

MS/Foundations of Algebra Negative Exponents Balanced Lesson Sample

Opening Session

Hook:

The Center for Disease Control (CDC) monitors public facilities to assure that there are no health risks to the people that visit these facilities. Occasionally, *Escherichia coli* will be discovered, which is also known as *E. coli*. This is a type of bacterium that can make people very sick. The mass of each *E. coli* bacterium is 2×10^{-12} gram.

If the mass of a small paper clip is about 1 gram, how many times more is its mass than that of the mass of an *E. coli* bacterium?

Foundational Skills/Standards of Mathematical Practice

Investigation of Exploring Powers of 10 Task modified from GADOE/ SMP's 1,2,3,7,8

Think-Pair-Share

Exploring Powers of 10

Part 1: Very Small Numbers (negative exponents)

Complete the following table. What patterns do you see?

	Expanded Form	Evaluate
10^5	$10 \times 10 \times 10 \times 10 \times 10$	100,000
10^4		
10^3		
10^2		
10^1		
10^0		
10^{-1}		
10^{-2}		
10^{-3}		
10^{-4}		

To test your pattern, use a calculator to explore.

DIRECTIONS FOR USING THE TI-36XPro: Exploring Powers

It may be appropriate to use a calculator or computer when data may contain numbers that are difficult to work with using paper and pencil. Exploring very large and very small numbers can be done on the calculator with the following instructions:

1. Turn on the calculator



2. Enter a number, press the



key, enter the number for the exponent, and press



3. For negative exponents, press the



before entering the exponent number.



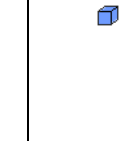
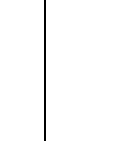
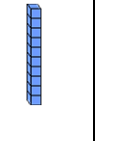
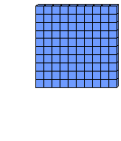

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Work Session: Foundational Skills/SMP's

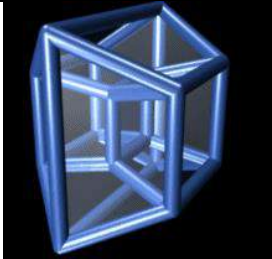
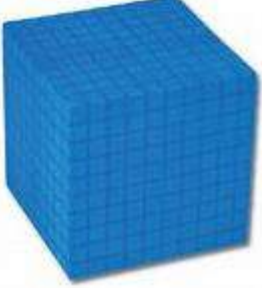
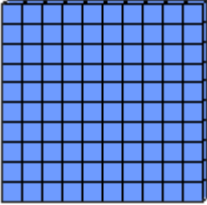


Explicit Instruction on Exponents/Powers of 10/SMP's 4,5,8

Chart to fill in the multiple representations of the powers of 10

Use of Base 10 Blocks as manipulatives

Vocabulary: Exponent KIM Chart

Knowledge	Information	Memory
4 th Power	10^4 $10 \times 10 \times 10 \times 10$ 10,000	 4D
3 rd Power or Cubed	10^3 $10 \times 10 \times 10$ 1,000	 3D
2 nd Power or Squared	10^2 10×10 100	 2D
1 st Power	10^1 10	 1D
Zero Power	10^0 1	

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Negative 1st Power	10^{-1} $\frac{1}{10^1} = \frac{1}{10}$ 0.1	■
Negative 2nd Power	10^{-2} $\frac{1}{10^2} = \frac{1}{100}$ 0.01	■
Negative 3rd Power	10^{-3} $\frac{1}{10^3} = \frac{1}{1000}$ 0.001	■

