

TOPIC 2

Parallel and Perpendicular Lines

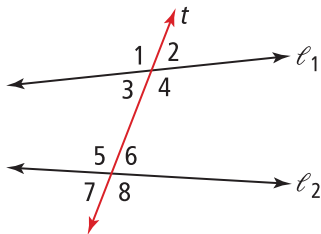
MATH BACKGROUND KEY CONCEPTS

Students begin by focusing on the properties of parallel lines and the angle relationships formed when parallel lines are cut by a transversal. The rest of the topic examines how these angle relationships can help prove whether or not lines are parallel, the relationships between parallel lines and triangle angles, and the relationships between the slopes of parallel and perpendicular lines.

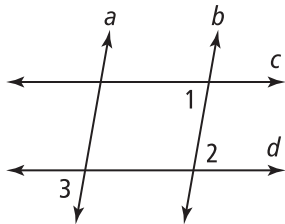
Understanding Parallel Lines and Angle Relationships

Understanding Transversals In Lesson 2-1, students learn the definition of a transversal and the names of angle pairs formed by a transversal. These angle relationships are used to prove whether lines are parallel in Lesson 2-2 and are extended to angle relationships in triangles in Lesson 2-3.

Angle Pair Relationships In Lesson 2-1, students learn about angle pairs: alternate interior, alternate exterior, same-side interior, and corresponding angles. For example, $\angle 1$ and $\angle 8$ are alternate exterior angles.



Identifying Theorems In Lesson 2-2, students also use information about angles to determine whether lines are parallel. For example, given the image below and $\angle 1 \cong \angle 2$, students can use the theorem stating that alternate interior angles are congruent to prove the lines are parallel.

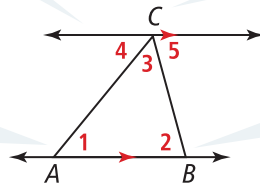


Parallel Lines and Triangles In Lesson 2-3, students use the relationships among angles in parallel lines and triangles to prove the Triangle Angle-Sum Theorem.

Proof:

Use Theorem 2-10 to justify drawing a line through C parallel to AB .

By the Alternate Interior Angles Theorem, $\angle 1 \cong \angle 4$, so $m\angle 1 = m\angle 4$.

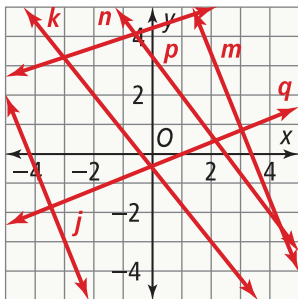


By applying the Angle Addition Postulate, $m\angle 4 + m\angle 3 + m\angle 5 = 180^\circ$.

By the Alternate Interior Angles Theorem, $\angle 2 \cong \angle 5$, so $m\angle 2 = m\angle 5$.

Comparing Slopes in Lines to Determine if They Are Parallel or Perpendicular

Relating Slopes of Parallel Lines The discussion in Lesson 2-4 leads students through the process of finding the slope of a line. To check for parallelism, students are provided various lines and asked to determine the relationship of two of those lines, such as lines n and q .



Since the slope of line n is $\frac{1}{3}$ and the slope of line q is $\frac{2}{5}$, the lines are not parallel.

Compare Geometric Relationships In Lesson 2-5, students consider Euclidean and spherical geometry, including the properties of parallel lines and the sum of the angles in a triangle. Then also analyze how geometric principles change when applied to a curved surface.

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MATH BACKGROUND COHERENCE

Students learn best when concepts are connected throughout the curriculum. This coherence is achieved within topics, across topics, across domains, and across grade levels.

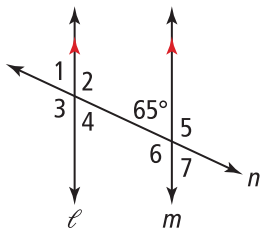
MAKING MATHEMATICAL CONNECTIONS

Looking Back

How does Topic 2 connect to what students learned earlier?

TOPIC 1

- **Length of a Segment** Students applied subtraction to find the length of a segment in Lesson 1-1. In Topic 2, they apply subtraction in the slope formula to find the ratio of the vertical change over the horizontal change. (G.5A)
- **Vertical Angle Congruence** Students learned that vertical angles are congruent in Lesson 1-7. In Lesson 2-1, they use this information to find congruent angles when parallel lines are cut by a transversal. (G.5A)



THIS TOPIC

How is content connected within Topic 2?

