TEXAS MATH SOLUTION

Grade 8

Student Textbook

Skills Program Edition

SY 2022-2023

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with Kelly Edenfield and Josh Fisher

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ISBN: 978-1-63862-059-4
Student Edition

Printed in the United States of America
1 2 3 4 5 6 7 8 9 CC 21 20 19 18 17

Our Manifesto

WE BELIEVE that quality math education is important for all students, to help them develop into creative problem solvers, critical thinkers, life-long learners, and more capable adults.

WE BELIEVE that math education is about more than memorizing equations or performing on tests—it's about delivering the deep conceptual learning that supports ongoing growth and future development.

WE BELIEVE all students learn math best when teachers believe in them, expect them to participate, and encourage them to own their learning.

WE BELIEVE teachers are fundamental to student success and need powerful, flexible resources and support to build dynamic cultures of collaborative learning.

WE BELIEVE our learning solutions and services can help accomplish this, and that by working together with educators and communities we serve, we guide the way to better math learning.

LONG + LIVE + MATH

Acknowledgments

Middle School Math Solution Authors

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- Janet Sinopoli, Algebra
- Jaclyn Snyder, Geometry and Measurement

Vendors

- Lumina Datamatics, Ltd.
- Cenveo Publisher Services, Inc.

Images

- www.pixabay.com

Special Thanks

- Alison Huettner for project management and editorial review.
- Jacyln Snyder and Janet Sinopoli for their contributions to the Teacher's Implementation Guide facilitation notes.
- Victoria Fisher for her review of content and contributions to all the ancillary materials.
- Valerie Muller for her contributions and review of content.
- The members of Carnegie Learning's Cognitive Scientist Team—Brendon Towle, John Connelly, Bob Hausmann, Chas Murray, and Martina Pavelko—for their insight in learning science and review of content.
- Bob Hausmann for his contributions to the Family Guide.
- John Jorgenson, Chief Marketing Officer, for all his insight and messaging.
- Carnegie Learning's Education Services Team for content review and providing customer feedback.
- In Memory of David Dengler, Director of Curriculum Development (deceased), who made substantial contributions to conceptualizing Carnegie Learning's middle school software.

Acknowledgments

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Special Thanks

- The entire Carnegie Learning Production Team, with extreme gratitude for Sara Kozelnik, Julie Leath, Lenore MacLeod, Olivia Rangel, Chloe Thompson, and Lindsay Ryan for their patience, attention to detail, and around-the-clock hours that made the production of this textbook possible.

- Thank you to all the Texas educators and education professionals who supported the review process and provided feedback for this resource.

"Mathematics is so much more than memorizing rules. It is learning to reason, to make connections, and to make sense of the world. We believe in Learning by Doing™—you need to actively engage with the content if you are to benefit from it. The lessons were designed to take you from your intuitive understanding of the world and build on your prior experiences to then learn new concepts. My hope is that these instructional materials help you build a deep understanding of math."

Sandy Bartle Finocchi, Chief Mathematics Officer

"My hope is that as you work through this course, you feel capable—capable of exploring new ideas that build upon what you already know, capable of struggling through challenging problems, capable of thinking creatively about how to fix mistakes, and capable of thinking like a mathematician."

Amy Jones Lewis, Senior Director of Instructional Design

"At Carnegie Learning, we have created an organization whose mission and culture is defined by your success. Our passion is creating products that make sense of the world of mathematics and ignite a passion in you. Our hope is that you will enjoy our resources as much as we enjoyed creating them."

Barry Malkin, CEO

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Patty Paper, Patty Paper

1

Introduction to Congruent Figures

WARM UP

Draw an example of each shape.

1. parallelogram
2. trapezoid
3. pentagon
4. regular hexagon

LEARNING GOALS

1

- Define congruent figures.
- Use patty paper to verify experimentally that two figures are congruent by obtaining the second figure from the first using a sequence of slides, flips, and/or turns.
- Use patty paper to determine if two figures are congruent.

KEY TERMS

- congruent figures
- corresponding sides
- corresponding angles

2 You have studied figures that have the same shape or measure. How do you determine if two figures have the same size and the same shape?

1. Learning Goals

Learning goals are stated for each lesson to help you take ownership of the learning objectives.

2. Connection

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. Getting Started

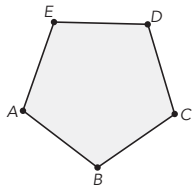
Each lesson begins with a Getting Started. When working on the Getting Started, use what you know about the world, what you have learned previously, or your intuition. The goal is just to get you thinking and ready for what's to come.

3 **Getting Started**

It's Transparent!

Let's use patty paper to investigate the figure shown.

1. List everything you know about the shape.



Patty paper is great paper to investigate geometric properties. You can write on it, trace with it, and see creases when you fold it.

2. Use patty paper to compare the sizes of the sides and angles in the figure.

a. What do you notice about the side lengths?

