Grade 8 Math · Lesson 2 — The Tank Report

Exponents and Radicals · ages 12 to 15 · 45 minutes · the workbook, one screen, this page, a pencil and paper

At a Glance

- **The book:** 8th Grade Math Workbook: Real-World Problem Solving, Chapter 2 (The Engineer), by Dr. Gene A Constant.
- **Free tool:** Math Jeopardy (a quiz game show with a Grade 8 board), free, no login, plays in the browser: globalsovereignuniversity.org/math-jeopardy.
- **Free class:** Lesson 2 of the free Grade 8 Mathematics class: globalsovereignuniversity.org/grade-8-math-class#lesson-2.
- **Ages and time:** Grade 8 · ages 12 to 15 · 45 minutes.
- **Prep (5 min):** read the Teaching Creed and have the workbook open to Chapter 2. Have one sheet of paper ready to fold in half five times.

Why this lesson

Exponents are how engineers, programmers and bankers write very large and very small quantities without mistakes. The rules are short, but children who only memorize them mix up adding and multiplying exponents. Folding paper makes the doubling real.

What the learner will be able to do

- Apply properties of integer exponents.
- Evaluate expressions with zero and negative exponents.
- Simplify square roots and cube roots.
- Add, subtract, and multiply radical expressions.

The 45-Minute Climb

How to read this: the gold box in each step is your lesson, word for word. Run it as written. The notes beneath are optional support. "The group" means your family; "host" means you.

1 · The Hook (5 min)

"Fold a sheet of paper in half, then in half again, five times. How many layers is that? Write it as a power of 2."

Say it like this: let your child do it with real objects if you can, then ask how they know their answer is right before you check it.

2 · Work It Together (15 min)

Open the workbook to the worked example Simplify $2^4 \times 2^3$ (Section 2.1) together: Apply product rule: add exponents with same base $2^4 \times 2^3 = 2^{4+3} = 2^7$ Calculate: $2^7 = 128$. Then read Simplify $5^6 \div 5^2$ (Section 2.1) together: Apply quotient rule: subtract exponents $5^6 \div 5^2 = 5^{6-2} = 5^4$ Calculate: $5^4 = 625$.

Read each step aloud and let your child say the next step before you read it. Then play one round of Math Jeopardy.

3 · The Talk (8 min)

1. Why do you add the exponents when you multiply $2^3 \times 2^4$? 2. What does a negative exponent mean? 3. Why can you add $3\sqrt{5} + 7\sqrt{5}$ but not $\sqrt{2} + \sqrt{3}$?

You are not fishing for one right answer. You are listening for understanding:

- Q1: 2^3 is three 2s multiplied and 2^4 is four more, so there are seven 2s in all.
- Q2: It means the reciprocal: $5^{-2} = 1/5^2 = 1/25$. It is not a negative number.
- Q3: Like terms: the first two share the same root, like 3 apples plus 7 apples. $\sqrt{2}$ and $\sqrt{3}$ are different roots.

4 · Solo Climb (12 min)

Five problems on your own, with your work shown.
1. Simplify: $7^8 \div 7^3$
2. Simplify: $2^5 \times 2^{-3}$
3. $\sqrt{144}$ = ___
4. Simplify: $\sqrt{128}$ = ___
5. Simplify: $\sqrt{5} \times \sqrt{20}$ = ___

Why solo: a test, a job and real life ask you to work alone. Five problems rehearse exactly that. The answers are at the end of this plan.

Keep It Fresh (5 min, the next day)

Two review problems from the book's Extra Practice.
1. Simplify: $\sqrt{180}$
2. Evaluate: $2^{-3} + 4^{-1}$

Ready to move on? Four of the five Solo Climb problems right, with work shown, means this skill is solid. If not, reread the worked examples together and try two more problems from the chapter before the next lesson. Short review of old skills keeps them from fading.

5 · The Takeaway (5 min)

Same base: add exponents to multiply, subtract to divide. A negative exponent means the reciprocal. · Homework: Find something at home that doubles or halves, such as a recipe, a phone battery or folded paper. Write each step as a power of 2.

The badge moment: finishing all five steps earns the Bronze ring of this lesson's badge, The Power Builder. Mark it on the Climber's Passport now; the homework is how Silver and Gold are earned during the week.

Common Mistakes to Watch For

- Multiplying the exponents when the bases are multiplied: $2^3 \times 2^4$ is 2^7, not 2^{12}.
- Reading a negative exponent as a negative number: 5^{-2} is 1/25, not −25.
- Adding square roots that do not match: $\sqrt{2} + \sqrt{3}$ is not $\sqrt{5}$.

The Teaching Creed

You are not the expert; the book and the method are. Your job is to ask "how do you know?" one more time than feels natural, and to celebrate wrong answers out loud. In here, a wrong answer is where the lesson lives.

GENO, GSU's free tutor, can explain any step a second way, any hour, in 83 languages, with no login: globalsovereignuniversity.org/free-tutor. A prompt for the host: Ask GENO: "Show me why any number to the zero power is 1, using a pattern, not a rule."

Adapt It and Measure It

Differentiation

- Struggling: write out every factor (2 × 2 × 2) before using a rule.
- Ahead: find how many folds it would take to reach 1,000 layers.
- Large co-op: each team builds one exponent rule from examples and teaches it.
- Reluctant: start with folding paper and counting layers before any symbols.

Evidence of learning (no exam)

Look for three things. Tried: finished all five Solo Climb problems with work shown. Noticed: can name the mistake in Common Mistakes that they almost made. Changed: the next day, solves one new problem from the same chapter without help. Those three words are the whole rubric, and they match the badge tiers below.

Gamify It — The Campus Climb

Every GSU lesson is one badge on the Climber's Passport, earned at four depths: Bronze, Silver, Gold and Platinum.

LESSON 2 BADGE — The Power Builder · Bronze — The Climb: finished the 45-minute lesson, all five steps. · Silver — The Try: did the homework and explained it to the host. · Gold — The Proof: completed the chapter's Action Report in the workbook with every answer checked against the Answer Key. · Platinum — The Teacher: ran this lesson as host for someone else. The harvest of a teacher is teachers.

Answers for the Host

1. $7^5 = 16{,}807$
2. $2^2 = 4$
3. 12
4. $8\sqrt{2}$
5. $\sqrt{100} = 10$

Keep It Fresh: 1. $6\sqrt{5}$ · 2. 1/8 + 1/4 = 3/8

Every answer above comes from the workbook's own Answer Key. The book behind this lesson: 8th Grade Math Workbook: Real-World Problem Solving, Chapter 2 (The Engineer).

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