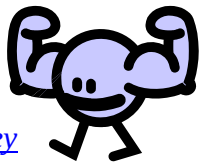


Practice Task: Power-ful Exponents

Adapted from www.nzmaths.co.nz/resource/beyond-million-amazing-math-journey

Students need to develop an understanding that place value can be expressed as a power of 10 (exponents). In addition, multiplication is a very powerful operation and can create very large numbers (exponential multiplication).

STANDARDS FOR MATHEMATICAL CONTENT

Understand the place value system.

- **MCC5.NBT.2** Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10.

STANDARDS FOR MATHEMATICAL PRACTICE

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

BACKGROUND KNOWLEDGE

This lesson will extend students' previous experience with whole number place value. Students should have an understanding of the place value names, the period names, and the values associated with them.

COMMON MISCONCEPTIONS

- *Multiplication can increase or decrease a number*. From previous work with computing whole numbers, students understand that the product of multiplication is greater than the factors. However, multiplication can have a reducing effect when multiplying a positive number by a decimal less than one or multiplying two decimal numbers together. We need to put the term *multiplying* into a context with which we can identify and which will then make the situation meaningful. Also using the terms times and of interchangeably can assist with the contextual understanding.
- *Is a x a x a = 3a? Is* $a^3 = a \times 3$*?* In mathematics each symbol has a uniquely defined meaning. a x 3 has been arbitrarily chosen as shorthand for a + a + a . It cannot mean

anything else. a^3 has been, equally arbitrarily, chosen as shorthand for a x a x a. It means precisely this. Always consider the unique meanings of the mathematics you write.

ESSENTIAL QUESTIONS

- How can we use exponents to represent the value of larger numbers?
- How can we describe the relationship between the number of zeroes and the exponent for base ten?

MATERIALS

- Suggested literature: On Beyond a Million: An Amazing Math Journey by David M. Schwartz
- "Place Value Houses" recording sheets
- Six sided dice
- Calculator
- "Powers of 10 Yahtzee" recording sheet

GROUPING

Whole/individual/small group task

TASK DESCRIPTION, DEVELOPMENT AND DISCUSSION

Comments: This task provides students with the opportunity to explore the different ways to express powers of 10 through a suggested literature connection. Instead of teaching this concept procedurally, allow students to discover the relationship between the powers of 10 and the number of zeros in a number with a 1 in the highest place and zeros in the rest.

TASK

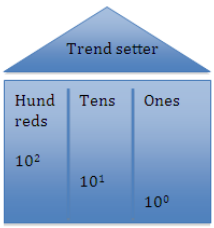
Part 1

Prior to reading the story, ask: What is the largest number you can read? Record a number with many places such as 1,234,567,890,123,456,789 or 1,000,000,000,000 and explore the understanding of place value "houses" with your students. Use the place value houses and insert the digits in the places and practice reading the numbers, stressing to remember to name the house before you leave for the next one (example 42,509,670 read as 42 MILLION, 509 THOUSAND, 670).

Share the book with your students on a first run through by sharing the story told in the middle sections of the 2-page spreads and focusing on the new vocabulary of the large numbers and the idea of infinity.

Next, or in a second session, read through the book again this time focusing on the idea of exponents and the math being explored by the professor's dog on the sidebars. Have students record the numbers expressed as exponents and as ordinary notation.

Revisit the Place Value houses and in each section of the house record the place as an expression of a power of ten.



Explore this pattern with the rest of the standard place value houses. Support students to discover the link between powers of 10 and the number of zeros in any large number which has a 1 in the highest place and zeros in the rest.

Part 2

Students will play "Powers of 10 Yahtzee."
Directions:

- Students play against an opponent. The pair needs one die.
- Players take turns rolling the die until each has rolled the die 5 times. Each time they roll the die, they are rolling a power of 10. The base number is always 10. The object of the game is to have the greatest sum after rolling five numbers.
- Player 1 rolls the die, writes the number as 10 to whatever power is indicated on the die and finds the value for that expression. Both players write the exponential expression on their recording sheets and may check the solution with a calculator.
- It is then player 2's turn to roll the die, write the expression and find the value.
- The players continue taking turns until each has had 5 turns. Players record both the five turns for player one and the five turns for player two. At that point the players each find the sum of their answers. The player with the greatest sum wins.

FORMATIVE ASSESSMENT QUESTIONS

- Did you develop a shortcut to find your answers?
- Did you identify any patterns or rules? Explain!

DIFFERENTIATION:

Extension

- Students can explore writing large numbers in scientific notation.
- Students can research large numbers and the meaning of their names.

Intervention

- Most students, including students needing an intervention here, would benefit from the use of base ten materials. For example, 10^2 would mean taking ten sets of tens. Students would put these together to make another base ten material, in this case the 100 (flat). For larger exponents, students would still find a cube, rod, or flat, since that is the pattern found in the base ten materials.
    - For example, 10^5 would mean taking 10 sets of 10 **rods**, which as we found before, makes a 100 **flat**, then taking 10 sets of 100 flats to make a 1,000 **cube**, then ten thousands cubes to make a 10,000 **rod**, then ten 10,000 rods to make a 100,000 **flat**. It is likely that students won't be able to make some of these with actual materials, but it does provide students with an investigation into the order of magnitude of our base ten system.

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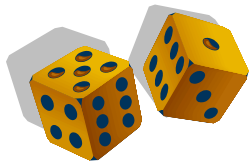
Name _____ Date _____

Powers of 10 Yahtzee



Materials: 1 die (6-sided); Recording Sheet
Number of Players: 2 or more
Directions:

- Take turns rolling the die until each has rolled 5 times. Each time you roll the die you are rolling a power of 10. The base number is always 10.
- Player 1 rolls the die, writes the number as 10 to whatever power is indicated on the die and finds the value for that expression. Both players write the exponential expression on their recording sheets and may check the solution with a calculator.
- It is then player 2's turn to roll the die, write the expression and find the value.
- Continue taking turns until each of you has had 5 turns. Record both the five turns for player one and the five turns for player two. At that point the players each find the sum of their answers. The player with the greatest sum wins.

Game 1:

Player 1		Player 2	
Exponential Expression	Value	Exponential Expression	Value

Player 1's Sum: _____ Player 2's Sum: _____

Game 2:

Player 1		Player 2	
Exponential Expression	Value	Exponential Expression	Value

Player 1's Sum: _____ Player 2's Sum: _____