Gradual Release Skills Practice/ SMP 1,8: Whole Group

I Do: Examples using Color Tiles as a model:

$$2^3 = 8$$

$$2^2 = 4$$

$$2^1 = 2$$

$$2^0 = 1$$

$$2^{-1} = \frac{1}{2^1} \text{ or } \frac{1}{2}$$

$$2^{-2} = \frac{1}{2^2} \text{ or } \frac{1}{4}$$

$$2^{-3} = \frac{1}{2^3} \text{ or } \frac{1}{8}$$

We Do: Examples using Color Tiles as a model, then check with a calculator:

$$3^3 =$$

$$3^2 =$$

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$$3^1 =$$

$$3^0 =$$

$$3^{-1} =$$

$$3^{-2} =$$

$$3^{-3} =$$

You Do: Examples using Color Tiles as a model, then check with a calculator:

$$4^3 =$$

$$4^2 =$$

$$4^1 =$$

$$4^0 =$$

$$4^{-1} =$$

$$4^{-2} =$$

$$4^{-3} =$$

Differentiation for advanced students:

$$(4.4)^{-3} =$$

$$3.56 \times 10^{-1} =$$

$$40.3 \times 10^{-2} =$$

$$350 \times 10^{-6} =$$

Formative Assessment

Individual

Evaluate.

10^{-12}	
6^{-4}	
3^{-5}	
4×10^{-8}	

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Differentiate/Investigate Further with a Calculator/ SMP 8:

Think-Pair-Share

Exploring Powers of 10 Part 2: Very Large Numbers (positive exponents)

Sometimes it can be cumbersome to say and write numbers in their common form (for example trying to display numbers on a calculator with limited screen space). Another option is to use exponential notation and the base-ten place-value system.



Using a calculator (with exponential capabilities), complete each of the following:

1. Explore 10^N for various values of N . What patterns do you notice?
2. Enter 45 followed by a string of zeros. How many will your calculator permit? What happens when you press enter? What does 4.5×10 mean? What about 2.3×10^4 ? Can you enter this another way?
3. Try sums like $(4.5 \times 10^N) + (2 \times 10^K)$ for different values of N and K . Describe any patterns that you may notice.
4. Try products like $(4.5 \times 10^N) \cdot (2 \times 10^K)$. Describe any patterns that you may notice.
5. Try quotients like $(4.5 \times 10^N) \div (2 \times 10)$. Describe any patterns that you may notice.

Let's Write About It-Interactive Notebook/SMP 3:

Individual/Peer Review

Explain how to evaluate negative exponents.

Work Session: Application & Problem Solving/SMP's

Small Group (3)

Word Problems:

An American Green Tree Frog Tadpole is about 0.00001 kilometer in length when it hatches. Write this decimal as a power of 10.

A blood cell has a diameter of about 5^{-5} inches. Write 5^{-5} using positive exponents.

Problem Solve/ SMP 2,3:

A common flea that is 2^{-4} inch long can jump about 2^3 inches high. About how many times its body size can a flea jump? Explain your reasoning.

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A circular swimming pool holds 1.22×10^6 cubic inches of water. It is being filled at a rate of 1.5×10^3 cubic inches per minute. How many hours will it take to fill the swimming pool?

Performance Task GaDOE/SMP's 2,3:

Nesting Dolls

The first Russian nesting dolls were made over a hundred years ago. They were brightly painted in classic Russian designs and made so that the finished doll had many similar dolls that fit one inside the other. This type of doll is called a Matryoshka which is derived from the Latin word for mother and is a common name for women in Russian villages.



Suppose there are a total of eight dolls. The finished doll is n centimeters tall with seven smaller dolls that fit inside one another. Each doll is $\frac{2}{3}$ the height of the next larger doll.

- What is the relationship of the heights of the third largest doll and the largest doll?
- What is the relationship of the smallest doll and the largest doll?
- As Russia has dropped the Iron Curtain and opened doors, many of their production facilities have more technology. Instead of hand carving the Matryoshka, factories use computerized robots to make them. You have been asked to develop the general statement to generalize the height of each doll regardless of the number of dolls in the finished product.

Closing Session

Misconceptions/SMP's 1-8

Whole Group

Does a negative exponent tell you the amount of numbers you should have to the right of the decimal? (Give a counterexample).

Is there a relationship between the exponent and the number of zeroes?

What number does ten to the negative sixth power represent?

Answer the opening hook:

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