Linear Functions in the Real World

Students read m and b in stories (rate and starting value), write and use linear models, test situations for a constant rate of change, and compare two linear functions given in different representations.

TIME	45 minutes (one student with a parent or tutor, or a small group)
WHO	Math 1 (algebra readiness), about age 12. Follows Unit 3, Lesson 4 (writing the equation of a line).
MATERIALS	Student worksheet (PDF), the Deep Dive 5 interactive page for this lesson, pencil, calculator optional
PRIOR KNOWLEDGE	y = mx + b, the jobs of m and b, and writing the equation from a graph, table, or points (Lessons 2 and 4). Solving equations with x on both sides (Unit 1, Lesson 5).
STANDARDS	NC Math 1 NC.M1.F-LE.1 (distinguish linear situations), NC.M1.F-LE.3 and F-LE.5 (interpret parameters in context), NC.M1.F-IF.9 (compare functions represented differently), NC.M1.A-CED.1.
KEEP OUT	Exponential growth beyond naming it as not linear. Systems of equations as a topic (Unit 6); here, setting two rules equal is enough.

Learning goals

1. Identify the starting value (b) and the rate (m, with its sign) in a story and write the model y = mx + b.
2. Use the model to predict an output and to solve for the input that gives a target output, including the x-intercept as when the story hits zero.
3. Decide whether a situation is linear by checking for a constant rate of change (equal differences with equal steps).
4. Compare two linear functions given as an equation, a graph, a table, or a story: which starts higher, which grows faster, and when they are equal.

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
Rate	m, per hour or per mile	How much y changes for each one of x. Negative when going down.
Starting value	b, the flat fee	The amount when x = 0.
Constant rate of change	equal differences	The same change every step: linear.
Linear, not linear	line or not	Constant rate, or a changing rate.
Compare	bigger b, bigger m, set equal	Starts higher, grows faster, equal when.

> THE ONE SENTENCE TO SAY OUT LOUD
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> Start is b, rate is m. Write rate times x plus start. Same change every step means linear. Starts higher, grows faster, equal when.

Lesson timeline (45 minutes)

0:00 to 0:05	Warm-up: a taxi. $3 to get in, $2 a mile. Ask for the cost of 1, 2, 3 miles, then the rule. Name the parts: 3 is the start (b), 2 is the rate (m). Ask what the 3 and the 2 look like on a graph.
0:05 to 0:15	Mini-lesson: build and use. The savings jar (predict after 6 weeks; solve for when it reaches 250) and the draining tank (negative rate; the x-intercept is when it is empty). Say start and rate every time. Then the linear test: two tables side by side, subtract down, one constant and one not.
0:15 to 0:25	Sort, then compare. The Is this linear sorting activity, saying the differences out loud. Then Plan A versus Plan B: pull m and b from each, ask the three questions, set the rules equal and solve, and check the crossing on the graph.
0:25 to 0:40	Practice. The practice problems or Worksheet Parts A to D. Same buttons: Hint, Show next step, Reveal answer, Hide help. Require units on every rate.
0:40 to 0:45	Exit ticket. Worksheet Part F or an index card. Success looks like: $y = 2c + 5$ with 5 the start and 2 the rate; linear with $m = 4$; A starts higher, B grows faster, equal at 5 months.

Misconceptions to listen for

- **The bigger number is the rate.** The rate is the per-something, whatever its size. The one-time amount is the start.
- **Going down still gets a positive m.** Draining, burning, descending: m is negative.
- **A table is linear if the numbers go up evenly-ish.** The differences must all be exactly the same.
- **Starts higher means better.** Depends on the question. For cost, lower is better; for savings, higher is better. Read the story.
- **Comparing only b.** The faster grower overtakes. Ask all three questions.
- **Setting two rules equal is a new trick.** It is Unit 1: x on both sides, gather the x terms, solve.

Support and stretch

Support

Use money stories first: fee and per-item are the clearest start and rate. Give the three comparison questions on a card. Build the table from the story before writing the rule.

Stretch

Give two plans that never cost the same (parallel lines) and ask why. Give a story with a rate per 5 minutes and ask for the rate per minute. Ask for a story that is linear for a while and then stops being linear.

Where this goes next

The optional Lesson 6 looks at two other ways to write a line, standard form and point-slope form, and how to turn each back into y = mx + b. After that, Unit 4: parallel and perpendicular lines, where same slope means parallel and perpendicular slopes are negative reciprocals.

> THE HABIT TO BUILD
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> Read every story for its start and its rate, write y = (rate)x + (start), and check the units.