- **Angle Relationships in Parallel Lines** Lesson 2-1 provides the students with the relationships among angles given two lines cut by a transversal. It develops theorems about these angles when the lines are parallel. In Lesson 2-2, students use those relationships to prove whether or not lines cut by a transversal are parallel. (G.5A)
- **Angles in Triangles and Parallel Lines** Students explore the relationships between parallel lines and the angles formed when the lines are cut by a transversal in Lesson 2-1. They then use those relationships in Lesson 2-3 to prove the Triangle Angle-Sum Theorem and to find missing angle measurements in triangles. (G.5A)
- **Slopes of Parallel and Perpendicular Lines** Lesson 2-4 presents students with the relationship between the slopes of parallel and perpendicular lines. (G.2B)
- **Spherical and Euclidean Geometry** In Lesson 2-5, students relate what they learned about parallel lines to Euclidean and spherical geometry. (G.4D)

MAKING MATHEMATICAL CONNECTIONS

Looking Ahead

How does Topic 2 connect to what students will learn later?

TOPIC 6

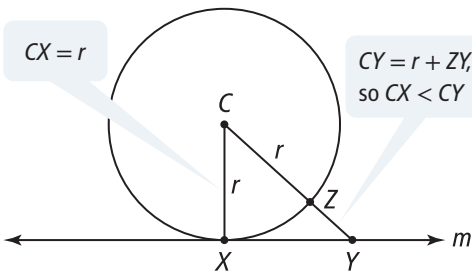
- **Parallel and Perpendicular Lines in Quadrilaterals** In Topic 6, students will work with parallel lines in Lesson 6-2 when solving problems with trapezoids. They will also use perpendicular relationships when discussing the diagonals of a rhombus in Lesson 6-5. (G.5A)

TOPIC 9

- **Using Slope** Students will learn how to use algebraic properties, such as slope, to describe geometric relationships in Lesson 9-1. (G.2B)

TOPIC 10

- **Perpendicular Lines and Tangent Lines in Circles** In Lesson 10-2, students will learn that the radius of a circle is perpendicular to the tangent of the circle at the point where the radius intersects the circle. (G.2B)



TOPIC 2

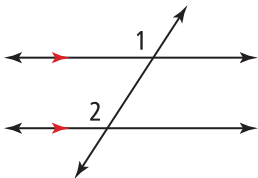
Parallel and Perpendicular Lines

MATH BACKGROUND BALANCE

A rigorous curriculum emphasizes conceptual understanding, procedural skill and fluency, and applications.

Conceptual Understanding

- Relating Angle Relationships and Parallel Lines Theorems**
Students use theorems about angle relationships to draw conclusions about angles when the lines that form them are parallel. For example, students can use the Corresponding Angles Theorem to conclude that $\angle 1 \cong \angle 2$ in the image below.



- Understanding Relationships with Parallel Lines in Triangles**
Students apply their understanding of the relationships of angles formed by parallel lines cut by a transversal to prove the Triangle Angle-Sum Theorem. Using one side of the triangle, a parallel line is constructed through the vertex opposite the chosen side. The resulting parallel lines can be used to prove the Triangle Angle-Sum Theorem or to find missing measurements in the interior or exterior of the triangle.
- Spherical and Euclidean Geometry** Students extend their understanding in Lesson 2-5 to compare how parallel lines never intersect in Euclidean geometry but do in spherical geometry.)

Procedural Skill

- Using Angle Relationships to Determine Parallelism**
In Lesson 2-2, students use angle pair relationships to determine whether given lines are parallel.
- Using Plotted Points to Find the Slope of a Line** In Lesson 2-4, students find the slopes of parallel and perpendicular lines graphed on a coordinate plane.
- Determining Angle Relationships in Triangles** In Lesson 2-3, students use angle relationships to prove the Triangle Angle-Sum Theorem and to find missing angle measurements in triangles.
- Comparing Slopes** In Lesson 2-4, students compare slopes to determine parallelism and perpendicularity. Comparisons are made using graphs of lines or tables of values, such as the one shown below.

x	$f(x)$	$g(x)$
0	20	22
1	35	37
2	50	52
3	65	67

Applications

- Modeling with Parallel Lines** In Lesson 2-2, students use angle relationships with parallel lines when placing solar panels to maximize sun absorption.
- Modeling with Lines and Triangles** In Lesson 2-3, students identify the angle measurements in a sketch of a Navajo rug design.

