LESSON 20: Squaring, Cubing, Taking Roots

Weekly Focus: squares, cubes, roots
Weekly Skill: evaluate, solve

Lesson Summary: For the Warm Up, students will solve a problem about measurement. In Activity 1, they will learn vocabulary about exponents (for this lesson and the next one). In Activity 2, students will practice with the GED calculators. In Activity 3, students will evaluate exponents. In Activities 4 and 5, they solve word problems. There is an exit ticket problem at the end. Estimated time for the lesson is 2 hours.

Materials Needed for Lesson 20:
- Video (length 3:00) on exponents. The video is optional for teachers and students.
- Worksheet (20.1) with answers (attached)
- *Mathematical Reasoning Test Preparation for the 2014 GED Test Student Book (pages xii, 54 – 55)*
- *Mathematical Reasoning Test Preparation for the 2014 GED Test Workbook (pages 66 – 69)*
- GED calculators

Objectives: Students will be able to:

- Solve the measurement word problem
- Understand exponent vocabulary
- Use the GED calculator
- Solve computation and word problems with exponents

ACES Skills Addressed: N, CT, LS, and ALS
CCRS Mathematical Practices Addressed: Building Solution Pathways, Mathematical Fluency, Model with Math
Levels of Knowing Math Addressed: Intuitive, Communication, Abstract, and Application

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Notes:
You can add more examples if you feel students need them before they work. Any ideas that concretely relates to their lives make good examples.

For more practice as a class, feel free to choose some of the easier problems from the worksheets to do together. The "easier" problems are not necessarily at the beginning of each worksheet. Also, you may decide to have students complete only part of the worksheets in class and assign the rest as homework or extra practice.

The GED Math test is 115 minutes long and includes approximately 46 questions. The questions have a focus on quantitative problem solving (45%) and algebraic problem solving (55%).

Students must be able to understand math concepts and apply them to new situations, use logical reasoning to explain their answers, evaluate and further the reasoning of others, represent real world problems algebraically and visually, and manipulate and solve algebraic expressions.

This computer-based test includes questions that may be multiple-choice, fill-in-the-blank, choose from a drop-down menu, or drag-and-drop the response from one place to another.

The purpose of the GED test is to provide students with the skills necessary to either further their education or be ready for the demands of today's careers.

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Lesson 20 Warm-up: Solve the measurement problem	Time: 10 Minutes

Write on the board: The Abdal family wants to put a fence around their property and have one entrance gate at the front. Home Depot sells chain link fence at $114 for 50 feet long. The drawing below shows the front of their property:
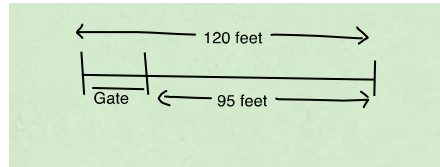
Basic Questions:

- How wide is the gate?
    - *120 feet – 95 feet = 25 feet*
- How much fencing should they buy (not counting the gate) if the length of the property is 1.5 times the width shown in the drawing? (W = 120, L = 180)
    - *95 + 120 + 180 + 180 = 575 feet*
- How much does the fencing cost (not including the gate)?
    - *575 feet divided by 50 foot sections =11.5 but you can't buy ½ a section, so you buy 12 sections; $114 x 12 = $1368*

Extension Questions:
- The Abdal family can use a 20% off coupon or a $200 off special, but can't combine offers. Which is better?
    - *$1368 x 0.2 = $273.60 so 20% off is a better offer*
- Write an equation to calculate the perimeter of the property. Use W (width) as the variable.
    - *Perimeter = w + w + 1.5w + 1.5w **or** perimeter= 2w + 2(1.5w)*

Lesson 20 Activity 1: Vocabulary	Time: 10 Minutes

1. Draw a 5 x 5 table on the board. Ask students what the area of this table would be if each square were 1 foot wide. How do they know? The area is 25 feet square because you can count all the squares or you can just multiply 5 x 5.
2. How do write this? You can write 5 x 5 or you can write 5^2. That is where the word **squared** comes from.
3. Write 5^3 on the board. Ask: "What does this mean?" *(5x5x5)*
4. What do we call the 3? It's **cubed.**
5. When would we use 5^3? One example is to measure volume because now we are adding a

third dimension. If we have a container with all 3 dimensions (width, length, height) of 5 feet, the volume is 5 cubed = 125 **cubic** feet.

