

Big Ideas

Numbers can be expressed using scientific notation to represent values and make computations in mathematical or real-world situations.

Vocabulary

Scientific notation, standard notation, decimal notation, calculator notation, coefficient

Prior Learning

Students begin using whole-number exponents in Grade 5. In 6th grade, students wrote and evaluated simple numerical expressions with whole number exponents (i.e. $5^3 = 5 \cdot 5 \cdot 5 = 125$). Grade 8 extends this learning to scientific notation.

Essential Questions

- Why do we use scientific notation in writing numbers?
- How can scientific notation help when writing numbers and equations?
- How is scientific notation used in real world application problems?
- How can we compare and manipulate numbers using scientific notation?
- Why does scientific notation involve using a power of ten in the expression?
- What is the different between scientific notation and standard form?
- How can we compare numbers in scientific and standard notation?
- How do we add and subtract numbers written in scientific notation with the same exponents?
- How do we multiply or divide numbers written in scientific notation?
- What does the “E” followed by a number represent on a calculator?

Competencies

- Students will convert values to and from scientific notation.
- Students will add, subtract, multiply and divide numbers represented in scientific notation.
- Students will solve real world problems involving values represented in scientific notation.

Misconceptions

- Students may think that negative exponents indicate a negative answer.
- Students may mistake exponents for multiplication.
- Students may not realize that a number with negative exponents will have a different value than the same number written with positive exponents.

Resources from The Key Elements to Mathematics Success - KEMS Grade 8 for Building the Conceptual Understanding of this Module

KEMS Lesson 8: Scientific Notation and Powers of Ten
 Additional Activities: Quiz on T215-T216, Chain Reaction on T966

KEMS Lesson 9: Application of Laws of Exponents and Scientific Notation
 Additional Activities: Quiz on T242-T243, Scavenger Hunt on T967

NYS Next Generation Learning Standard	Examples
<p>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. e.g., 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.</p>	<p>Students use scientific notation to express very large or very small numbers. Students compare and interpret scientific notation quantities in the context of the situation, recognizing that if the exponent increases by one, the value increases 10 times. If the exponent decreases by one, the value decreases 10 times.</p> <p>Example 1: Write 75,000,000,000 in scientific notation. Solution: $7.5 \cdot 10^{10}$ Example 2: Write 0.0000429 in scientific notation. Solution: $4.29 \cdot 10^{-5}$ Example 3: Express 2.45×10^5 in standard form. Solution: 245,000 Example 4: How much larger is $6 \cdot 10^5$ compared to $2 \cdot 10^3$ Solution: 300 times larger since 6 is 3 times larger than 2 and 10^5 is 100 times larger than 10^3. Example 5: Which is the larger value: $2 \cdot 10^6$ or $9 \cdot 10^5$? Solution: $2 \cdot 10^6$ because the exponent is larger</p>
Questions for 8.EE.3	
<p>1. Write the following number in scientific notation. 3,500,000,000 _____</p> <p>2. Write the following in standard notation. 4.1×10^5</p> <p>3. Compare the following values that are written in scientific notation. Use the symbols $<$, $>$ or $=$ to make a true statement.</p> <p style="padding-left: 40px;">3.4×10^5 _____ 8.7×10^4</p> <p style="padding-left: 40px;">2.6×10^3 _____ 9.6×10^2</p> <p style="padding-left: 40px;">1.5×10^8 _____ 5.7×10^9</p> <p>4. Write the following values in scientific notation.</p> <p>3,600,000 _____ 0.56 _____</p> <p>Change the scientific notation to standard form.</p> <p>2.4×10^{-2} _____ 3.2×10^3 _____</p> <p>5. Write the following values in scientific notation.</p> <p>14,708 _____ 0.961 _____</p> <p>Change the scientific notation to standard form.</p> <p>2.51×10^{-6} _____ 1.92×10^4 _____</p> <p>6. Write the following values in scientific notation.</p> <p>4,500 _____ 0.718 _____</p> <p>Change scientific notation to standard form</p> <p>3.9×10^{-5} _____ 8.14×10^5 _____</p> <p>7. Write the following values in scientific notation.</p> <p>4,270 _____ 0.95 _____</p>	

Change scientific notation to standard form

2.7×10^{-4} _____ 3.84×10^3 _____

8. Write the following values in scientific notation.

19,604 _____ 0.084 _____

Change the scientific notation to standard form.