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MATHEMATICAL PROCESS STANDARDS

Math Processes Within Topic 2 Lessons

The mathematical processes describe the behaviors and habits of mind that mathematically proficient students demonstrate when actively engaged in mathematics work. Opportunities to develop expertise with these important behaviors and thinking habits exist throughout the topic and program.

In this topic, you may choose to focus on developing and assessing proficiency with process standards G.1F and G.1C. As students work with parallel and perpendicular lines, look for the following behaviors to assess and identify students who demonstrate proficiency with these math processes.

Highlighted Math Processes Within Topic 1 Lessons	
The student is expected to analyze mathematical relationships to connect and communicate mathematical ideas. (G.1F)	The student is expected to 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. (G.1C)
Mathematically proficient students:	Mathematically proficient students:
Interpret and make sense of the problem, looking for starting points when determining the relationship between the angles formed by parallel lines and a transversal.	Use a straightedge and compass while applying the converses of the parallel line theorems to construct a line parallel to a given line.
Explain the relationship between angles formed by the intersection of two parallel lines and a transversal.	Use a protractor to verify relationships between the angles created by the intersection of parallel lines and a transversal.
Use parallel lines and angle relationships to explore the angles of a triangle.	Use graphing calculators or other technology to verify whether or not two lines are parallel or perpendicular.
Plan a solution to find measurements of missing angles in a figure containing parallel lines and a transversal.	Recognize that parallel lines can be used to identify relationships between the angles in a triangle and find missing measurements.
Plan a solution for finding the equation of a line parallel or perpendicular to a given line.	Use mathematical models to verify and analyze problems involving parallel and perpendicular lines.

Help students become more proficient with mathematical reasoning and using tools.

If students do not understand how to identify and use the relationships in parallel and perpendicular lines, then use these questions to help them develop proficiency analyzing relationships and using appropriate tools strategically.

- Q: How would you describe the steps for finding the measurements of angles formed by two parallel lines and a transversal?

Q: Describe the relationship between corresponding angles, alternate interior angles, and alternate exterior angles.
- Q: How can you use technology to help find equations of lines parallel or perpendicular to a given line?

Q: How can you use technology to determine if the equations of two lines represent parallel or perpendicular lines?

TOPIC 2

Linguistic Accommodations

PARALLEL AND PERPENDICULAR LINES

Language Accommodations and Oral/Written Discourse

There are many opportunities to interact with the topic’s vocabulary words: by using the Vocabulary Builder activity, the Language Routines, as you Talk About Math Ideas, and review of vocabulary learned in the topic in the Topic Review, the Math Literacy and Vocabulary activity, the student prompts in the margins, the math games, and more.

Activities in this topic offer diverse and engaging experiences with math vocabulary to build confidence and support for all, but particularly for Emergent Bilingual (EB) students in developing both, their academic and language skills.

Topic Vocabulary Support

Topic Vocabulary			
Flow Proof		Spherical Geometry	
Great Circle		Spherical Triangle	
Prior Terms			
Collinear Points	Conjecture	Hypothesis	Paragraph Proof
Line	Counterexample	Inverse	Proof
Plane	Inductive Reasoning	Negation	Theorem
Point	Biconditional	Truth Table	Two-Column Proof
Postulate	Conclusion	Truth Value	Indirect Proof
Angle Bisector	Conditional	Deductive Reasoning	
Construction	Contrapositive	Law of Detachment	
Midpoint	Converse	Law of Syllogism	
Upcoming Terms			
Rigid Motion		Point Symmetry	
Perpendicular Bisector		Reflectional Symmetry	
Composition of Rigid Motions		Rotational Symmetry	
Glide Reflection			
Vocabulary in Context			
Word	Math Meaning	Other Meaning(s)	
Measure	The unit used for stating the size of angles	An official action to achieve an aim	
Remote	Angles that are distant or far apart	A device to operate from a distance; far away in time	
Slope	The steepness of the line given by the ratio $\frac{\text{rise}}{\text{run}}$	A part of a mountain	
Context Setting Vocabulary			
Students will encounter the following terms in this topic, be sure they understand their meaning to make sense of the problem situation.			
Lesson 1 parallel, transversal, pairs of angles, same-side, alternate, proof, angle relationships		Lesson 4 parallel, perpendicular, slope of a line, scaffolding, distance, land bridge, faucets, hoses	
Lesson 2 corresponding angles, parallel, transversal, blueprint		Lesson 5 parallel lines, perpendicular lines, reciprocal, infinite amount, finite amount, plane, antipodal points, hyperbolic, Euclidean, spherical	
Lesson 3 alternate exterior angles, alternate interior angles, remote, remote interior angles			

