Unit 02: Parallel and Perpendicular Lines

Content Area: **Template**
Course(s):
Time Period: **Full Year**
Length: **4 Weeks**
Status: **Published**

Unit 2: Parallel and Perpendicular Lines (Modules 3 and 4)

Unit Rationale

In prior learning, students used postulates to prove theorems about lines and angles. They learned how to construct an angles and bisect a segment. They learned about slope of a line and wrote equations of lines in slope-intercept form. In this unit, students will construct and identify angle pairs formed by transversal. They will identify, explain, and prove the relationship between angle pairs and prove whether two lines are parallel. They will use slope to identify, write, and use equations of parallel and perpendicular lines. They will prove the distance formula and use it to prove congruence of segments on the coordinate plane. In later units, they will use the properties of angles formed by a transversal and parallel lines to prove theorems about triangles. They will investigate transformations in the coordinate plane and use properties of parallel and perpendicular lines to represent transformations. They will write coordinate proofs about triangles and parallelograms.

Essential Questions

- How do parallel lines interact with a transversal, and what geometric properties can we deduce from their relationships?
- How can we apply theorems and postulates to justify that lines are parallel or perpendicular?
- How does the slope of a line define its relationship to other lines, especially parallel and perpendicular lines?
- What are the steps to find the equation of a line that is parallel or perpendicular to a given line through a specific point?

Pre-Assessments

- Into Geometry: Are you ready? Interactive lesson TE p. 76

Instructional Plan

Parallel Lines Crossed by a Transversal (3.1)

Student Learning Intentions or We are learning to … (WALT)

- Identify and explain prove the relationships formed when a transversal crosses parallel lines so that I can prove statements about angle and line relationships.

Student Success Criteria … "I can statements"

- I can identify all pairs of angles formed by a transversal crossing parallel lines.
- I can determine the relationship between angle pairs formed by a transversal crossing parallel lines.

Instructional Strategies and Activities

- Into Geometry Spark Your Learning p. 77D
- Guided Notes
    - Explore angle pairs formed by transversals
    - Investigate transversals and parallel lines
    - Prove relationships between angles pairs formed by parallel lines and a transversal
    - Use parallel lines to determine angle measures
- DeltaMath practice assignment
- Into Geometry Practice p. 82

Formative Assessments

- Into Geometry Check Understanding

Instructional Materials and Resources

- Into Math resources
- DeltaMath
- Desmos

Reflections and Suggested Modifications

Prove Lines and Parallel (3.2)

Student Learning Intentions or We are learning to … (WALT)

- Students will be able to prove whether or not two lines are parallel.

Student Success Criteria … "I can statements"

- I can construct two parallel lines using corresponding angles.
- I can ensure that two lines are parallel by construction.

Instructional Strategies and Activities

- Into Geometry Spark Your Learning TE p. 85D
- Guided Notes
    - Construct parallel lines
    - Converses of the Parallel Lines Theorem
    - Prove whether or not two liens are parallel
    - Transitive Property of Parallel Lines
- DeltaMath practice assignment
- Into Geometry Practice p. 90

Formative Assessments

- Into Geometry Check Your Understanding Interactive Lesson

Instructional Materials and Resources

- Into Math resources
- DeltaMath
- Desmos

Reflections and Suggested Modifications

Prove Lines are Perpendicular (3.3)

Student Learning Intentions or We are learning to … (WALT)

- Students will be able to define and construct the perpendicular bisector of a line segment as the set of points that are equidistant from its endpoints.

Student Success Criteria … "I can statements"

- I can identify and construct a perpendicular bisector
- I can ensure that a line is a perpendicular bisector of a segment by construction.

Instructional Strategies and Activities

- Into Geometry Spark Your Learning TE p. 93D
- Guided Notes
    - Prove the Perpendicular Bisector Theorem
    - Prove the Converse of the Perpendicular Bisector Theorem
    - Construct perpendicular bisectors and lines
    - Use theorems about right angles
- DeltaMath practice assignment
- Into Geometry Practice p. 98

Formative Assessments

- Into Geometry Check Your Understanding Interactive Lesson

Instructional Materials and Resources

- Into Math resources
- DeltaMath
- Desmos

Reflections and Suggested Modifications

Slope and Equations of Parallel Lines (4.1)

Student Learning Intentions or We are learning to … (WALT)

- Use slope to identify, write, and utilize equations of parallel lines to understand how geometric properties can be algebraically represented and applied in problem-solving contexts.

Student Success Criteria … "I can statements"

- I can determine the slope of a line given an equation.
- I can determine if two lines are parallel using the slope criteria.
- I can find the equation of a line that is parallel to a given line.

