Reading a Graph: The Behaviors

Students learn one repeatable checklist for reading any graph, formula or not: intercepts, increasing or decreasing, positive or negative, maximum and minimum, and end behavior, saying where with an inequality and what it means in the story.

TIME	45 minutes (one student with a parent or tutor, or a small group)
WHO	Math 1 (algebra readiness), about age 12. Follows Unit 2, Lesson 3 (domain and range).
MATERIALS	Student worksheet (PDF), the Deep Dive 5 interactive page for this lesson, pencil, two colors of highlighter
PRIOR KNOWLEDGE	Reading points (x, y). Domain and range (Lesson 3). Continuous versus discrete (Lesson 2). Inequalities like $3 < x < 15$ (Unit 1, Lesson 6).
STANDARDS	NC Math 1 NC.M1.F-IF.4 (interpret key features of graphs: intercepts, intervals where increasing or decreasing, positive or negative, maximums and minimums, end behavior) and NC.M1.F-IF.7.
KEEP OUT	No formulas for the graphs, on purpose. No slope, no $y = mx + b$ (Unit 3). No interval notation: inequalities only.

Learning goals

1. Find the x-intercepts (output 0) and the y-intercept (input 0, the starting value) and say what each means in the story.
2. Say where a graph is increasing and where it is decreasing, reading left to right, with an inequality for each stretch.
3. Say where a graph is positive and where it is negative, and explain why increasing and positive are different questions.
4. Name the maximum and minimum with both coordinates, and describe end behavior plainly first and then with the word infinity.

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
Intercept	crosses an axis	x-intercept: output is 0. y-intercept: input is 0, the starting value.
Increasing, decreasing	climbing, falling	Read left to right. Say where with an inequality.
Positive, negative	above, below the x-axis	Which side of the axis the output is on. Not the same as climbing or falling.
Maximum, minimum	highest, lowest point	Give x and y. Can be at an end.
End behavior	the far ends	Keeps climbing, keeps falling, levels off. Then: as x goes to infinity, y goes to ...

> THE ONE SENTENCE TO SAY OUT LOUD
>
> Read left to right. Where does it cross? Is it climbing or falling? Above or below the axis? Where is the top and the bottom? What do the far ends do? Say where with an inequality, and say what it means.

Lesson timeline (45 minutes)

0:00 to 0:05	**Warm-up: no formula.** Show the temperature graph. Ask: "When was it coldest? Warmest? When was it warming up?" Point out that nobody used a formula, and that these questions have names.
0:05 to 0:15	**Mini-lesson: the checklist.** Go through the five steps on the ball graph, saying each math word with its plain English. Stop hard at step 3: highlight where the graph is climbing in one color and where it is above the axis in another, and show that the colors do not match. Say: "Increasing is direction. Positive is place."
0:15 to 0:27	**Read these graphs.** Student works the three interactive graphs (temperature, freezer test, end behavior), typing answers and checking. For every from-to answer, have them say the inequality out loud: "increasing when 3 is less than x is less than 15."
0:27 to 0:40	**Practice.** Interactive practice problems or Worksheet Parts B to E. Same buttons: Hint, Show next step, Reveal answer, Hide help. Ask for the story meaning of every intercept and every maximum.
0:40 to 0:45	**Exit ticket.** Worksheet Part F or an index card: the diver's graph, decreasing when, negative when, both when. Success looks like: $0 < x < 2$; $1 < x < 3$; $2 < x < 3$.

Misconceptions to listen for

- **Increasing means positive.** The most common one. Highlight direction and place in two colors until they see the difference.
- **Reading right to left.** A graph read backwards flips increasing and decreasing. Always left to right, like a sentence.
- **Giving one coordinate for a maximum.** Where it happens (x) and how high (y). Both.
- **Missing a maximum or minimum at the edge.** The highest point can be the very first point.
- **Saying where with a single number.** Increasing at 4 is not a stretch. Increasing when $4 < x < 9$ is.
- **Skipping the plain-English end behavior.** Say keeps climbing before saying goes to infinity, or the words stay empty.

Support and stretch

Support

Give the checklist as a printed card with the five questions in plain English. Use the highlighters every time. Let the student describe the story in words first (rising, falling, on the ground) and then attach the math word to each phrase.

Stretch

Ask for a graph that is increasing and negative for its whole length, then one that is decreasing and positive. Ask what the end behavior of a temperature graph should be if the record went on for a week. Introduce a graph with two maximums and ask which is the higher one.

Where this goes next

Lesson 5: graphing stories. The checklist words become the vocabulary for telling the story a graph shows, sketching a graph from a story, and matching graphs to stories, including the distance-versus-speed mix-up.

> THE HABIT TO BUILD
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> On every graph, run all five steps in the same order, out loud, and say where with an inequality. The order is the habit.