Expressions and Equations

Estimating Very Large and Very Small Numbers

Grade 8

Rationale

- Students must be able to write numbers in a variety of formats. This lesson builds upon prior knowledge of different ways to write numbers. Students should be able to write numbers in expanded notation and understand powers of 10 to complete this lesson. The focus of the lesson is for students to estimate numbers as a single digit times an integer power of 10 in preparation for using scientific notation. For example, 7×10^9 is an estimation for 712,003,000.

Goal

- To estimate and work with very large and very small numbers as a single digit times an integer power of 10

Standards

- **8.EE.3** Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. For example, estimate the population of the United States as 3×10^8 and the population of the world as 7×10^9, and determine that the world population is more than 20 times larger.

Objectives

- Students will estimate very large and very small numbers.
- Students will write very large numbers as a single digit times an integer power of 10.

Materials

- Pencils
- Paper
- Internet or reference sheets of U.S. and state population
- Student Activity Sheet: ***Estimate Very Large and Very Small Numbers***

Procedure

- Begin the lesson by asking students, "On average, how many miles away from the earth is the moon? " <238,854> "On average, how many miles away from the earth is the sun?" <92,748,018> "Roughly how long does it take light to travel one meter?" <.000000003 seconds>
- Record student guesses and then list actual numbers. Ask students, "Does anyone know a shorter way to write these numbers?" Allow students to say a variety of ways to write the

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numbers. Explain today you are going to use an even different way. You will be using a single digit times a power of 10.

- Ask students what number 3×10^2 would represent. Then ask, "If it was an approximation, what number could it be approximating?"
- Allow students to give a variety of answers. If it does not already come up in discussion ask, "Could it be an approximation of 387?" "How do you know?"
- Assign students into groups of 2 or 3. Pass out the ***Estimate Very Large and Very Small Numbers*** sheet. First students will complete the powers of 10 chart, then the remainder of the activity. Tell students that they will need to determine which power of 10 to use when approximating numbers. Tell them that after they finish the activity, they will be sharing their methods for determining the correct power of 10.
- Have groups share with the class how they determined the powers of 10. If students have different answers, ask students to prove how they know that their answers are correct. Help students to experiment with the numbers and call their attention to smaller and more familiar powers of 10.
- Ask students to share how their estimates compared to the actual numbers. Were their answers reasonable? Why? Why not?
- Closing: Return to the 3 questions presented at the beginning of class. Ask students to write these numbers as a single number times a power of ten. In particular, call students attention to the time it takes light to travel one meter. Have students think about how they would handle this. Some students make think of fractions. Other students may be familiar with negative exponents or may choose to place a negative simply by following a pattern. Help students to use patterns to see the connections between these forms of notation and also to see why they make sense.

Teacher Tips

- You may want to briefly review expanded notation and powers of 10 before beginning this lesson. Have students look at familiar powers of ten and use these to extrapolate patterns for larger powers of 10. Use multiplication and division to help students to understand what happens as powers of ten increase or decrease. In order to understand negative exponents continue to divide. Make sure that students understand the difference between negative powers of 10 and negative numbers. Ask, "Why do you think mathematicians chose to represent powers of ten less than one in this way?"
- Feel free to research and ask students their estimations of different facts besides the ones presented. The ones listed are just examples.
- Note: The distance from the earth to moon, and earth to the sun differ depending upon where the earth is in its orbit.
- The speed that light takes to travel one meter is an estimate. Ask students what number it could actually represent. Many students will want to put numbers in place of the zeros that precede the 3. Have students think about how this would change the value of the number.
- You can get population facts from http://www.census.gov/ .

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Extension Activities

- Students could also compare the actual population of their state and the United States.
- Teach students about “googol” and “googolplex.”
- Give students numbers written in scientific notation. Have them practice writing these numbers as just a single digit times a power of 10.
- Students could match up scientific notation numbers to their corresponding whole number times a power of 10.
- Have students create a number fact poster where the numbers are presented in a variety of ways.
- Let students create a map of the continents and have them research and write the population of each continent as a single digit times a power of 10.
- Have students further explore very small numbers. Ask them what kinds of things would be represented in very small numbers. If they research these, they will find many of them already written in approximations and scientific notation. Ask them to come up with numbers that these could be approximating.
- As a challenge, have students converts numbers such as the time it takes light to travel one meter from meters to centimeters.

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Powers of 10 – Warm Up

Standard Form	Expanded Form	Power of 10
10	10	10^1
100		10^2
1,000	$10 \times 10 \times 10$	
	$10 \times 10 \times 10 \times 10$	10^4
100,000	$10 \times 10 \times 10 \times 10 \times 10$	
1,000,000		10^6
10,000,000	$10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10$	
	$10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10$	10^8
		10^9

United States and Your State Population Measurement

To estimate very large or small numbers write the digit of the place value of the first digit times a power of 10.

1. Estimate the population of the United States.

2. Estimate the population of your state.

3. How much greater is the population of the United States?

4. Research the actual population of United States. Write this number as a single digit times a power of 10.

5. Research the actual population of your state. Write this number as a single digit times a power of 10.

6. Now how much greater is the population of the United States?

7. How do your estimates compare?

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8. Choose 2 of the largest states and two of the smallest states. Write each of their populations as a single digit times a power of 10.

9. Compare the populations of the largest and smallest states that you chose. Write a statement comparing their populations mathematically.

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Answer Key Power of 10 – Warm Up

Standard Form	Expanded Form	Power of 10
10	10	10^1
100	<10 × 10>	10^2
1,000	10 × 10 × 10	<10^3>
<10,000>	10 × 10 × 10 × 10	10^4
100,000	10 × 10 × 10 × 10 × 10	<10^5>
1,000,000	<10 × 10 × 10 × 10 × 10 × 10>	10^6
10,000,000	10 × 10 × 10 × 10 × 10 × 10 × 10	<10^7>
<100,000,000>	10 × 10 × 10 × 10 × 10 × 10 × 10 × 10	10^8
<1,000,000,000>	<10 × 10 × 10 × 10 × 10 × 10 × 10 × 10 × 10>	10^9

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