MISSISSIPPI DEPARTMENT OF EDUCATION
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MISSISSIPPI
# EXEMPLAR
## Units & Lessons
## MATHEMATICS

## Grade 6

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## Lesson 1: Introduction to Exponents

**Focus Standard(s):** 6.EE.1

**Additional Standard(s):** 6.EE.2c

**Standards for Mathematical Practice:** SMP.3, SMP.4, SMP.7

**Estimated Time:** 60 min

**Resources and Materials:**

- Document camera
- Color tiles
- Centimeter cubes
- Personal white boards-1 per student
- Dry erase markers-1 per student
- Scissors
- Sticky-notes
- Handout 1.1: The Power of Exponents – Area & Volume
- Handout 1.2: The Power of Exponents – Length Cards
- Handout 1.3: Exponents Practice Homework
- Rational Expressions: www.rationalexpressions.blogspot.com
- Practice with Exponents: https://www.ixl.com/math/grade-6/write-multiplication-expressions-using-exponents

**Learning Target(s):**

Students will create models to represent exponential expressions, evaluate numbers with exponents, write numbers in standard form, exponential form, and expanded form.

**Guiding Question(s):**

- What pattern is evident when numbers with exponents are evaluated?

- How are exponents useful in real-world situations?

## Vocabulary

| Academic Vocabulary: | Instructional Strategies for Academic Vocabulary: |
|---|---|
| • Base<br>• Cubed<br>• Exponent<br>• Expanded form<br>• Exponential form<br>• Power<br>• Squared<br>• Standard form | ☐ Introduce words in a mathematical context.<br>☐ Model how to use the words in discussion. |

| Symbol | Type of Text and Interpretation of Symbol |
|---|---|
|  | Instructional support and/or extension suggestions for students who are EL, have disabilities, or perform well below the grade level and/or for students who perform well above grade level. |
| ✓ | Assessment (Pre-assessment, Formative, Self, or Summative) |

## Instructional Plan

**Understanding Lesson Purpose and Student Outcomes:**
Students will create models to represent exponential expressions, evaluate area and volume with exponents, and write area and volume calculations in standard form, exponential form, and expanded form.

**Anticipatory Set/Introduction to the Lesson:**

Display a set of blocks (see above) using a document camera (SMP.4).
**Note:** If a document camera is not available, display the above picture.

Give students 5 minutes to determine the number of cubes in the seventh figure if the pattern were to continue. Allow students to share solutions with other members of their group. Students compare answers and approaches for solving the problem (SMP.3).

**Note:** Students should be able to defend the method they used to complete the pattern, and groups should be able to agree upon a final solution.

One student from each group records the answer on the board. Discuss student answers and address any misconceptions that became present in the activity.

**For students who are EL, have disabilities, or perform well below the grade-level:**

- Provide manipulatives or visuals for students to create the figures and extend the pattern.

**Extensions for students with high interest or working above grade level:**

- Provide sticky notes to record the exponential expression that represents each figure.
- Allow students the opportunity to work on more challenging figures.

**Activity 1**: **Modeling Exponents with Manipulatives**
Review the picture from the Anticipatory Set.
Discuss how to find area by multiplying the length by the width.

T: The first figure in the pattern has only one cube.
This means that it has an area of 1 unit by 1 unit, or 1 square unit, or 1 unit squared.
There are four cubes in the second figure.
What can we determine about its area by the picture?

Possible responses include: The area is 4 square units. There are 4 units in the whole square.

T: The third figure in the pattern has 9 cubes.
Are you noticing any pattern in the set of figures?
Look at the fourth figure; what do all the shapes have in common?

Possible solutions: They are all squares. The squares are growing/increasing.

**Note:** Using prior knowledge, students should be able to calculate the number of cubes in the figures as the pattern continues (SMP.7).

T: As the pattern continues, the squares are increasing.
This pattern represents exponents in terms of square units.
The second figure has an area of 4 square units or 4 units squared.
This can be solved by multiplying 2 x 2 to find the area of the square.
The second figure has an area of 4 square units or 4 units squared.

Explain the remaining figures in the pattern by stating that $3 \times 3 = 3^2$, or 9 square units and that $4 \times 4 = 4^2$, or 16 square units.
Write this on an anchor chart showing how to calculate the area for each of the 4 figures.
Explain that 3x3 is called expanded form, $3^2$ is called exponential form, and 9 is called standard form.

Distribute color tiles to students.

T: Use 6, 1-inch color tiles to make a length.
What is the length including the unit? (6 in)
Create a square with a length and width of 6, 1-inch color tiles.

What is the total number of color tiles? (36)
What is the area of the square? (36 square in)
What multiplication number sentence can you write to show this? (6x6)
Write 6 x 6 in exponential form. ($6^2$)

Students use color tiles to create 3 more squares with different lengths from the ones already used. On their personal white boards, students write the length of the square, expanded, exponential, and standard form to show the total number of color tiles they used.