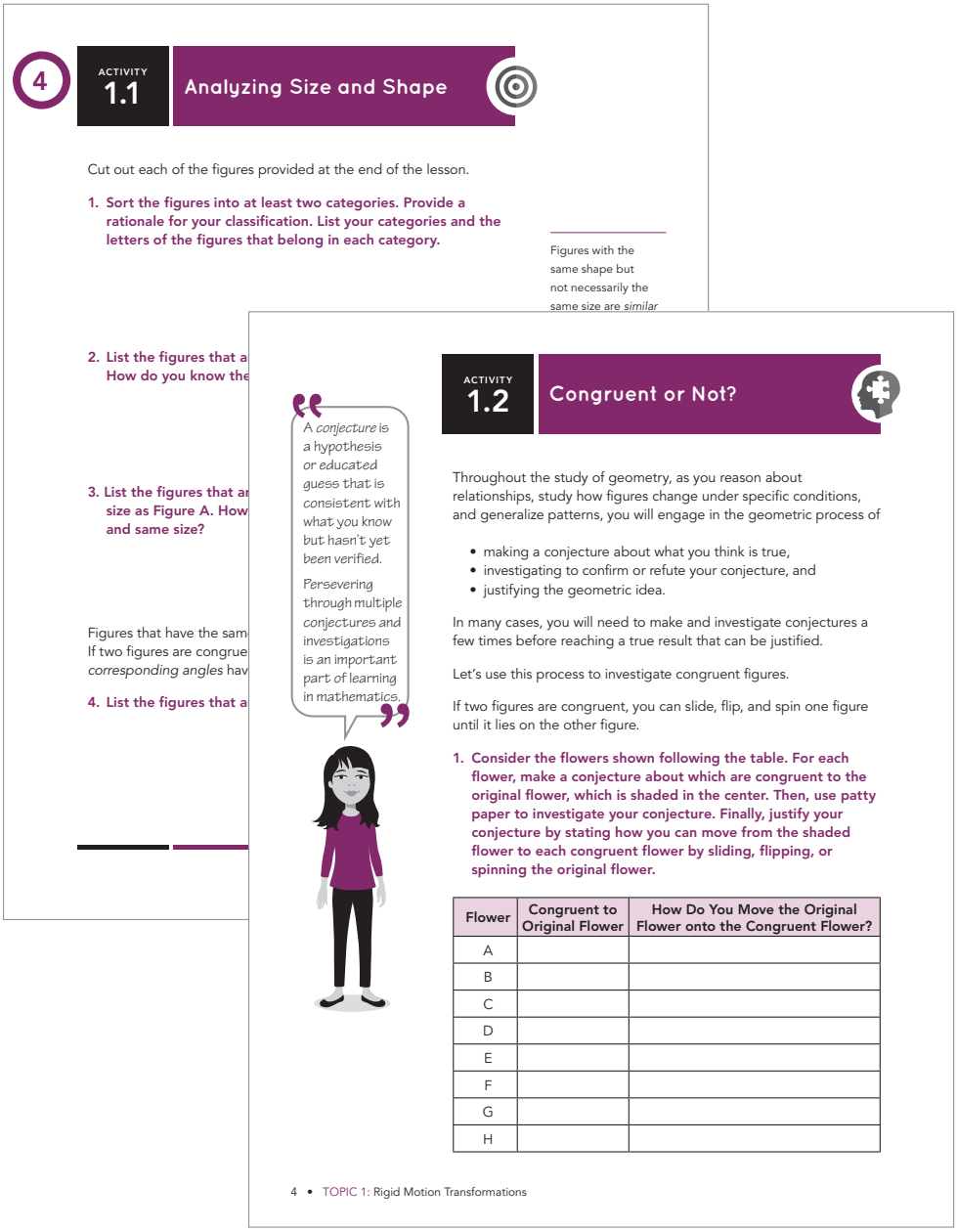
b. What do you notice about the angle measures?

c. What can you say about the figure based on this investigation?

"Patty paper was originally created for separating patties of meat! Little did the inventors know that it could also serve as a powerful geometric tool."

Trace the polygon onto a sheet of patty paper.

3. Use five folds of your patty paper to determine the center of each side of the shape. What do you notice about where the folds intersect?



4

ACTIVITY 1.1

Analyzing Size and Shape

Cut out each of the figures provided at the end of the lesson.

1. **Sort the figures into at least two categories. Provide a rationale for your classification. List your categories and the letters of the figures that belong in each category.**

Figures with the same shape but not necessarily the same size are *similar*

2. **List the figures that a**
How do you know the

3. **List the figures that ar**
size as Figure A. How
and same size?

Figures that have the sam
If two figures are congrue
corresponding angles hav

4. **List the figures that a**

ACTIVITY 1.2

Congruent or Not?

A *conjecture* is a hypothesis or educated guess that is consistent with what you know but hasn't yet been verified.

Persevering through multiple conjectures and investigations is an important part of learning in mathematics.

Throughout the study of geometry, as you reason about relationships, study how figures change under specific conditions, and generalize patterns, you will engage in the geometric process of

- making a conjecture about what you think is true,
- investigating to confirm or refute your conjecture, and
- justifying the geometric idea.

