The Form y = a · b^x

Students ask the three family questions of the exponential form y = a · b^x, learn the two jobs of a and b (with the multiply-by-1 reason for the y-intercept), build tables and plot points from an equation, evaluate power first, and explore a and b with sliders.

TIME	40 minutes (one student with a parent or tutor, or a small group)
WHO	Math 1 (algebra readiness), about age 12. Follows Unit 7, Lesson 1.
MATERIALS	Student worksheet (PDF), the Deep Dive 5 interactive page for this lesson (the explorer needs a screen), pencil, graph paper
PRIOR KNOWLEDGE	Exponents and the zero power (Lesson 1). Function notation (Unit 2). The family questions and the line explorer (Unit 3, Lesson 3). The multiplicative identity (Unit 1).
STANDARDS	NC Math 1 NC.M1.F-LE.5 (interpret the parameters of an exponential function), NC.M1.F-IF.7 (graph exponential functions), NC.M1.F-BF.3.
KEEP OUT	Growth versus decay in depth (Lesson 3). Percent rates (Lesson 3). Asymptotes (Lesson 4).

Learning goals

1. Answer the three family questions for y = a · b^x and say the two jobs: a is the initial value and y-intercept, b is the growth factor.
2. Explain why a is the y-intercept using b^0 = 1 and the multiply-by-1 idea.
3. Build a table from an equation (start at a, multiply by b), plot it, and evaluate with function notation, power first.
4. Read a and b from a table (a at x = 0, b as the ratio) and write the equation.

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
Family, member, parameter	$y = a \cdot b^x$, a and b	The family thread.
a, initial value	output at $x = 0$	The y-intercept; $b^0 = 1$.
b, growth factor	the multiplier	The ratio down the table.
Power first	b^x then times a	$3 \cdot 2^4 = 48$.

> THE ONE SENTENCE TO SAY OUT LOUD
>
> What family? Exponential, y = a times b to the x. What numbers? a and b. What do they do? a starts it, because b to the zero is 1; b multiplies it each step.

Lesson timeline (40 minutes)

0:00 to 0:05	**Warm-up: the three questions for a line.** Ask them for $y = 2x + 1$ (Unit 3). Then show $y = 3 \cdot 2^x$ and ask the same three.
0:05 to 0:15	**Mini-lesson: two jobs, and why.** Put $x = 0$ in: $2^0 = 1$, so $y = 3$. Multiply-by-1 from Unit 1. Then build the table by multiplying by 2, plot it, and see the curve. Do f(4) power first and show the 6^4 trap.
0:15 to 0:25	**Explorer and tables.** The student moves a and b, compares with the line explorer (slide versus tilt; start versus multiply). Then the two build-and-plot tables, including the one-half case.
0:25 to 0:36	**Practice.** The practice problems or Worksheet Parts A to D. Same buttons: Hint, Show next step, Reveal answer, Hide help. Require power first every time.
0:36 to 0:40	**Exit ticket.** Worksheet Part F. Success looks like the two jobs named, and f(0) = 2, f(3) = 250.

Misconceptions to listen for

- **Multiply a and b first.** $3 \cdot 2^4 = 48$, not 6^4. The exponent belongs to the base.
- **b is the start.** a starts, b multiplies.
- **Add b each step.** Multiply. Lines add, exponentials multiply.
- **No number in front means a = 0.** It means a = 1, the invisible 1.
- **Changing a tilts the curve.** It moves the start; b changes the multiplying.

Support and stretch

Support

Keep the table builder from Lesson 1 handy. Have the student write b^x in a box before multiplying by a. Use small bases (2 and 3) first.

Stretch

Ask what a and b are for a table starting at x = 1 instead of 0 (divide back to find a). Ask two students to pick a and b and predict each other's f(3) before checking with the explorer.

Where this goes next

Lesson 3: growth and decay. b bigger than 1 grows, b between 0 and 1 decays, and percents turn into factors.

> THE HABIT TO BUILD
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> Read a as the start and b as the multiplier. Power first, then times a.