Metalinguistic Transfer to Spanish

Transferrable Skills
Both English and Spanish uses lower cases for naming the imaginary line around the earth: equator/ <i>ecuador</i> .
Non-Transferrable Skills
While the passive voice is commonly used in English, its use in Spanish language is unnatural and, in many cases, considered a mistake. A wildlife land bridge is being constructed over a highway./Se está construyendo un puente de fauna sobre una autopista.

Cognates

Cognates in this Topic	
Peninsula : Península	Triangle : Triángulo
Theorem : Teorema	Adjacent : Adyacente
Parallelogram : Paralelogramo	
False Cognates	
Glazier A person that fits glass into the frames of windows.	
Glaciar Glacier.	

Academic Vocabulary

Recommended Terms
Although the academic vocabulary can be used anytime during the year, you may emphasize the terms below in written and oral opportunities:
Define To show a point or a line.
Prove To show that something is true.

English Language Proficiency Standards (ELPS)				
Lesson	(1) Listening	(2) Speaking	(3) Reading	(4) Writing
Lesson 1		2B		
Lesson 2	1C			
Lesson 3		2E		
Lesson 4		2B		
Lesson 5		2E		

TOPIC 2

Parallel and Perpendicular Lines

TOPIC OVERVIEW

Lesson	2-1 Parallel Lines	2-2 Proving Lines Parallel	2-3 Parallel Lines and Triangle Angle Sums
	1 DAY	2 DAYS	1 DAY
Essential Understanding	When parallel lines are cut by a transversal, the special angle pairs that are formed are congruent, supplementary, or both.	Pairs of congruent or supplementary angles formed when two lines are cut by a transversal can be used to prove parallel lines.	The sum of the measures of the interior angles of a triangle is 180° , and the measure of an exterior angle of a triangle is equal to the sum of the measures of the remote interior angles.
Mathematics Objectives	- Define parallel lines using the undefined terms <i>point</i> and <i>line</i>. - Prove theorems about lines and angles. - Use theorems to find the measures of angles formed by parallel lines and a transversal.	- Prove that two lines cut by a transversal are parallel using the converses of parallel line angle relationship theorems. - Use properties of parallel lines and transversals to solve real-world and mathematical problems. - Write and use flow proofs.	- Use line constructed parallel to another line to solve problems and prove theorems. - Use the sum of the angle measures in a triangle to solve problems.
Language Objective	Identify parallel lines, corresponding angles, alternate interior angles, and alternate exterior angles using the correct terms.	Explain the steps of a geometric proof concerning parallel lines, using correct terminology.	Read and identify the theorems relating to the interior and exterior angles of a triangle.
Vocabulary	New Vocabulary alternate exterior angles, alternate interior angles, corresponding angles, parallel, transversal	Reinforce Vocabulary alternate exterior angles, alternate interior angles, corresponding angles, parallel, transversal	Reinforce Vocabulary alternate exterior angles, alternate interior angles
TEKS & ELPS	TEKS G.5A, G.6A Mathematical Process Standards G.1B, G.1D, G.1F ELPS Speaking 2B	TEKS G.5A, G.5B, G.6A Mathematical Process Standards G.1A, G.1B, G.1D, G.1F, G.1G ELPS Listening 1C	TEKS G.5A, G.6A, G.6D Mathematical Process Standards G.1A, G.1C, G.1D, G.1F, G.1G ELPS Speaking 2E

The suggested pacing for each lesson is shown for a 45-minute class. In addition allow 1 day for the Topic Review and 1 day for the Topic Assessment.

For planning information such as timing of lesson components and student materials required, find an editable **LESSON PLAN** for each lesson on SavvasRealize.com.