In many cases, you will need to make and investigate conjectures a few times before reaching a true result that can be justified.

Let's use this process to investigate congruent figures.

If two figures are congruent, you can slide, flip, and spin one figure until it lies on the other figure.

1. **Consider the flowers shown following the table. For each flower, make a conjecture about which are congruent to the original flower, which is shaded in the center. Then, use patty paper to investigate your conjecture. Finally, justify your conjecture by stating how you can move from the shaded flower to each congruent flower by sliding, flipping, or spinning the original flower.**

Flower	Congruent to Original Flower	How Do You Move the Original Flower onto the Congruent Flower?
A		
B		
C		
D		
E		
F		
G		
H		

4 • TOPIC 1: Rigid Motion Transformations

4. 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 answer-getting. 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.

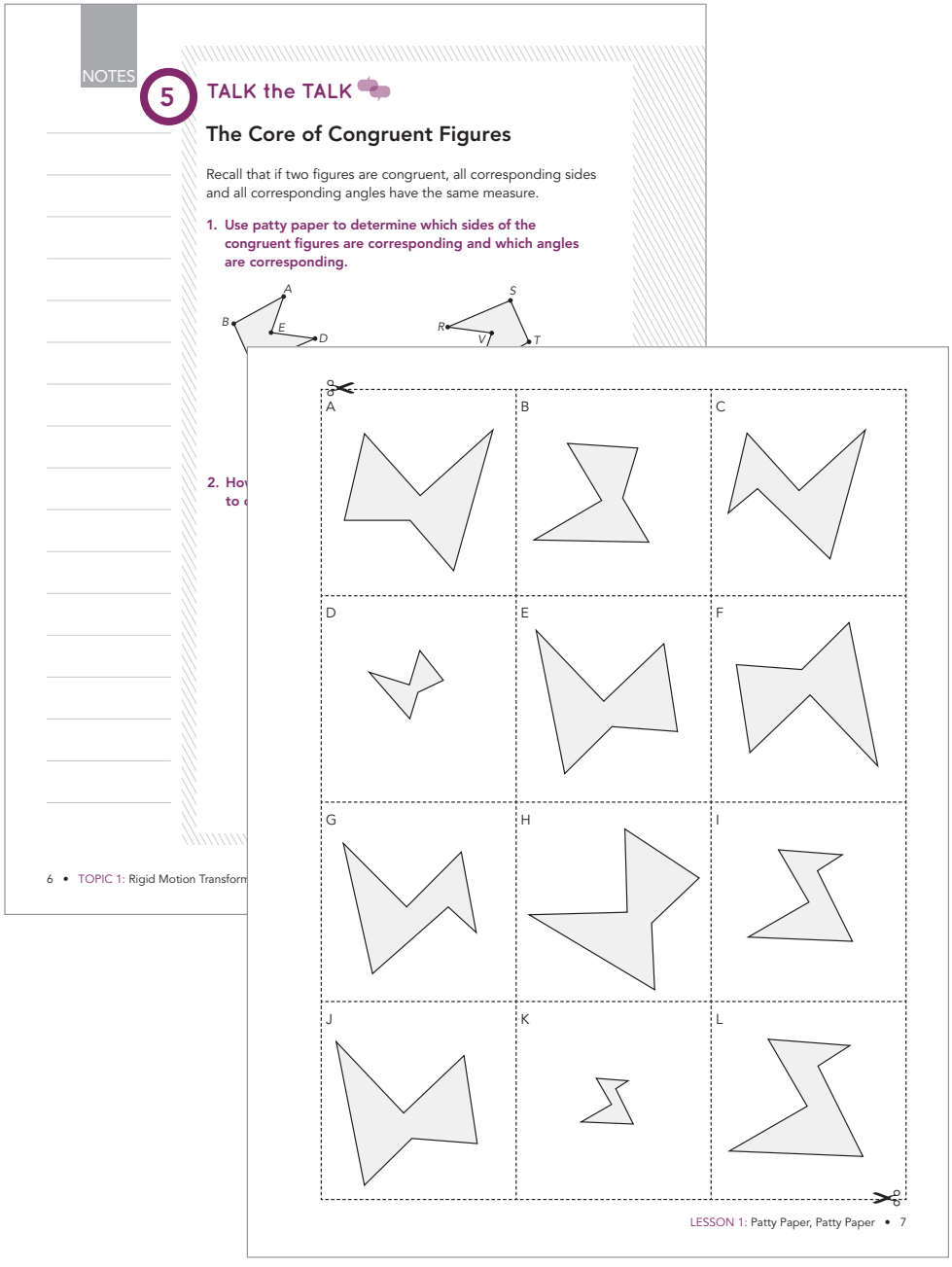
Be prepared to share your solutions and methods with your classmates.