Instructional Strategies and Activities

- Into Geometry Spark Your Learning TE p. 105D

- Guided Notes
    - Investigate properties of parallel lines
    - Identify parallel segments
    - Prove the slope criteria of parallel lines
    - Write equations of parallel lines
    - Write equations of parallel, horizontal, and vertical lines
    - Apply the slope criteria for parallel lines
- DeltaMath practice assignment
- Into Geometry Practice p. 111

Formative Assessments

- Into Geometry Check Your Understanding Interactive Lesson

Instructional Materials and Resources

- Into Math resources
- DeltaMath
- Desmos

Reflections and Suggested Modifications

Slope and Equations of Perpendicular Lines (4.2)

Student Learning Intentions or We are learning to … (WALT)

- Write the equation of a line that is perpendicular to a given line, understanding the geometric relationship between perpendicular lines and applying it to solve mathematical problems involving spatial relationships and line properties

Student Success Criteria … "I can statements"

- I can recognize when two lines are perpendicular by comparing their slopes.
- I can write the slope of a line that is perpendicular to a line with a given equation.
- I can use slope to write the equation of a line that is perpendicular to a given line.

Instructional Strategies and Activities

- Into Geometry Spark Your Learning TE p. 115D
- Guided Notes
    - Investigate properties of perpendicular lines and segments
    - Prove the slope criteria for perpendicular lines
    - Write equations of perpendicular lines
    - Apply the criteria for slopes of perpendicular lines
- DeltaMath practice assignment

- Into Geometry Practice p. 120

Formative Assessments

- Into Geometry Check Your Understanding Interactive Lesson

Instructional Materials and Resources

- Into Math resources
- DeltaMath
- Desmos

Reflections and Suggested Modifications

Write a Coordinate Proof (4.3)

Student Learning Intentions or We are learning to … (WALT)

- Use coordinates to prove simple geometric theorems algebraically, then analyze and verify geometric properties using algebraic methods.

Student Success Criteria … "I can statements"

- I can apply the distance formula if given two points.
- I can verify the distance between two points by using the distance formula with the Pythagorean theorem.
- I can use the Distance Formula to show congruence on the coordinate plane.

Instructional Strategies and Activities

- Into Geometry Spark Your Learning TE p. 123D
- Guided Notes
    - Prove the distance formula
    - Prove the midpoint formula
    - Use the distance formula to find segment length and prove congruence
    - Apply the distance formula to a real world problem
- DeltaMath practice assignment
- Into Geometry Practice p. 128

Formative Assessments

- Into Geometry Check Your Understanding Interactive Lesson

Instructional Materials and Resources

- Into Math resources
- DeltaMath
- Desmos

Reflections and Suggested Modifications

Write Proofs about Lines (2.3)

Student Learning Intentions or We are learning to … (WALT)

- Use congruence and the Segment Addition Postulate to complete proofs about segments.

Student Success Criteria … "I can statements"

- I can use properties of segments to show congruence.

Instructional Strategies and Activities

- Into Geometry Spark Your Learning
- Guided Notes
- DeltaMath practice assignment
- Into Geometry Practice

Formative Assessments

- Into Geometry Check Your Understanding Interactive Lesson

Instructional Materials and Resources

- Into Math resources
- DeltaMath
- Desmos

Reflections and Suggested Modifications

Modifications and/or Accommodations

Suggested Modifications (ELL, Sp. Ed, Glfted, At-risk of Failure)

English Language Learners

Native language support: The teacher provides auditory or written content to students in their native language.

Adjusted Speech: The teacher changes speech patterns to increase student comprehension. This could include facing the students, paraphrasing, clearly indicating the most important ideas, and speaking more slowly.

Visuals: The teacher uses graphics, pictures, visuals, and manipulatives. This helps ELL students better understand and comprehend the subjects at hand.

Front-Loading Vocabulary: The teacher front loads vocabulary. This means providing students with a list of important vocabulary words they will need to know for a book, lesson, etc. prior to the lesson being taught. Including pictures to go with the vocabulary words is also very beneficial for the students.

Special Education Students

Chunking: The teacher presents information in a way that makes it easy for students to understand and remember. Chunking is based on the presumption that our working memory is easily overloaded by excessive detail. The best way to deliver information is to organize it into meaningful units. Because students with special needs get overloaded easily, chunking is an effective strategy to use with them.

Checking for Understanding: It is important to constantly check for understanding, especially for students who have accommodations. Teachers want to make sure students understand the concepts being covered in a way that makes sense to them.

