Reading the Graph

Students read the key features of an exponential graph (y-intercept, domain, range, horizontal asymptote, end behavior, increasing or decreasing), trace each back to a or b, explain why the curve never touches the x-axis, and match equations to graphs by elimination.

TIME	45 minutes (one student with a parent or tutor, or a small group)
WHO	Math 1 (algebra readiness), about age 12. Follows Unit 7, Lesson 3.
MATERIALS	Student worksheet (PDF), the Deep Dive 5 interactive page for this lesson (the zoom graph needs a screen), pencil, graph paper
PRIOR KNOWLEDGE	y = a · b^x, growth and decay (Lessons 2 and 3). Domain and range (Unit 2). Reading a line's graph and matching by elimination (Unit 3, Lesson 3).
STANDARDS	NC Math 1 NC.M1.F-IF.4 (interpret key features: intercepts, intervals of increase or decrease, end behavior), NC.M1.F-IF.7 (graph exponential functions showing intercepts and end behavior), NC.M1.F-LE.3.
KEEP OUT	Vertical shifts and other transformations (later). Interval notation (not used). Logarithms.

Learning goals

1. List the key features of an exponential graph and say which of a or b each comes from.
2. Explain why the curve never touches the x-axis, and name y = 0 as the horizontal asymptote.
3. Describe end behavior plainly and then with the words as x goes to infinity or negative infinity.
4. Match an equation to its graph in two looks: direction from b, then crossing from a.

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
y-intercept	(0, a)	Because $b^0 = 1$.
Domain, range	all reals; y greater than 0	Never 0, never negative.
Asymptote	y = 0	Approached, never touched.
End behavior	far right, far left	Plain first, then math words.
Increasing, decreasing	b above or below 1	Direction.

> THE ONE SENTENCE TO SAY OUT LOUD
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> It crosses at a. It never touches the x-axis. b decides which way it goes. Say the ends plainly, then in math words.

Lesson timeline (45 minutes)

0:00 to 0:05	**Warm-up: walk left.** Powers of 2 walking left: 8, 4, 2, 1, one half, one quarter. Ask if it ever reaches 0, and why not.
0:05 to 0:17	**Mini-lesson: four features.** y-intercept, domain, range, asymptote, each with its reason. Draw the dashed line. Then end behavior on the growth and decay examples: plain sentence first, then the infinity wording. Run the zoom-out graph.
0:17 to 0:27	**Read the graph, then match.** The two key-feature graphs, then the two-look elimination habit on the match widget. Insist on direction first, crossing second, no plugging in.
0:27 to 0:40	**Practice.** The practice problems or Worksheet Parts A to E, including the sketch. Same buttons: Hint, Show next step, Reveal answer, Hide help.
0:40 to 0:45	**Exit ticket.** Worksheet Part F. Success looks like (0, 7), y = 0, increasing; and both ends described both ways.

Misconceptions to listen for

- **The curve touches the x-axis.** It only approaches. Positive times positive stays positive.
- **Range is all reals.** y stays above 0.
- **Growth goes to 0 on the right.** Growth goes to 0 on the left; decay on the right.
- **Matching by plugging in.** Two looks: b then a.
- **The asymptote is part of the graph.** It is a reference line the graph never reaches.

Support and stretch

Support

Keep the walk-left list on the desk. Have the student trace the curve with a finger and say plain sentences before the infinity words. Use the zoom buttons to see the hug.

Stretch

Ask what changes if a is negative (the curve flips below the axis, range y less than 0, same asymptote). Ask how you could tell b = 2 from b = 3 on two climbing curves crossing at the same a.

Where this goes next

Lesson 5: linear or exponential? Deciding from a table, a story, or a graph, and seeing why the exponential eventually wins.

> THE HABIT TO BUILD
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> Crossing at a, direction from b, asymptote y = 0. Say the ends plainly, then in math words.