5. Talk the Talk

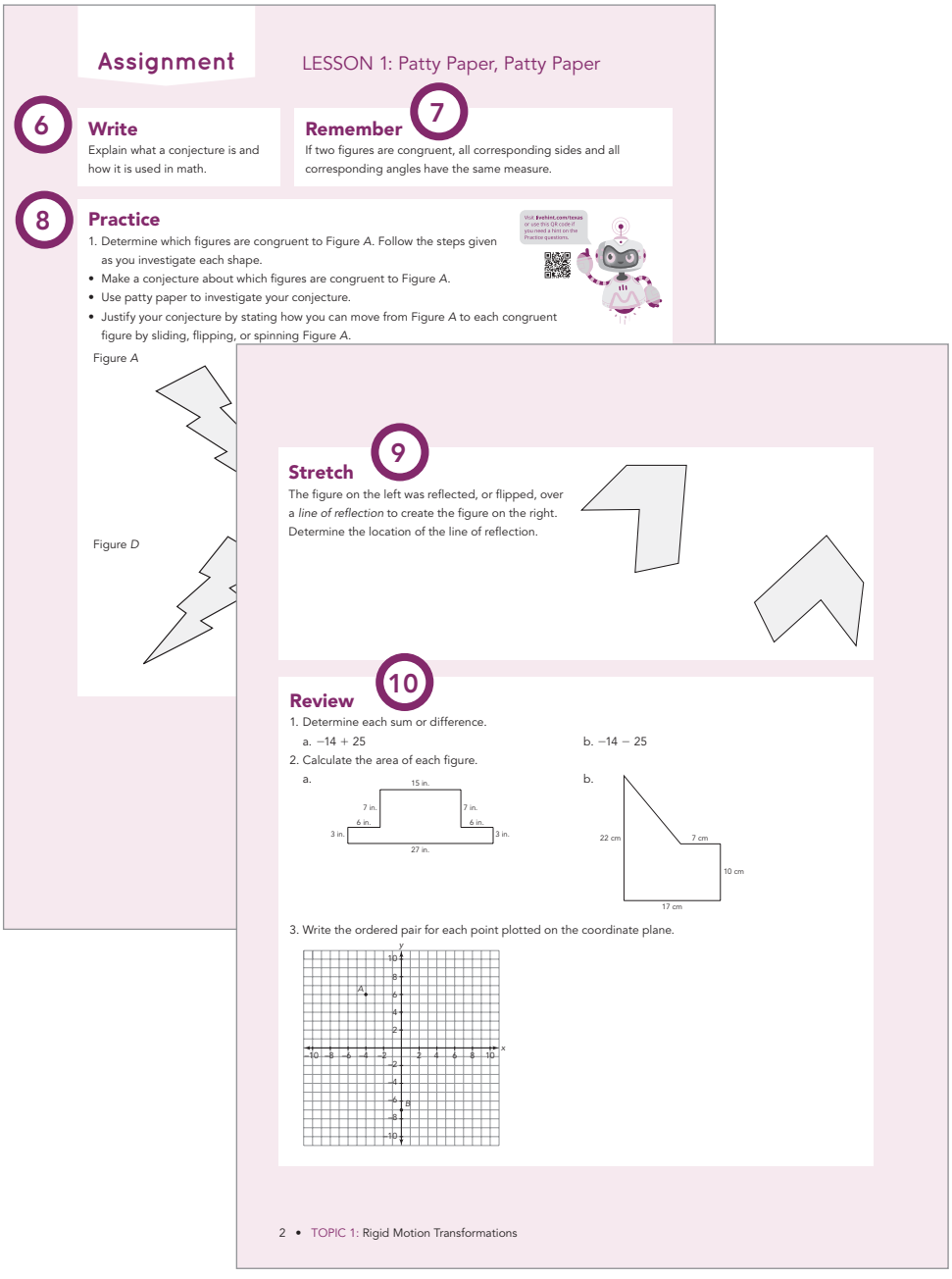
Talk the Talk gives you an opportunity to reflect on the main ideas of the lesson.

- 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.



Assignment



Assignment

LESSON 1: Patty Paper, Patty Paper

6 **Write**

Explain what a conjecture is and how it is used in math.

7 **Remember**

If two figures are congruent, all corresponding sides and all corresponding angles have the same measure.

8 **Practice**

1. Determine which figures are congruent to Figure *A*. Follow the steps given as you investigate each shape.
   - Make a conjecture about which figures are congruent to Figure *A*.
   - Use patty paper to investigate your conjecture.
   - Justify your conjecture by stating how you can move from Figure *A* to each congruent figure by sliding, flipping, or spinning Figure *A*.

Figure *A*

Figure *D*

9 **Stretch**

The figure on the left was reflected, or flipped, over a *line of reflection* to create the figure on the right. Determine the location of the line of reflection.

10 **Review**

1. Determine each sum or difference.
   a. −14 + 25
   b. −14 − 25
2. Calculate the area of each figure.
   a. 15 in., 7 in., 6 in., 3 in., 27 in.
   b. 22 cm, 7 cm, 10 cm, 17 cm
3. Write the ordered pair for each point plotted on the coordinate plane.

2 • TOPIC 1: Rigid Motion Transformations

6. Write
Reflect on your work and clarify your thinking.

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

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

9. Stretch
Ready for a challenge?

10. Review
Remember what you've learned by practicing concepts from previous lessons and topics.

Problem Types You Will See

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.