Topic Assessment Options

in Assessment Sourcebook and Online

• Topic Readiness Assessment

• Topic Performance Task

• Topic Assessment

• Benchmark Assessment Topics 1–2

TOPIC OVERVIEW

Lesson	2-4 Slopes of Parallel and Perpendicular Lines	Math Modeling in 3 Acts	2-5 Compare Spherical And Euclidean Geometry
	2 DAYS	1 DAY	1 DAY
Essential Understanding	Two parallel lines have equal slopes. The product of the slopes of perpendicular lines is -1 .	Many real-world problem situations can be represented with a mathematical model, but that model might not represent the real-world situation exactly.	In Euclidean geometry, parallel lines never intersect, while in spherical geometry, all lines eventually intersect. Triangle angle sums differ because Euclidean geometry is flat, while spherical geometry applies to curved surfaces.
Mathematics Objectives	• Show that two lines in the coordinate plane are parallel by comparing their slopes, and use that information to solve problems. • Show that two lines in the coordinate plane are perpendicular by comparing their slopes, and use that information to solve problems.	• Use mathematical modeling to represent a problem situation and to propose a solution. • Test and verify the appropriateness of their math models. • Explain why the results from their mathematical models might not align exactly with the problem situation.	• Compare and contrast geometric relationships in Euclidean and spherical geometry, including the properties of parallel lines and the sum of the angles in a triangle. • Analyze how geometric principles change when applied to a curved surface instead of a flat plane.
Language Objective	• Summarize in writing how slopes can be used to identify parallel and perpendicular lines.	• Describe and solve a problem involving parallel and perpendicular lines using appropriate terms.	• Describe and discuss the key differences between Euclidean and spherical geometry using precise mathematical vocabulary.
Vocabulary	New Vocabulary parallel, perpendicular, slope of a line	Reinforce Vocabulary model, parallel, perpendicular	New Vocabulary great circle, spherical geometry, spherical triangle
TEKS & ELPS	TEKS G.2B, G.2C, G.5B Mathematical Process Standards G.1A, G.1D, G.1F, G.1G ELPS Speaking 2B	TEKS G.2B, G.2C Mathematical Process Standards G.1A	TEKS G.4D Mathematical Process Standards G.1A, G.1D, G.1F, G.1G ELPS Speaking 2E

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TOPIC RESOURCES

DIGITAL	Print and Digital Resources	LESSON	TOPIC	PROGRAM
	Student and Teacher's Edition			
	• Math Walk and Video		•	
	• Pick a Project		•	
	• Math Modeling in 3 Acts		•	
	• Practice & Problem Solving	•		
	• Concept Summary	•		
	• Topic Review		•	
	• Visual Glossary (English and Spanish)			•
	Resource Originals			
	• Reteach to Build Understanding	•		
	• Additional Practice	•		
	• Mathematical Literacy and Vocabulary	•		
	• Enrichment	•		
	• Pick a Project		•	
	• Amazing Contributions	•	•	•
	• Math Walk		•	
	• Game Cards and Instructions for Hands-On Games	•	•	
	Assessment Sourcebook			
	• Course Readiness Assessment			•
	• Progress Monitoring Assessments A, B, C			•
	• Topic Readiness Assessment		•	
	• Exit Ticket	•		
	• Quick Check	•		
	• Topic Assessment		•	
	• Topic Performance Tasks		•	
	• Cumulative/Benchmark Assessments			•
	• Item Analysis Charts and Scoring Guides	•	•	•

DIGITAL	Digital-only Resources	LESSON	TOPIC	PROGRAM
	Savvas Realize			
	Interactive Student Edition	•	•	•
	Student Edition eBook	•	•	•
	Teacher's Edition eBook	•	•	•
	Program Overview			•
	Student Companion	•		
	Lesson Plans	•		
	Math Talks	•		
	Vocabulary Builder Activities	•		
	Interactives powered by Desmos® Calculators and Tools	•		
	Lesson Presentation Slides	•		
	Interactive Practice	•		
	Spiral Review	•		
	Skills Review & Practice	•	•	•
	Digital Math Games		•	
	Student Tutorial Videos	•		
	Interactive Answers & Solutions	•	•	
	Adaptive Practice	•		
	Test Generator	•	•	•
	Family Engagement	•	•	•
	Classroom Videos			•
	Topic Overview Teacher Support Video		•	
	Multilingual Handbook			•
	Problem Solving Model			•
	Scope and Sequence	•	•	•
	Pacing Guide		•	•
	Internalization Protocols			•
	Student and Teacher Progress Trackers	•	•	•
	Editable Assessments and Resource Originals	•	•	•

TOPIC 2

Parallel and Perpendicular Lines

TOPIC OPENER

TOPIC ESSENTIAL QUESTION

What properties are specific to parallel lines and perpendicular lines?

Revisit the Topic Essential Question throughout the topic. Refer to the Topic Review for notes about answering the Topic Essential Question.