Extra time: The teacher provides students with special needs extra time to complete work or answer questions. It is important to give students enough time to process their thoughts.

Oral Reading: The teacher will read work orally to students. Class work such as tests and literature circles may need to be read aloud to the student.

Timers: The teacher will use timers as an instructional tool. The use of timers is beneficial for students who have trouble completing tasks. Timers can be helpful so the student is aware of how much time they have to complete an assignment.

Students with 504 Plans

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Gifted & Talented Strategies

Extensions/Enrichments: Teachers will provide gifted and talented students with extension/enrichment projects. Students will be challenged to further their understanding, to apply acquired knowledge, and/or to produce something in reference to acquired knowledge.

Modify/Change Activities: Teachers will monitor and modify activities to accommodate those students who need to be challenged further. Additional reading, problem-solving, writing, or project work is necessary for those students who are ready to move on at a rate more accelerated than their peers. In this way, G & T students are provided the same opportunity for support as special needs students.

Students at Risk of School Failure

Directions or Instructions: Make sure directions and/or instructions are given in limited numbers. Give directions/instructions verbally and in simple written format. Ask students to repeat the instructions or directions to ensure understanding occurs. Check back with the student to ensure he/she hasn't forgotten.

Peer Support: Peers can help build confidence in other students by assisting in peer learning. Many teachers use the 'ask 3 before me' approach. This is fine, however, a student at risk may have to have a specific student or two to ask. Set this up for the student so he/she knows who to ask for clarification before going to you.

Alternate or Modified Assignments: Always ask yourself, "How can I modify this assignment to ensure the students at risk are able to complete it?" Sometimes you'll simplify the task, reduce the length of the assignment or allow for a different mode of delivery. For instance, many students may hand something in, the at-risk student may jot notes and give you the information verbally. Or, it just may be that you will need to assign an alternate assignment.

Increase One to One Time: When other students are working, always touch base with your students at risk and find out if they're on track or needing some additional support. A few minutes here and there will go a long way to intervene as the need presents itself.

Contracts: It helps to have a working contract between you and your students at risk. This helps prioritize the tasks that need to be done and ensure completion happens. Each day write down what needs to be completed, as the tasks are done, provide a checkmark or happy face. The goal of using contracts is to eventually have the student come to you for completion sign-offs.

Hands On: As much as possible, think in concrete terms and provide hands-on tasks. This means a

child doing math may require a calculator or counters. The child may need to tape record comprehension activities instead of writing them. A child may have to listen to a story being read instead of reading it him/herself.

Tests/Assessments: Tests can be done orally if need be. Break tests down in smaller increments by having a portion of the test in the morning, another portion after lunch and the final part the next day.

Seating: Seat students near a helping peer or with quick access to the teacher. Those with hearing or sight issues need to be close to the instruction which often means near the front.

Integration of Diversity, Equity and Inclusion; Climate Change; Informational and Media Literacy

Diversity, Equity, and Inclusion

NCTM: Access and Equity in Mathematics Education

A Pathway to Equitable Math Instruction

Provide students with opportunities to give feedback to teachers about the classroom and instruction.

• Verbal Example: Fist to five, How well do you understand what we talked about today? Fist to five, How well did I teach this today?

• Classroom Activity: Exit tickets or surveys that ask students to identify how well teachers taught, what helped them learn, what got in the way of their learning, etc.

Treat mathematics as a language that everyone is learning while authentically centering students home languages.

• Classroom Strategies: Color-coding ideas, learning vocabulary in student languages, visual and kinesthetic learning, representations of learning without words.

• Classroom Activity: Multilingual Frayer Models for
definitions or concepts

Incorporate true culturally relevant pedagogy, practice, and curriculum.

• Verbal Example: What are some of your family traditions that you are proud of? Would you be okay if we brought some of those into the classroom?

• Classroom Activity: Use Ankara fabric to teach mathematical concepts such as tessellations, fractions, area, percentages, etc.

Incorporate the history of mathematics into lessons.
• Verbal Example: Why do you think we call it Pythagorean's theorem, when it was used before he was even born? What should we call it instead?
• Classroom Activity: Learn about different bases and numerical ideas: Base 2, binary and connections to computer programming, how the Yoruba of Nigeria used base 20, and how the Mayans conceptualized the number 0 before the first recording of it

Solicit student ways of thinking and processing.
• Verbal Example: How might you all go about this? What do you notice?
• Classroom Activity: Incorporate explorations, where students interact with mathematics in a way that allows them to "discover" or experience mathematics.