6. Another way of describing 5^3 is to call 5 the **base** and 3 the **exponent**.
7. We can also say five to the **power** of 3.
8. Give other examples like 4^5. Say 4 to the power of 5. It means 4x4x4x4x4.
9. The reason for the exponents is to have a shorter way of expressing repeated multiplication.
10. What are **roots**? Roots are the opposite of powers. The first example was 5^2, which equals 25. The opposite is to write $\sqrt{25}$, which is the square root of 25. It means what number multiplied by itself = 25? The answer is 5.
11. The opposite of 5^3, which equals 125, is $\sqrt[3]{125}$, which means the **cubed root** of 125 = 5.
12. Do more examples if necessary.
13. You can mention that scientific notation also uses exponents and it will be studied in the next lesson.

Lesson 20 Activity 2: Calculator Practice	**Time: 5-10 Minutes**

1) Handout the GED calculators. Look at directions for use on page **xii of student book.**
2) Practice squaring. Write on the board: 2^2, 3^2, 4^2. Ask students what the answers are (4, 9,16). Now have them try on the calculator. Press: on, clear, 2, x^2 key, enter. Answer is 4. Let students practice for a few minutes.
3) Practice finding the square root. Write on the board: $\sqrt{16}$, $\sqrt{25}$, $\sqrt{169}$. On the calculator, press: clear, 2nd (green key to get green symbols), x^2 (because we want the $\sqrt{}$ symbol), 16, enter. Answer is 4. Let students practice a few minutes.

Lesson 20 Activity 3: Evaluate Exponents	**Time: 10 Minutes**

1) Practice squaring and cubing integers with **Worksheet 20.1.** It's okay to use calculators.
2) Do a few examples together. Make sure to do an example of a negative number squared: a negative x a negative = a positive.
3) Also, do an example of a negative number cubed: a negative x a negative = positive x negative = negative.
4) Students who finish quickly can create their own problems and become more familiar with the calculator.

Lesson 20 Activity 4: Practice Word Problems	**Time: 20-25 Minutes**

1. Do the problems in the **student book pages 54-55** together.

2. Look at the examples on page 54. Make sure to explain why the square root of a positive number can be + or –.
3. Explain why the square root of a negative number is undefined but the cubed root of a negative number is negative.
4. Note that questions 2 and 9 may be the more challenging problems.

Lesson 20 Activity 5: Word Problems	Time: 35-45 Minutes

1) Have students work independently in the **workbook pages 66-69.** Circulate to help.
2) Notes on some of the problems:
   a. Encourage students to eliminate choices that you can tell are not valid just from the information in the question (like #9).
   b. Make an equation to help solve whenever possible (like #11and #13).

Lesson 20 Exit Ticket: Bacteria Question	Time: 5 Minutes

Write this problem on the board, and have students brainstorm the answer in pairs.

Exponents are often used to express large numbers in science and medicine. Here is an example: A certain bacteria doubles every half hour. At 7:00 a.m., there are 8 bacteria. How many bacteria are there at 11:00 a.m.? Write the answer as a power of two, because it is <u>doubling</u> every half hour.

Hints: At 7:00 am, there are 2^3 bacteria, because 2^3 = 8. (2^1 = 2, 2^2 = 4, 2^3 = 8). You can also draw a number line to help.

<u>*Answer:*</u> 2^{11} = 248 bacteria. (There are eight half hours between 7:00am and 11:00am, so add 8 to the power of 3 to go from 2^3 to 2^{11}.)

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Worksheet 20.1 Evaluate Exponents

1) $(9)^3$ = _____

2) $(-3)^2$ = _____

3) $(-6)^2$ = _____

4) $(-2)^3$ = _____

5) $(2)^2$ = _____

6) $(-5)^3$ = _____

7) $(2)^2$ = _____

8) $(8)^2$ = _____

9) $(12)^3$ = _____

10) $(-9)^2$ = _____

11) $(7)^3$ = _____

12) $(-4)^3$ = _____

13) $(-2)^2$ = _____

14) $(3)^2$ = _____

15) $(3)^3$ = _____

16) $(4)^3$ = _____

17) $(-10)^3$ = _____

18) $(5)^2$ = _____

19) $(-3)^2$ = _____

20) $(-12)^3$ = _____

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Worksheet 20.1 Answers

1) $(9)^3$ = __729__

2) $(-3)^2$ = __9__

3) $(-6)^2$ = __36__

4) $(-2)^3$ = __-8__

5) $(2)^2$ = __4__

6) $(-5)^3$ = __-125__

7) $(2)^2$ = __4__

8) $(8)^2$ = __64__

9) $(12)^3$ = __1728__

10) $(-9)^2$ = __81__

11) $(7)^3$ = __343__

12) $(-4)^3$ = __-64__

13) $(-2)^2$ = __4__

14) $(3)^2$ = __9__

15) $(3)^3$ = __27__

16) $(4)^3$ = __64__

17) $(-10)^3$ = __-1000__

18) $(5)^2$ = __25__

19) $(-3)^2$ = __9__

20) $(-12)^3$ = __-1728__