Math Walk

 **Math Walk Video:** Generate excitement about the topic by having students watch the Math Walk video.

Question in the Video

How many are in the array?

Questions for Students

You might give students copies of the Math Walk questions or just project them and have students turn and talk to a partner followed by whole-class discussion.

What did you notice?

What did you wonder?

What question in the video is the person trying to answer?

What did you see in the video that would help you answer the question?

What other information do you need to answer the question?

What math do you already know that can help you answer the question?

What math questions do you have about what you saw in the video?

Later in the Topic

Any time after Lesson 2-4, show the video again.

Ask: What math did you learn that could help you answer the question or find the answer in a different way?

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TOPIC ESSENTIAL QUESTION

What properties are specific to parallel lines and perpendicular lines?





MATH WALK

Point of View

Watch the video to see where you might find parallel and perpendicular lines while on a math walk. How does an artist use math to show how objects in a painting are closer to or farther from the viewer?



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Activity

TOPIC 2

Parallel and Perpendicular Lines

Pick a Project

Overview

A variety of rich projects is provided for each topic. Students may select the project that is most interesting to them.

Project	Different Engaging Contexts	Different Activity Modalities	Different Final Products
2A	Math Walk	Explore	Video
2B	Roofing	Design	Drawing
2C	Spherical Geometry	Investigate	Model
2D	Optical Illusions	Research	Illusion

Selecting a Project

Introduce each project option with the students. Sharing the resource masters with students might help them choose.

During the Project

Pacing Projects will be completed over a number of lessons. The amount of time students spend on each project will vary. You may wish to let early finishers choose an additional project.

Grouping You might have students work independently, with a partner, or in small groups.

Content Projects are related to the content of this topic. As students continue their work on projects throughout the topic, new math ideas should be incorporated.

Project Sharing Invite students to share their completed projects with a partner, a small group, or with the whole class. Encourage students to discuss how they demonstrated math processes during the project. Provide students an opportunity for reflection by asking what interesting information they learned and what math they used in the project.

Extension Suggestions are included for each project.

Scoring Guide

Provide a scoring rubric to students as they begin work on the project. A full and editable version can be found online. For students who score Emerging on any goal, review the rubric score with them in detail. Encourage them to update their project, or select a different project, to demonstrate their understanding of the mathematics in this topic.

Sample Scoring Rubric

Emerging (1 point)	Developing (2 points)	Proficient (3 points)	Advanced (4 points)
		Mathematical Concepts Demonstrates understanding of a key mathematical concept from the topic with minimal or no errors.	
		Context Connects mathematical concepts to the project context in a logical and natural way.	
		Presentation Presentation is clear and coherent.	

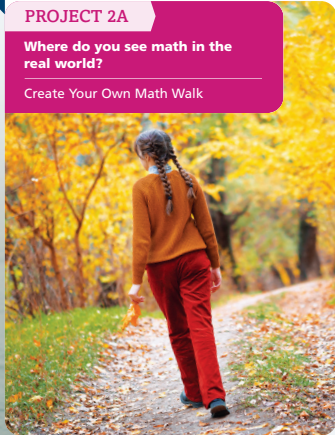
AVAILABLE ONLINE

PICK A PROJECT

PROJECT 2A

Where do you see math in the real world?

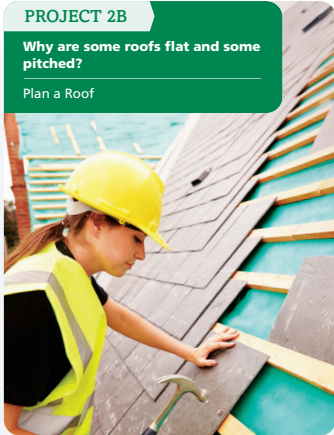
Create Your Own Math Walk



PROJECT 2B

Why are some roofs flat and some pitched?

Plan a Roof



PROJECT 2C

What do parallel lines look like on a sphere? On a hemisphere?

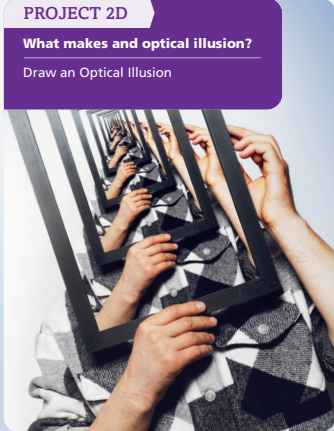
Explore Parallelism



PROJECT 2D

What makes an optical illusion?