Introduce cubed figures by displaying a picture of a building that looks like a cube.
Tell students the building is 20 feet tall, 20 feet wide, and 20 feet long.
Review the meaning of volume – how much space an object takes up.
Students talk with a neighbor to determine the multiplication expression used to find the total volume of the building. (20x20x20)
Discuss students' responses and correct any misconceptions.

T: Use 3 cm cubes to make a length.
What is the length including the unit? (3 cm)
Create a square with a length and width of 3 cm
What is the total number of blocks? (9 cm)
Make a cube by adding 2 more layers of 9 cm cubes on top of the first layer.
How many centimeter cubes did you use? (27)
What multiplication number sentence can you write to show this? (3x3x3)
Can you write that in a shorter form using an exponent? ($3^3$)

Students create 3 more cubes. Students write on their white boards the length, width and height of the cube, expanded, exponential, and standard form to show the total number of centimeter cubes they used, and write an expression using an exponent.

**Note:** Rational Expressions provides the teacher with additional support in using manipulatives when working with squared and cubed numbers.

**Activity 2: Exponents Practice**

Review the meaning of each column heading:

- Expanded Form – how many times the base is multiplied (the expanded form of $3^2$ is 3 x 3)
- Exponential Form – a base number written with an exponent ($3^2$)
- Standard Form– the value of the product ($3^2 = 9$, 9 is the Standard Form/Product)

Distribute **Handout 1.1: The Power of Exponents – Area & Volume** to each student. Have students work in pairs to complete the activity. Distribute **Handout 1.2: The Power of Exponents - Length Cards** and scissors to each student pair. Instruct students to cut out the length cards and work with a partner to complete the Exponents Practice for Area and Volume.

- ✓ Student pairs use the length cards to calculate area and volume, writing the length, expanded form, exponential form, and standard form.

**Note:** This discussion will be useful in the upcoming lessons involving equivalent expressions. Provide students with additional support and opportunities to Practice with Exponents.

**For students who are EL, have disabilities, or perform well below the grade-level:**

- Students use color tiles and centimeter cubes to model the squares and cubes.

**Extensions for students with high interest or working above grade level:**

- Find the length of a square or the volume of a cube given the standard form of the area or volume.

**Reflection and Closing:**

- ✓ Review Activity 2 with the class.

Prompting questions:

- What patterns do you see?
- Which affected the value of the product more: the value of the base or the value of the exponent?
- Which form is more efficient: expanded form or exponential form and why?

✓ **Exit Ticket**

The yard at Lee's school, McGyver Middle School, is a square with a side length of 34 feet. Lee's bedroom forms a cube with a side length of 12 ft. Which is greater, the area of the playground at Lee's school or the volume of his bedroom? Write your calculations for both area and volume in expanded, exponential, and standard form.

**For students who are EL, have disabilities, or perform well below the grade-level:**

- Provide side lengths with lesser values.
- Students can use an anchor chart to review or notes previously taken.

## Homework

Students complete **Handout 1.3: Exponents Practice Homework**.

**Handout 1.1: The Power of Exponents - Area**

Name: _____ Date: _____

Directions: Each player turns over a card and uses that for the length of the square. Write and calculate the area in expanded form, exponential form, and standard form for each length.

| Length of Square | Expanded Form | Exponential Form | Standard Form (Area with Unit) |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**Handout 1.1: The Power of Exponents – Volume**

Directions: Each player turns over a card and uses that for the length of the square. Write and calculate the volume in expanded form, exponential form, and standard form for each length.

| Length of Cube | Standard Form | Expanded Form | Standard Form (Volume with Unit) |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**Handout 1.2: The Power of Exponents - Length Cards**

| | | |
|---|---|---|
| 3 mm | 4 mm | 5 mm |
| 6 in | 2.3 in | 8 in |
| 9 ft | 10 ft | $\frac{2}{5}$ ft |
| 12 cm | 13 cm | 14 cm |
| 15 m | 16 m | 1.7 m |
| $\frac{1}{8}$ yd | 3.1 yd | $\frac{1}{2}$ yd |
| 2.01 in | 20 ft | 3 yd |
| 40 mL | $\frac{3}{4}$ mL | 6 mL |

**Handout 1.3: Exponents Practice Homework**

Name: _____ Date: _____

Directions: Complete the chart by filling in the missing values.

| Exponential Form | Expanded Form | Standard Form |
|---|---|---|
| $5^2$ | | |
| | 3x3x3 | |
| | | $1000\ mL^3$ |
| | | $144\ ft^2$ |
| | 7x7x7x7 | |
| $2^5$ | | |

**Handout 1.3: Exponents Practice Homework - Key**

Name: _____ Date: _____

Directions: Complete the chart by filling in the missing values.

| Exponential Form | Expanded Form | Standard Form |
|---|---|---|
| $5^2$ | 5 x 5 | 25 |
| $3^3$ | 3x3x3 | 27 |
| $10^3$ | 10x10x10 | 1000 $mL^3$ |
| $12^2$ | 12x12 | 144 $ft^2$ |
| $7^4$ | 7x7x7x7 | 2401 |
| $2^5$ | 2x2x2x2x2 | 32 |

For training or questions regarding this unit,
please contact:

exemplarunit@mdek12.org