Ask Yourself:

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

WORKED EXAMPLE

The first right triangle has sides of length 3 units, 4 units, and 5 units, where the sides of length 3 units and 4 units are the legs and the side with length 5 units is the hypotenuse.

The sum of the squares of the lengths of the legs: $3^2 + 4^2 = 9 + 16 = 25$

The square of the hypotenuse: $5^2 = 25$

Therefore $3^2 + 4^2 = 5^2$, which verifies the Pythagorean Theorem, holds true.

The Pythagorean Theorem can be used to determine unknown side lengths in a right triangle. Evan and Sophi are using the theorem to determine the length of the hypotenuse, c, with leg lengths of 2 and 4. Examine their work.

Sophi

$c^2 = 2^2 + 4^2$
$c^2 = 4 + 16 = 20$
$c = \sqrt{20} \approx 4.5$

The length of the hypotenuse is approximately 4.5 units.

Evan

$c^2 = 2^2 + 4^2$
$c^2 = 6^2$
$c = 6$

The length of the hypotenuse is 6 units.

Thumbs Up

When you see a Thumbs Up icon:

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

Ask Yourself:

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

Thumbs Down

When you see a Thumbs Down icon:

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

Ask Yourself:

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

Isabel says that $2^2 + 2^3 = 2^5$, and Elizabeth says that $2^2 + 2^3 \neq 2^5$. Who is correct? Explain your reasoning.

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 if correct or not correct.

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?

The Crew

The Crew is here to help you on your journey. 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 members of your group—someone you can rely on!

Teacher aides will guide you along your journey. They will help you make connections and remind you to think about the details.

Mathematical Process Standards

Texas 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.

Academic Glossary

Visit the Students & Caregivers Portal on the Texas Support Center at **www.CarnegieLearning.com/texas-help** to access the Mathematics Glossary for this course anytime, anywhere.

There are important terms you will encounter throughout this book. It is important that you have an understanding of these words as you get started on your journey through the mathematical concepts. Knowing what is meant by these terms and using these terms will help you think, reason, and communicate your ideas.

ANALYZE

Related Phrases

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

Definition

To 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?

EXPLAIN YOUR REASONING

Related Phrases

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

Definition

To 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?

REPRESENT

Definition

To 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?

Related Phrases

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

ESTIMATE

Definition

To 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?

Related Phrases

- Predict
- Approximate
- Expect
- About how much?

DESCRIBE

Definition

To 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?