Draw an Optical Illusion



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Pick a Project

Project 2A G.5B, G.5C

Materials video recording device

Guidelines Students may brainstorm locations and objects for their Math Walk throughout the topic.

Extension Ask students to explore other questions inspired by their Math Walk.

Project 2B G.6D

Materials graph paper, protractor

Guidelines Encourage students to examine pictures of different roof styles and to research the requirements for different materials.

Extension Interested students may want to research the effects of different types of weather on roofs of different styles. What roof styles are more appropriate for Texas weather conditions?

Project 2C G.4D

Materials a model sphere (ball, globe, etc.)

Guidelines In a thought experiment, such as in this project, students may need to brainstorm ways to check their assumptions. If they get stuck, listen to what they want to try to find out, and help them think of potential materials that might help them investigate their questions.

Extension Students may want to investigate other aspects of spherical geometry. Encourage them to experiment online spherical geometry simulators and add information to their presentations about topics they are interested in, such as polygons on a sphere.

Project 2D G.6A

Materials straightedge, compass, protractor, markers

Guidelines As students investigate the different types of optical illusion, encourage them to examine how they use parallel lines in different ways. Sometimes, lines in an image are parallel but do not look parallel.

Name _____

Topic 2 Pick a Project A

Create Your Own Math Walk

To find math all around you, just take a walk!

Math Walks can focus on many different themes, including nature, art, design, computation, community, or careers.

There are a few criteria for a successful Math Walk.

- It prompts a question that can be solved using math.
- It is a real-world situation or spot.
- You can observe important information during your math walk.

Plan Your Math Walk

What's your question?

What location will you include in your Math Walk?

Answer Your Question

Use math you know to answer your question.

Name _____

Topic 2 Pick a Project C

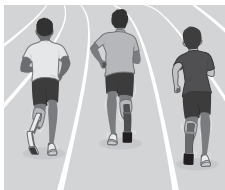
Line Up

Picture train tracks, shelves in a library, or the strings of a guitar. What do these images have in common? They all feature parallel lines. And it turns out there are perpendicular lines in these examples as well. The ties of the train tracks, the edges of the bookshelves, and the frets of the guitar all intersect these parallel lines at right angles.

Parallel and perpendicular lines play a crucial role in many undertakings. Civil engineers use them to design roads, buildings, and bridges. Landscapers rely on them to achieve symmetry in garden layouts, plant spacing, and pathways. Archaeologists use them to map out dig sites and reconstruct facial features based on the shapes of skulls.

Your Project Explore Parallelism

Suppose two people are walking at the same pace along unending parallel lines. The distance between the people stays the same, they have both walked the same distance at any point in time, and they never meet. But now imagine they could walk all the way around a sphere. What would that look like? Would all those observations still be true? Explore parallel and perpendicular lines on a sphere. Build a physical model to demonstrate the concept of parallelism on a sphere. Use a ball, two bowls, or a globe as the base of your sphere. Be creative. Present what you have learned using your model as a visual aid.



enVision® Geometry • Pick a Project

Name _____

Topic 2 Pick a Project B

Up On the Rooftop

A roof is a critical component of shelter, one of humankind's most basic needs. Roofs vary depending on climate, local materials, and designs. For example, Bermuda has no fresh water other than falling rain, so roofs there are designed to funnel rain into underground holding tanks. The weight of snow on a roof can be up to 21 pounds per square foot. A green roof is topped with earth and plants, which cools the building in the summer and insulates it in the winter.

Your Project Plan a Roof

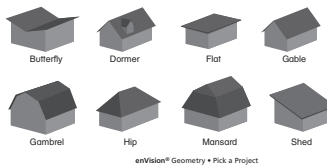
Plan the construction of a roof. Begin by deciding on a roof style. Then choose a roofing material and calculate how many rafters the roof will need.

Decide on the pitch, or slope, of the roof. Decide how many gable studs your roof will have, and calculate the length of each one. (*Hint: Use the Pythagorean Theorem.*)

Some common roofing materials are asphalt shingles, wood shingles, clay tiles, and tin. The heavier the roofing material, the closer together the rafters need to be. Rafters and gable studs are made from 2 in.-by-6 in. boards. Research the cost of the boards. Based on the square footage of your roof, calculate the total cost.

