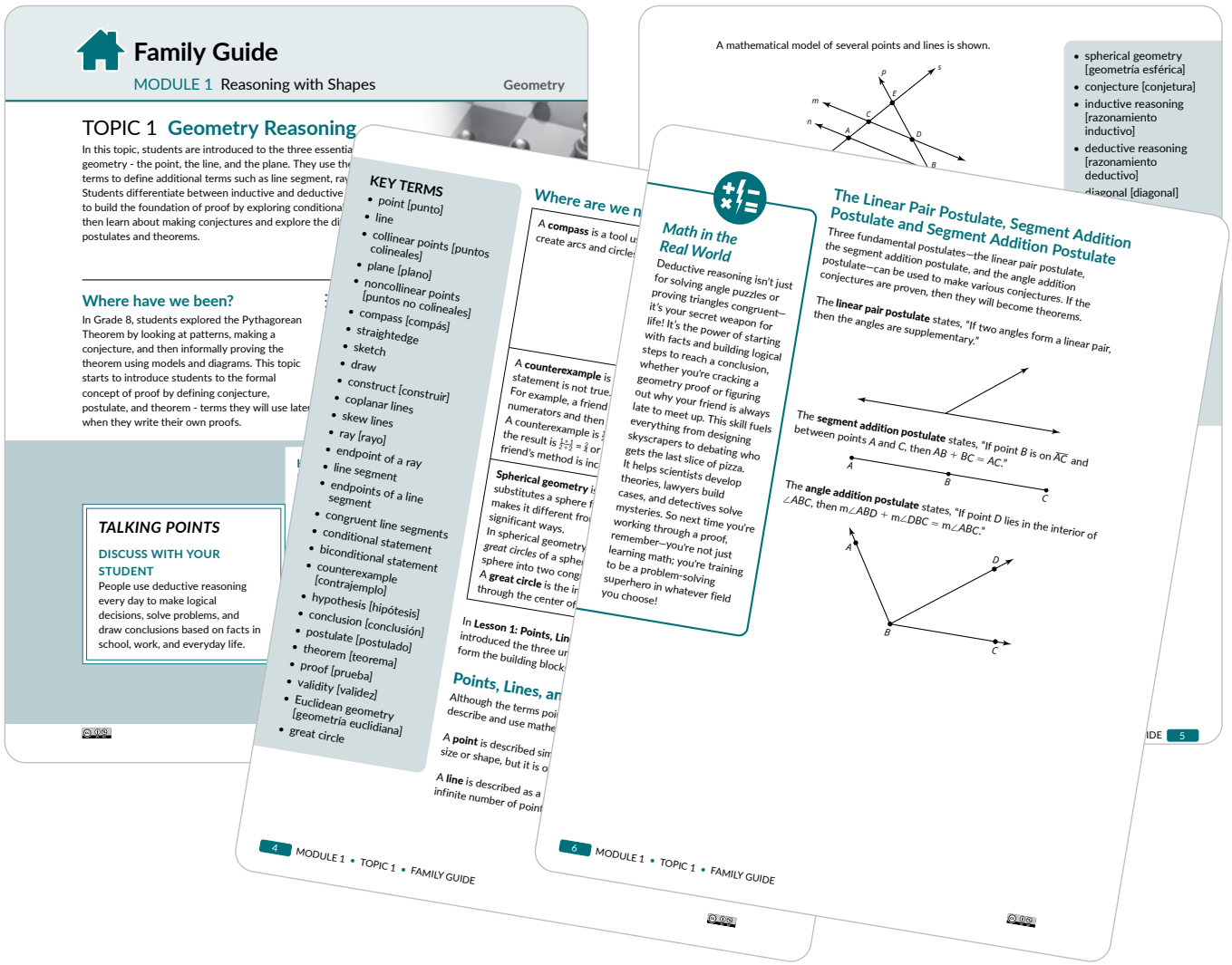


Table of Contents

MODULE 1 Reasoning with Shapes

TOPIC 1 Geometry Reasoning 3

Introduction to the Problem-Solving Model and Learning Resources

LESSON 1 Points, Lines, Planes, Rays, and Line Segments

LESSON 2 Formal Reasoning in Euclidean Geometry

LESSON 3 Conjectures and Deductive Reasoning

TOPIC 2 Using a Rectangular Coordinate System 63

LESSON 1 Constructing a Coordinate Plane

LESSON 2 Parallel and Perpendicular Lines

LESSON 3 Classifying Quadrilaterals on the Coordinate Plane

LESSON 4 Classifying Triangles on the Coordinate Plane

LESSON 5 Area and Perimeter on the Coordinate Plane

TOPIC 3 Sequences of Rigid Motions 211

LESSON 1 Translations On and Off the Coordinate Plane

LESSON 2 Sequences of Multiple Transformations

LESSON 3 Reflections On and Off the Coordinate Plane

LESSON 4 Rotations On and Off the Coordinate Plane

LESSON 5 Sequences of Transformations

TOPIC 4 Congruence Through Transformations 319

LESSON 1 Reflectional and Rotational Symmetry

LESSON 2 Proving Triangle Congruence Theorems

LESSON 3 Using Triangle Congruence to Solve Problems

MODULE 2 Justifying Mathematical Ideas and Arguments

TOPIC 1 Composing and Decomposing Shapes. 387

LESSON 1 Using Circles to Make Conjectures

LESSON 2 Conjectures About Quadrilaterals

LESSON 3 Constructing an Inscribed Regular Polygon

LESSON 4 Conjectures About Triangles

LESSON 5 Points of Concurrency

TOPIC 2 Justifying Line and Angle Relationships 493

LESSON 1 Forms of Proof

LESSON 2 Proving Parallel Line Theorems

LESSON 3 Interior and Exterior Angles of Polygons

LESSON 4 Perpendicular Bisector and Isosceles Triangle Theorems

LESSON 5 Inverse, Contrapositive, Direct Proof, and Indirect Proof

LESSON 6 Angle Relationships Inside and Outside Circles

TOPIC 3 Using Congruence Theorems 665