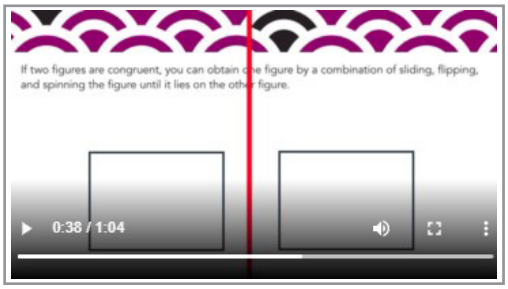
Related Phrases

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

Resources for Students and Caregivers

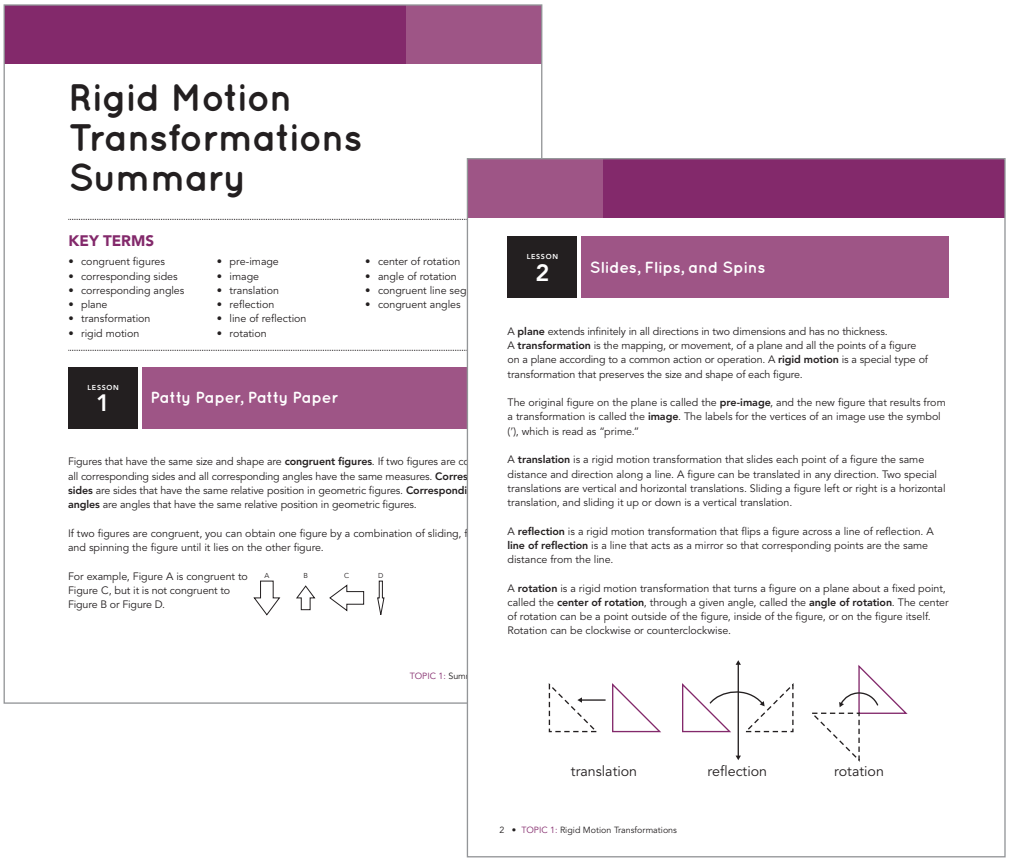
Student Lesson Overview Videos

Each lesson has a corresponding lesson overview video(s) for you to use and reference as you are learning. The videos provide an overview of key concepts, strategies, and/or worked examples from the lessons.



Topic Summary

A Topic Summary is provided at the end of each topic. The Topic Summary lists all key terms of the topic and provides a summary of each lesson. Each lesson summary defines key terms and reviews key concepts, strategies, and/or worked examples.



Rigid Motion Transformations Summary

KEY TERMS

- congruent figures
- corresponding sides
- corresponding angles
- plane
- transformation
- rigid motion
- pre-image
- image
- translation
- reflection
- line of reflection
- rotation
- center of rotation
- angle of rotation
- congruent line seg
- congruent angles

LESSON 1 Patty Paper, Patty Paper

Figures that have the same size and shape are **congruent figures**. If two figures are co all corresponding sides and all corresponding angles have the same measures. **Corres sides** are sides that have the same relative position in geometric figures. **Correspondi angles** are angles that have the same relative position in geometric figures.

If two figures are congruent, you can obtain one figure by a combination of sliding, f and spinning the figure until it lies on the other figure.

For example, Figure A is congruent to Figure C, but it is not congruent to Figure B or Figure D.

A B C D

TOPIC 1: Sum

LESSON 2 Slides, Flips, and Spins

A **plane** extends infinitely in all directions in two dimensions and has no thickness. A **transformation** is the mapping, or movement, of a plane and all the points of a figure on a plane according to a common action or operation. A **rigid motion** is a special type of transformation that preserves the size and shape of each figure.

The original figure on the plane is called the **pre-image**, and the new figure that results from a transformation is called the **image**. The labels for the vertices of an image use the symbol (′), which is read as "prime."

A **translation** is a rigid motion transformation that slides each point of a figure the same distance and direction along a line. A figure can be translated in any direction. Two special translations are vertical and horizontal translations. Sliding a figure left or right is a horizontal translation, and sliding it up or down is a vertical translation.

A **reflection** is a rigid motion transformation that flips a figure across a line of reflection. A **line of reflection** is a line that acts as a mirror so that corresponding points are the same distance from the line.

A **rotation** is a rigid motion transformation that turns a figure on a plane about a fixed point, called the **center of rotation**, through a given angle, called the **angle of rotation**. The center of rotation can be a point outside of the figure, inside of the figure, or on the figure itself. Rotation can be clockwise or counterclockwise.

translation reflection rotation

2 • TOPIC 1: Rigid Motion Transformations

Mathematics Glossary

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

Glossary

A

absolution deviation

The absolute value of each deviation is called the absolute deviation.

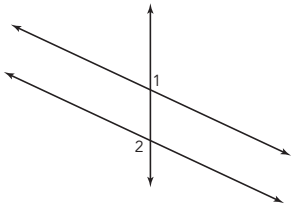
absolute value function

An absolute value function is a function that can be written in the form $y = |x|$, where x is any number or expression.

alternate exterior angles

Alternate exterior angles are angles formed when a transversal intersects two other lines. These angle pairs are on opposite sides of the transversal and are outside the other two lines.

Example

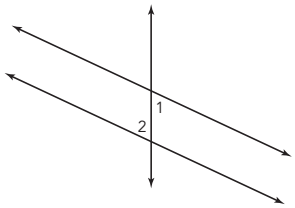


Angles 1 and 2 are alternate exterior angles.

alternate interior angles

Alternate interior angles are angles formed when a transversal intersects two other lines. These angle pairs are on opposite sides of the transversal and are between the other two lines.

Example

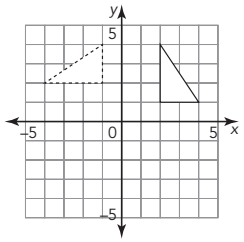


Angles 1 and 2 are alternate interior angles.

angle of rotation

The angle of rotation is the amount of rotation, in degrees, about a fixed point, the center of rotation.