2.57×10^{-7} _____ 9.1×10^3 _____

9. Write a comparison to describe the relationship between the values below.

1.3×10^2 and 3.9×10^6

10. Write the following values in scientific notation.

38,097,640 _____ 0.22 _____

11. Change the scientific notation to standard form.

4.6×10^{-2} _____ 3.5×10^6 _____

12. The Andromeda Galaxy contains at least 200,000,000 stars. What is this number in scientific notation?

- A. 2×10^6 B. 2×10^8 C. 20×10^9 D. 2×10^7

Answer Key for Questions for 8.EE.3

1. $3,500,000,000 = 3.5 \times 10^9$

2. $4.1 \times 10^5 = 410,000$

3. $3.4 \times 10^5 > 8.7 \times 10^4$
 $2.6 \times 10^3 > 9.6 \times 10^2$
 $1.5 \times 10^8 < 5.7 \times 10^9$

4. $3,600,000$ $\frac{3.6 \times 10^6}{0.024}$ 0.56 $\frac{5.6 \times 10^{-1}}{3,200}$
 2.4×10^{-2} _____ 3.2×10^3 _____

5. Write the following values in scientific notation. $14,708 = 1.4708 \times 10^4$ $0.961 = 9.61 \times 10^{-1}$

Change the scientific notation to standard form. $2.51 \times 10^{-3} = 0.00251$ $1.92 \times 10^4 = 19,200$

6. $4,500 = 4.5 \times 10^3$ $0.718 = 7.18 \times 10^{-1}$
 $3.9 \times 10^{-5} = 0.000039$ $8.14 \times 10^5 = 814,000$

7. Write the following values in scientific notation. $4,270 = 4.27 \times 10^3$ $0.95 = 9.5 \times 10^{-1}$

Change scientific notation to standard form $2.7 \times 10^{-4} = 0.00027$ $3.84 \times 10^3 = 3,840$

8. $19,604 = 1.9604 \times 10^4$ $0.084 = 8.4 \times 10^{-2}$
 $2.57 \times 10^{-7} = 0.000000257$ $9.1 \times 10^3 = 9,100$

9. $1.3 \times 10^2 < 3.9 \times 10^6$
 $130 < 3,900,000$

10. $38,097,640 = 3.809764 \times 10^7$ $0.22 = 2.2 \times 10^{-1}$

11. $4.6 \times 10^{-2} = 0.046$ $3.5 \times 10^6 = 3,500,000$

12. B. 2×10^8

Tasks for 8.EE.3

*Teacher Note: Please read the Commentary section for the Illustrative Math Tasks. Some tasks will be instructional requiring more teacher modeling and direction. Others will provide the opportunity for students to demonstrate their knowledge of a concept.

- Illustrative Math Task: Order of Magnitude
<https://tasks.illustrativemathematics.org/content-standards/8/EE/A/3/tasks/1593>
 Illustrative Math Task: Ant and Elephant
<http://tasks.illustrativemathematics.org/content-standards/8/EE/A/3/tasks/476>
 Illustrative Math Task: Pennies to Heaven
<http://tasks.illustrativemathematics.org/content-standards/8/EE/A/3/tasks/1291>

Extra Questions for Warm-ups and Homework for 8.EE.3

- Distance from the Earth to the Sun is 155,000,000 kilometers. Write this number in scientific notation.
- Write the number in scientific notation: 8,870,000

NYS Next Generation Learning Standard

Examples

8.EE.4

Perform multiplication and division with numbers expressed in scientific notation, including problems where both standard decimal form and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities. Interpret scientific notation that has been generated by technology.

Students understand scientific notation as generated on various calculators or other technology. Students enter scientific notation using E or EE (scientific notation), * (multiplication), and ^ (exponent) symbols.

Example 1:

$2.45E^{23}$ is $2.45 \cdot 10^{23}$ and $3.5E^{-4}$ is $3.5 \cdot 10^{-4}$ (NOTE: There are other notations for scientific notation depending on the calculator being used.)

Students solve problems scientific notation using addition, subtraction, multiplication and division.

Example 2:

In July 2010 there were approximately 500 million face book users. In July 2011 there were approximately 750 million face book users. How many more users were there in 2011? Write your answer in scientific notation.

