Systems of Inequalities

Students graph a system of two linear inequalities by shading each one and keeping the overlap, and decide whether a point is a solution by testing it in both.

TIME	35 minutes (one student with a parent or tutor, or a small group)
WHO	Math 1 (algebra readiness), about age 12. Follows Unit 6, Lesson 4.
MATERIALS	Student worksheet (PDF), the Deep Dive 5 interactive page for this lesson, pencil, two colored pencils, graph paper
PRIOR KNOWLEDGE	Graphing one linear inequality (Unit 5, Lesson 2). What a solution of a system means (Lesson 1). Parallel lines (Unit 4).
STANDARDS	NC Math 1 NC.M1.A-REI.12 (graph the solution set of a system of linear inequalities as the intersection of half-planes).
KEEP OUT	Story constraints (Lesson 6).

Learning goals

1. Graph a system of two inequalities by shading each one with its own boundary style and side, and identify the overlap as the solution.
2. Test a point in both inequalities and decide whether it is in the overlap.
3. Explain why the edges of the overlap keep their own style and why a point on a dashed edge is not a solution.
4. Recognize an empty overlap (no solution) when parallel boundaries face away from each other.

Vocabulary: say both, every time

The rule for the whole lesson: whenever the adult or the student says a math word, they follow it with the plain-English version. Proper term first, plain English second, until the student does it without being asked.

TERM	LOOKS LIKE	PLAIN ENGLISH
System of inequalities	two at once	All must hold.
Overlap	shaded by both	The solutions; the feasible region.
Test in both	both sentences	All true means solution.
Edges	keep their style	Dashed edges excluded.

> THE ONE SENTENCE TO SAY OUT LOUD
>
> Shade the first. Shade the second in another color. The overlap is the answer. It has to obey every inequality.

Lesson timeline (35 minutes)

0:00 to 0:05	**Warm-up: Unit 5 twice.** Shade $y \leq x + 1$. Then, in a second color, shade $y > -x + 3$. Ask where both colors are.
0:05 to 0:14	**Mini-lesson: the overlap.** Name it. Test (4, 2), (0, 0), and (1, 2) on the dashed edge, in both. Say the rule: it has to obey every inequality. Then the two figures with different shapes of overlap, including the vertical-and-horizontal corner.
0:14 to 0:22	**Checkers.** The two interactive overlap checkers: in, out, on a dashed edge, on a solid edge.
0:22 to 0:32	**Practice.** The practice problems or Worksheet Parts A and B. Same buttons: Hint, Show next step, Reveal answer, Hide help. Include the empty-overlap case.
0:32 to 0:35	**Exit ticket.** Worksheet Part D, item 3. Success looks like yes and no with both checks.

Misconceptions to listen for

- **One shading is enough.** Both, and only the overlap counts.
- **Testing in one inequality.** Both.
- **The overlap's edges are all solid.** Each keeps its own style.
- **Every system has an overlap.** Parallel boundaries facing away give none.

Support and stretch

Support

Use two colors, or color one and hatch the other. Trace the overlap with a finger before testing points. Keep the boundaries with whole-number m and b.

Stretch

Ask for a system whose overlap is a triangle (three inequalities). Ask for a system whose overlap is a single strip between two parallel lines.

Where this goes next

Lesson 6: systems in the real world. Two equations from a story, and two constraints whose overlap is every plan that obeys both limits.

> THE HABIT TO BUILD
>
> Shade both, keep the overlap, test in both.