Example

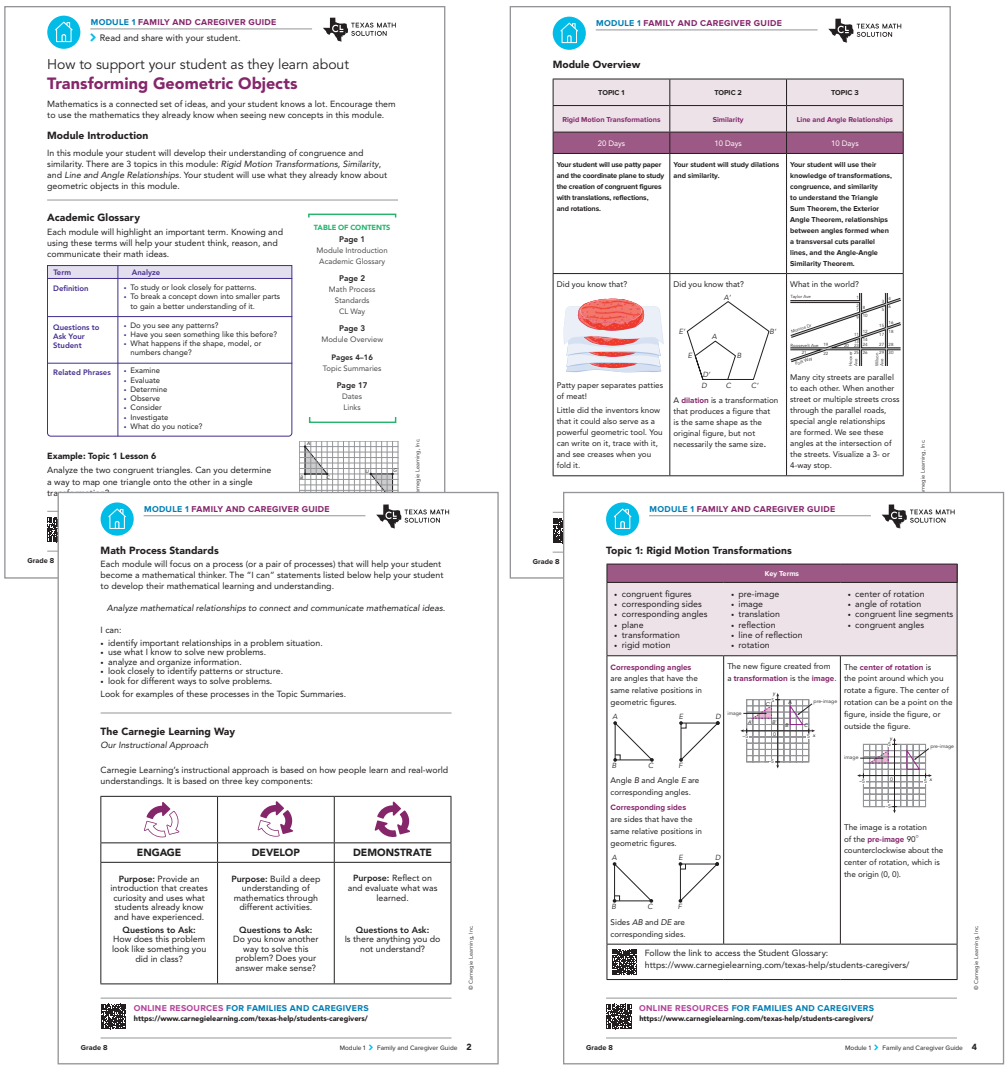


The angle of rotation is 90° counterclockwise about the origin (0, 0).

Module Family and Caregiver Guides

Each module guide will provide a different highlight of the academic glossary, description and examples of TEKS Mathematical Process Standards, and an overview of a different component of our instructional approach known as The Carnegie Learning Way. Also included is a module overview of content, specific key terms, visual representations, and strategies you are learning in each topic of the module.