Solution: Subtract the two numbers: $750,000,000 - 500,000,000 = 250,000,000 = 2.5 \cdot 10^8$

Example 3:

$(6.45 \cdot 10^{11})(3.2 \cdot 10^4) = (6.45 \cdot 3.2)(10^{11} \cdot 10^4)$ *Rearrange factors*
 $= 20.64 \cdot 10^{15}$ *Add exponents when multiplying powers of 10*
 $= 2.064 \times 10^{16}$ *Write in scientific notation*

Example 4:

$(0.0025)(5.2 \cdot 10^4) = (2.5 \cdot 10^{-3})(5.2 \cdot 10^4)$ *Write factors in scientific notation*
 $= (2.5 \cdot 5.2)(10^{-3} \cdot 10^5)$ *Rearrange factors*
 $= 13 \cdot 10^2$ *Add exponents when multiplying powers of 10*
 $= 1.3 \cdot 10^3$ *Write in scientific notation*

Questions for 8.EE.4

- Find the sum. $(3 \times 10^5) + (1.45 \times 10^5)$
- Find the difference. $(8 \times 10^4) - (2.7 \times 10^4)$
- Find the product of each of these problems.
 $(9.32 \times 10^3) (3.32 \times 10^2) = \underline{\hspace{2cm}}$

$(7.22 \times 10^1)(4.45 \times 10^3) =$ _____

$(6.82 \times 10^5)(3.77 \times 10^2) =$ _____

4. Find the sum or difference

$(1.3 \times 10^6) + (8.4 \times 10^5) =$ _____

$(2.1 \times 10^4) - (9.2 \times 10^3) =$ _____

5. $\frac{5.26 \times 10^5}{11.1 \times 10^3}$

6. $(5.75 \times 10^4) \cdot (4.7 \times 10^2) =$

7. Find the value of the following expression: $\frac{4.32 \times 10^7}{2.4 \times 10^9}$

- A. 1.8×10^{-2} B. 1.8×10^{-3} C. 1.8×10^{-1} D. 1.8×10^2

8. The bedroom of our house is 1,200 cubic meters. We know that there are 3.4×10^9 particles of dust per cubic meter. Write how many particles of dust are present in the bedroom of our house.

9. Find the value of the following expression: $(1.41 \times 10^3)(4.2 \times 10^{-6})$

- A. 5.922×10^{-3}
 B. 5.922×10^3
 C. 5.922×10^{-18}
 D. 5.922×10^{-9}

10. Find the value of the following expression: $(8.4 \times 10^4)(1.02 \times 10^{-2})$

Answer Key for Questions for 8.EE.4

1. $(3 \times 10^5) + (1.45 \times 10^5) = 4.45 \times 10^5$

2. $(8 \times 10^4) - (2.7 \times 10^4) = 5.3 \times 10^4$

3. $(9.32 \times 10^3)(3.32 \times 10^2) = 3.09424 \times 10^6$

$(7.22 \times 10^1)(4.45 \times 10^3) = 3.2129 \times 10^5$

$(6.82 \times 10^5)(3.77 \times 10^2) = 2.57114 \times 10^8$

4. $(1.3 \times 10^6) + (8.4 \times 10^5) = 2.14 \times 10^6$

$(2.1 \times 10^4) - (9.2 \times 10^3) = 1.18 \times 10^4$

5. $\frac{5.26 \times 10^5}{11.1 \times 10^3} = 4.\overline{738} \times 10^1$

6. $(5.75 \times 10^4) \cdot (4.7 \times 10^2) = 2.7025 \times 10^7$

7. A. 1.8×10^{-2}

8. 3,400,000,000

9. 5.922×10^{-3}

10. 8.568×10^2

Tasks for 8.EE.4

*Teacher Note: Please read the Commentary section for the Illustrative Math Tasks. Some tasks will be instructional requiring more teacher modeling and direction. Others will provide the opportunity for students to demonstrate their knowledge of a concept.

Illustrative Math Task: Choosing appropriate units

<https://tasks.illustrativemathematics.org/content-standards/8/EE/A/4/tasks/1981>

Illustrative Math Task: Ants versus humans

<https://tasks.illustrativemathematics.org/content-standards/8/EE/A/1/tasks/823>

Illustrative Math Task: Giantburgers

<http://tasks.illustrativemathematics.org/content-standards/8/EE/A/4/tasks/113>

Illustrative Math Task: Pennies to Heaven

<http://tasks.illustrativemathematics.org/content-standards/8/EE/A/3/tasks/1291>

Extra Questions for Warm-ups and Homework for 8.EE.4

1. What is the sum? $7 \times 10^3 + 8.6 \times 10^4$

Works Referenced in the Development of the Module

Common Core State Standards Initiative www.corestandards.org	Ohio Department of Education http://education.ohio.gov/Topics/Learning-in-Ohio/Mathematics
Illustrative Mathematics Project https://illustrativemathematics.org/	North Carolina Math Tools for Teachers https://tools4ncteachers.com/
Mathematics Assessment Project https://www.map.mathshell.org/index.php	Smarter Balanced Assessment Consortium https://smarterbalanced.org/
PARCC http://parconline.org/	Utah Education Network https://www.uen.org/core/math/
NOYCE Foundation: https://www.insidemathematics.org/	