LESSON 1 Using Triangle Congruence to Determine Relationships Between Segments

LESSON 2 Using Congruent Triangles to Determine Relationships Between Chords and Tangents

LESSON 3 Properties of Quadrilaterals

MODULE 3 Investigating Proportionality

TOPIC 1 Similarity 743

LESSON 1 Dilating Figures to Create Similar Figures

LESSON 2 Establishing Triangle Similarity Criteria

LESSON 3 Theorems About Proportionality

LESSON 4 More Similar Triangles

LESSON 5 Application of Similar Triangles

LESSON 6 Partitioning Segments in Given Ratios

TOPIC 2 Trigonometry 887

LESSON 1 Introduction to Trigonometry

LESSON 2 Tangent Ratio and Inverse Tangent

LESSON 3 Exploring Sine and Cosine Ratios

LESSON 4 Complement Angle Relationships

MODULE 4 Connecting Geometric and Algebraic Descriptions

TOPIC 1 Circles 985

LESSON 1 Tangents, Secants, and More Chords

LESSON 2 Similarity Relationships in Circles

LESSON 3 Sectors and Segments of a Circle

LESSON 4 Deriving the Equation of a Circle

LESSON 5 Determining Points on a Circle

TOPIC 2 Building Three-Dimensional Shapes. 1087

LESSON 1 Building Three-Dimensional Figures

LESSON 2 Cross-Sections

LESSON 3 Building Volume Formulas for Pyramids, Cones, and Spheres

LESSON 4 Building Lateral and Surface Area Formulas for Pyramids, Cones, and Spheres

MODULE 5 Making Informed Decisions

TOPIC 1 Independence and Conditional Probability . . . 1183

LESSON 1 Compound Sample Space

LESSON 2 Compound Probability with *And*

LESSON 3 Compound Probability with *Or*

LESSON 4 Calculating Compound Probability

TOPIC 2 Computing Probabilities 1281

LESSON 1 Compound Probability for Data Displayed in Two-Way Tables

LESSON 2 Conditional Probability

LESSON 3 Permutations and Combinations

LESSON 4 Independent Trials

LESSON 5 Expected Value

Math Glossary G-1

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