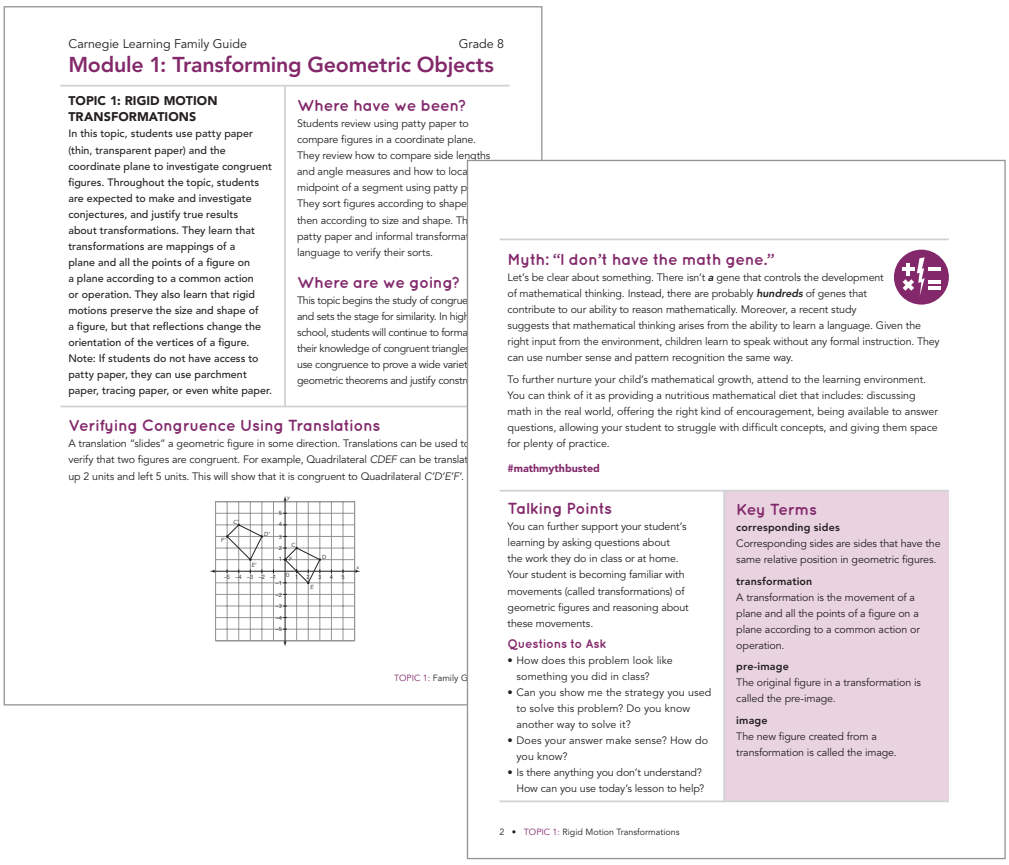
The purpose of the Family and Caregiver Guides is to bridge student learning in the classroom to student learning at home. Our goal is to empower you and your family to understand the concepts and skills learned in the classroom so that you can review, discuss, and solidify the understanding of these key concepts together. Videos will be available on the Students & Caregivers Portal on the Texas Support Center to provide added support.



Topic Family Guides

Each topic contains a 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 Family Guide are, as follows: an example of a math model or strategy taught in the topic, definitions of a few key terms, busting of a math myth, and questions families and caregivers can ask you to support your learning.

We recognize that learning outside of the classroom is crucial to student success at school. While we don't expect families and caregivers to be math teachers, the Family Guides are designed to assist families and caregivers as they talk to you about what you are learning. Our hope is that both you and your family will read and benefit from these guides.



Carnegie Learning Family Guide Grade 8

Module 1: Transforming Geometric Objects

TOPIC 1: RIGID MOTION TRANSFORMATIONS

In this topic, students use patty paper (thin, transparent paper) and the coordinate plane to investigate congruent figures. Throughout the topic, students are expected to make and investigate conjectures, and justify true results about transformations. They learn that transformations are mappings of a plane and all the points of a figure on a plane according to a common action or operation. They also learn that rigid motions preserve the size and shape of a figure, but that reflections change the orientation of the vertices of a figure. Note: If students do not have access to patty paper, they can use parchment paper, tracing paper, or even white paper.

Where have we been?

Students review using patty paper to compare figures in a coordinate plane. They review how to compare side lengths and angle measures and how to loca midpoint of a segment using patty p They sort figures according to shape then according to size and shape. Th patty paper and informal transforma language to verify their sorts.

Where are we going?

This topic begins the study of congrue and sets the stage for similarity. In high school, students will continue to forma their knowledge of congruent triangles use congruence to prove a wide variet geometric theorems and justify constr

Verifying Congruence Using Translations

A translation "slides" a geometric figure in some direction. Translations can be used to verify that two figures are congruent. For example, Quadrilateral *CDEF* can be translat up 2 units and left 5 units. This will show that it is congruent to Quadrilateral *C'D'E'F'*.

TOPIC 1: Family G

Myth: "I don't have the math gene."

Let's be clear about something. There isn't ***a*** gene that controls the development of mathematical thinking. Instead, there are probably ***hundreds*** of genes that contribute to our ability to reason mathematically. Moreover, a recent study suggests that mathematical thinking arises from the ability to learn a language. Given the right input from the environment, children learn to speak without any formal instruction. They can use number sense and pattern recognition the same way.

To further nurture your child's mathematical growth, attend to the learning environment. You can think of it as providing a nutritious mathematical diet that includes: discussing math in the real world, offering the right kind of encouragement, being available to answer questions, allowing your student to struggle with difficult concepts, and giving them space for plenty of practice.

#mathmythbusted

Talking Points

You can further support your student's learning by asking questions about the work they do in class or at home. Your student is becoming familiar with movements (called transformations) of geometric figures and reasoning about these movements.

Questions to Ask

- How does this problem look like something you did in class?
- Can you show me the strategy you used to solve this problem? Do you know another way to solve it?
- Does your answer make sense? How do you know?
- Is there anything you don't understand? How can you use today's lesson to help?

Key Terms

corresponding sides
Corresponding sides are sides that have the same relative position in geometric figures.

transformation
A transformation is the movement of a plane and all the points of a figure on a plane according to a common action or operation.

pre-image
The original figure in a transformation is called the pre-image.

image
The new figure created from a transformation is called the image.

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