

Lesson Outline: Parallel and Perpendicular Lines

Prerequisite Skills:

- Students should know the basics of linear graphs like the meaning of slope and intercept, how to graph in slope-intercept form and point-slope form.
- What “perpendicular” means and how it relates to a right angle.

Grade Level: Algebra 1 (9th grade)

The lesson was designed to be done after the students have learned how to graph lines in slope-intercept and point-slope form and before the students start talking about systems of linear equations.

Learning Goals:

- Students will be able to explain what parallel and perpendicular lines are.
- Students will be able to create a rule for when two lines are parallel, perpendicular, or neither based on slope.

Common Core Standards:

CCSS.MATH.CONTENT.HSG.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).

Mathematical Practices:

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
5. Use appropriate tools mathematically
6. Attend to precision

Materials:

- Chromebooks or other computers so students can access the PhET simulation: https://phet.colorado.edu/sims/html/graphing-lines/latest/graphing-lines_en.html?screens=3
- Worksheets
- Exit Tickets
- Challenge Problems

Time	Students	Teacher
5 min	Go to the PhET simulation and explore what the controls do. The students are encouraged to try everything on the page.	Directs students to the PhET website by providing a link (probably a shortened one that should be edited directly in the activity worksheet) Walks around making sure the students are not getting lost and helping guide students to try controls they have not already.

5 min	Write about what the points do and what the “Save Line” button does.	Check student answers to see if there are any misconceptions.
8-10 min	Explore parallel lines by creating pairs of parallel lines and then seeing what changes and what does not.	Make sure students are using the “Save Line” button correctly (I think this is the easiest thing for the students to trip up on)
3-5 min	Explain what they found about parallel lines. The goal at this point is that students should recognize that parallel lines have the same slope.	Lead a discussion so that students can explain what they found about parallel lines. This could be a whole class discussion or you could have students share their thoughts in groups or pairs.
10-15 min	<p>Attempt to create pairs of perpendicular lines. The students should test whether their lines are perpendicular using a right angle. This could be the corner of a piece of paper or something the teacher provides.</p> <p>Students will write pairs of equations they find on the board for everyone to see. Then, the students will try to discover a pattern in the equations to see what all pairs of perpendicular lines have in common.</p> <p>(I originally was going to have them just write the slope since that is the important part, but I decided to change it to the full equations so they can figure out that the slope is what matters. You can change this if you prefer)</p>	<p>Verify that students understand what perpendicular lines are and that the students are creating perpendicular lines.</p> <p>I think one of the toughest parts of this lab is going to be creating precisely perpendicular lines. The worksheet asks the students to identify something in the room that has perpendicular lines. It would be useful to check in with students to see what they identified and to push the students to identify something at their table (like a piece of paper).</p> <p>The teacher should urge the students to check whether their lines are perpendicular in some way.</p>
4-6 min	Students can ask questions or bring up ideas they had as they worked on the sim.	<p>Lead a discussion to help solidify the idea that perpendicular lines have slopes that are opposite reciprocals. This would also be a good time to address any difficulties or misconceptions that arose during the activity.</p> <p>If there is time, this could also be a good time to address interesting questions such as:</p>

		<p>If I have a line, how many lines could I find that are parallel/perpendicular to that line?</p> <p>Are all pairs of lines either parallel or perpendicular to each other?</p>
5 min	<p>Students complete an exit ticket testing whether they can identify pairs of lines that are parallel, perpendicular, or neither.</p>	<p>Teacher distributes exit tickets.</p> <p>The exit tickets could be interesting to revisit at the beginning of the next class.</p> <p>Important ideas:</p> <ul style="list-style-type: none">• People can provide different parallel or perpendicular lines, but both be correct because there are an infinite number of correct equations.• All that matters is slope. The y-intercept does not matter when considering parallel or perpendicular.