Reorganize your classroom teaching around concepts, and teach them more like a web rather than discrete sets of knowledge.
• Verbal Example: How does this connect to what you've learned in the past? How can you use that knowledge today?
• Classroom Activity: Learning webs that connect content

Start with more complex math problems and scaffold as necessary.
• Verbal Example: If we wanted to build a rocket, what are all the things we might need to know before we get started? Along the way, we decided that we want the rocket to reach the moon. What do we need to consider now?
• Classroom Activity: When solving equations, start with the most complex problem, generate ideas for how to solve it, and use the simpler equations as examples to support those ideas.

Offer a variety of ways to demonstrate thinking and knowledge.
• Verbal Example: Show your thinking with words, pictures, symbols.

Ask other questions that will demonstrate learning when it is not clear to you how students know the answer.
• Verbal Example: If you were working with a fellow mathematician who was absent this day, what might you tell them to help them learn it?

Learn about, engage with, and incorporate ethnomathematics.
• Verbal Example: Reflect on your day so far. What math have you already used today?
• Classroom Activity: Community walks to engage with slope.

Co-construct knowledge in the classroom.

• Verbal Example: Let's get into partners and do a think pair-share. We will incorporate everyone's ideas and try to synthesize them.
• Classroom Activity: Have students create mathematical definitions in their own words in groups, and bring the groups together to co-construct mathematical definitions as a class

Choose problems that have complex, competing, or multiple answers.
• Verbal Example: Come up with at least two answers that might solve this problem.
• Classroom Activity: Challenge standardized test questions by getting the "right" answer, but justify other answers by unpacking the assumptions that are made in the problem.
• Classroom Activity: Deconstructed Multiple Choice
- given a set of multiple choice answers, students discuss why these answers may have been included (can also be used to highlight common mistakes).

Identify what is right about the thinking, and highlight the mistake in what is factually or procedurally accepted.
• Verbal Example: You recognized that you had to combine the constants 27 and 9, could you explain your thinking?
• Classroom Activity: Error Analysis worksheets that highlight what is the right idea behind the mistake.

Using thoughtful questioning to solicit mathematical thoughts rather than telling.

• Verbal Example: What would a mathematician who is confused ask about this question?

• Classroom Activity: After students demonstrate knowledge of a topic, have them play a game where they have to explain their topic to a fellow mathematician and a skeptic. Develop their own reflective questioning/explaining in all three roles.

Create multiple ways of participating that honor myriad ways of thinking and being.
• Verbal Example: For this section, feel free to work alone, in pairs, trios, or quads (let them choose).
• Classroom Activity: Community circles or storytelling circles, incorporating dance, music, song, call and response, and other cultural ways of communicating.

Climate Change

Math Climate Change Companion Guide

New Jersey Student Learning Standards: Content Area

MATH.9-12.G.CO.A.1	Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment,

	based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
MATH.9-12.G.CO.C.9	Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.
MATH.9-12.G.CO.D.12	Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.
MATH.9-12.G.GPE.B.4	Use coordinates to prove simple geometric theorems algebraically.
MATH.9-12.G.GPE.B.5	Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).

Integration of Career Readiness, Life Literacies and Key Skills

TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CI.2	Identify career pathways that highlight personal talents, skills, and abilities (e.g., 1.4.12prof.CR2b, 2.2.12.LF.8).
TECH.9.4.12.CI.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
TECH.9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
TECH.9.4.12.TL.3	Analyze the effectiveness of the process and quality of collaborative environments.

Integration of Computer Science and Design Thinking

CS.9-12.8.1.12.AP.1	Design algorithms to solve computational problems using a combination of original and existing algorithms.
CS.9-12.8.1.12.AP.5	Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.

Interdisciplinary Connections: NJSLS for ELA, Social Studies, Science and/or Math

ELA.RI.MF.9–10.6	Analyze, integrate, and evaluate multiple interpretations (e.g., charts, graphs, diagrams, videos) of a single text or text/s presented in different formats (visually, quantitatively) as well as in words in order to address a question or solve a problem.
ELA.W.AW.9–10.1.E	Provide a concluding paragraph or section that supports the argument presented.

Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

21st Century Life and Career

TECH.9.4.12.TL	Technology Literacy
TECH.9.4.12.TL.1	Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task (e.g., W.11-12.6.).
TECH.9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
TECH.9.4.12.TL.3	Analyze the effectiveness of the process and quality of collaborative environments.
TECH.9.4.12.TL.4	Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem (e.g., 7.1.AL.IPERS.6).
	Digital tools differ in features, capacities, and styles. Knowledge of different digital tools is helpful in selecting the best tool for a given task.
	Collaborative digital tools can be used to access, record and share different viewpoints and to collect and tabulate the views of groups of people.