When Money Shrinks, and Using the Models

Students extend the compound interest form to depreciation with a decay factor of 1 minus the rate, convert between factors and rates in both directions, see compound interest working against a borrower, change a parameter and describe the effect, and answer goal questions with a table.

TIME	45 minutes (one student with a parent or tutor, or a small group)
WHO	Math 1 (algebra readiness), about age 12. Follows Unit 8, Lesson 4. Closes Unit 8.
MATERIALS	Student worksheet (PDF), the Deep Dive 5 interactive page for this lesson (explorer, what-if tool, and goal finder need a screen), pencil, calculator with a power key
PRIOR KNOWLEDGE	Growth factor 1 + r (Lesson 2). Growth and decay, percent and factor (Unit 7, Lesson 3). Backward questions by table (Unit 7, Lesson 6).
STANDARDS	NC.M1.F-IF.8b, NC.M1.F-LE.5, NC.M1.A-SSE.1a, NC.M1.A-CED.1.
KEEP OUT	Solving for the exponent with logarithms. Loan payment formulas. Memorizing the rule of 72.

Learning goals

1. Write and read a depreciation model A = P(1 - r)^t, naming the starting value, the decay factor, and the decay rate.
2. Convert between factors and rates in both directions, growth and decay, starting from 1.
3. Explain that compound interest grows a debt the same way it grows savings.
4. Predict the effect of changing P or r, and answer a how-long question with a table.

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
Depreciation	losing value	Factor below 1.
Decay factor	1 – r	What you multiply by.
Decay rate	r	Distance below 1.
Doubling time	time to double	From a table; 72 ÷ rate estimates it.

> THE ONE SENTENCE TO SAY OUT LOUD
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> Start from 1, keeping all of it. Add the rate to grow, take it away to shrink. Every factor is 1 plus or minus the rate.

Lesson timeline (45 minutes)

0:00 to 0:05	**Warm-up: growth factors.** 5%, 8%, 12% as factors. Then ask: what if it loses 13% instead?
0:05 to 0:17	**Mini-lesson: depreciation.** Read $35{,}000(0.87)^t$: cost new, 1 – 0.13, value after 3 years. State the warning: 0.85 means losing 15%. Both directions, mixed. Run the car explorer.
0:17 to 0:22	**Interest against you.** $1,000 at 5% saved versus $1,000 at 20% owed, five years each. Same formula.
0:22 to 0:33	**Using the models.** The city: change the start, then the rate, with the what-if tool. Then the doubling table for $500 at 8%, the goal finder, and the 72 check as an estimate.
0:33 to 0:41	**Practice.** The practice problems or Worksheet Parts A to E. Same buttons: Hint, Show next step, Reveal answer, Hide help.
0:41 to 0:45	**Exit ticket.** Worksheet Part F. Success looks like decay of 8%, and $20{,}000(0.85)^t$ with $14,450.00.

Misconceptions to listen for

- **0.85 means losing 85%.** It keeps 85%: loses 15%.
- **A 13% loss is a factor of 0.13.** 1 – 0.13 = 0.87.
- **The car reaches $0.** Positive times positive stays positive.
- **Doubling the rate doubles the balance.** The gap widens every year; it is not a fixed multiple.
- **72 divided by the rate is exact.** It is an estimate.

Support and stretch

Support

Keep a number line from 0 to 2 with 1 marked keeping all of it; place each factor on it and read its distance from 1. Let the goal finder confirm hand-built tables.

Stretch

Ask for the halving time of the car (about 5 years: 0.87 to the 5 is about 0.50). Ask how long $1,000 at 5% simple interest takes to double (20 years) against compound (about 14).

Where this goes next

Unit 9: arithmetic and geometric sequences. The yearly balances with simple interest are an arithmetic sequence, adding the same amount each term; the balances with compound interest are a geometric sequence, multiplying by the same factor each term.

> THE HABIT TO BUILD
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> Start from 1. Read every factor as 1 plus or minus the rate, and answer how-long questions with a table.