Make a drawing of your roof showing how the rafters will be placed. Include your calculations, the cost of your roof, and an explanation of why you made the choices you did.

Types of Roofs



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Name _____

Topic 2 Pick a Project D

Seeing Is Believing

Have you ever seen a picture and thought it was one thing, only to see something completely different when you looked again? Have stared at a still image and thought it was moving?

Your eyes collect information and transmit it to your brain, which then interprets the information, creating a unique perception of what you are seeing. Your brain fills in holes when information is incomplete and sometimes creates images that are not there.

An *optical illusion* is something that deceives the eye by appearing to be something other than it is. The three main types of illusions are physiological, cognitive, and physical, and they may use shadows, color, or perspective to create the illusion. While many people consider optical illusions to be entertainment, medical and scientific researchers use them to study the mind and diagnose cognitive issues.



Your Project Draw an Optical Illusion

Research how optical illusions are classified, what makes an image an optical illusion, and how they are created. Then draw your own optical illusion and incorporate parallel lines. Your final product should be an optical illusion for others to view and an explanation of how you created it.



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As they create their own optical illusions, remind them first to work in pencil so they can erase, and to try out a small design before committing to the final image so they can be certain to make something that will work as intended.

Extension Students may want to extend their investigation into optical illusions by looking for illusions that distort the size of objects. How can you make two objects that are actually congruent look as though they are different from each other?

Parallel and Perpendicular Lines

TOPIC OPENER

Math Modeling in 3 Acts

Generate excitement about the upcoming Math Modeling in 3 Acts lesson by having students read about the math modeling problem for this topic.

Refer to the Teacher's Edition lesson support for notes about how to use the lesson video in your classroom.

Expand the Learning with Math Games

Encourage students to engage with the math in this topic and further develop their skills with parallel and perpendicular lines by taking on the challenge of the Math Games.

There are multiple types of games throughout the program that provide students with more opportunities for playful exploration and skill practice. For guidance on these games, see the Expand the Learning section in Step 4 of the lesson.

Build G.R.I.T.

While helping students navigate the properties of parallel and perpendicular lines, it's vital to focus on building grit. Encourage students to take time to carefully analyze the various theorems for a deeper understanding of how to use each one. There are many different types of angles created by transversals, so urge students to use visual aids when possible. With deductive reasoning and hard work, students can achieve their mathematical goals.

Grow Confidence

Students can expand on their skill set when analyzing slopes for perpendicular and parallel lines. Help students apply their knowledge of algebra to the geometric scenarios of the lines in this topic.

Resilience

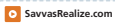
There can be more than one way to model linear relationships in the 3 Act Math Modeling lesson. Encourage students to be resilient if they get stuck and be open to different ideas from their peers.

Self Efficacy

Flow proofs are a valuable tool in students' proof toolbox. Some students may prefer to use more traditional approaches, but encourage students to practice the technique. A visual approach like flow proofs may help some students build confidence when proving results.

Time Management

When two lines are intersected by a transversal, help the students by creating visual notes for each pair of resulting angles. The sooner students understand the angle relationships, the faster they will become at applying the theorems.



MATH MODELING IN 3 ACTS

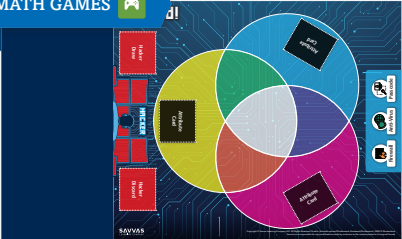


A Preview of Parallel Paving Company

Once a site is prepared, pavers come to smooth hot asphalt.

What extra math is needed if the road crew starts at both ends and meets in the middle?

MATH GAMES



Be a Math Gamer

Gamify your learning with competitive quiz games, vocabulary games, partner/group hands-on games, and STEAMQuests.

You will apply your knowledge and skills in parallel and perpendicular lines as you play the Topic 2 games.



Family Engagement

Involve family in your learning. Go online with your family to access topic and lesson summaries, objectives, standards, and other supports.



Family

70 TOPIC 2 Parallel and Perpendicular Lines

Instructional Routines in This Topic

Lesson	Language Routines	Math Talk / Data Talk
1	Co-Craft Questions and Problems	Every Picture Tells a Story
2	Discussion Supports	Slow Reveal Graphs
3	Collect and Display	Which One Doesn't Belong?
4	Three Reads	Find a Rule
5	Compare and Connect	Equation Detective