Writing and Comparing Numbers in Scientific Notation – Grade Eight

Ohio Standards Connection:

Number, Number Sense and Operations

Benchmark A
Use scientific notation to express large numbers and numbers less than one.

Indicator 1
Use scientific notation to express large numbers and small numbers between 0 and 1.

Related Benchmark I
Estimate, compute and solve problems involving scientific notation, square roots and numbers with integer exponents.

Indicator 8
Add, subtract, multiply, divide and compare numbers written in scientific notation.

Mathematical Processes Benchmarks

C. Recognize and use connections between equivalent representations and related procedures for a mathematical concept; e.g., zero of a function and the *x*-intercept of the graph of the function, apply proportional thinking when measuring, describing functions, and comparing probabilities.

***Lesson Summary**:*
In this lesson, students explore multiple representations of large numbers in scientific notation through the use of models, visual representations and expanded numeric form. The activities for comparing and ordering numbers in scientific notation use contexts familiar and motivating to middle school students. Select appropriate parts of the lesson based on pre-assessment data and needs of the students. Flexible grouping options, cooperative learning strategies and multiple representations embedded throughout the lesson address auditory, kinesthetic and visual learning preferences.

Estimated Duration: *One hour and 30 minutes*

Commentary:
Students begin to write numbers in scientific notation in seventh grade. Students in eighth grade continue to develop understanding and learn to apply scientific notation. Using familiar and interesting contexts and opportunities for multiple groupings provides students with an engaging experience for learning scientific notation.

Pre-Assessment:
The purpose of the pre-assessment activities is to review topics addressed in Grade Level Indicators from sixth and seventh grade. Students demonstrating a lack of familiarity, exposure or understanding of these topics may require some scaffolding to ensure success with the content presented in this lesson.

Part One
Use *What I Know About Numbers-KWL*, Attachment A.
For this pre-assessment activity, chart paper, markers and a timer are needed. Students work in small groups followed by a class discussion.

- Prepare a KWL chart on chart paper, using Attachment A as a reference, for each of the following topics: scientific notation, negative exponents, place value using powers of 10 and exponent of zero.

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E. Use a variety of mathematical representations flexibly and appropriately to organize, record and communicate mathematical ideas.
F. Use precise mathematical language and notations to represent problem situations and mathematical ideas.
G. Write clearly and coherently about mathematical thinking and ideas.
H. Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.

- Divide students into groups of four and distribute *What I Know About Numbers- KWL* handout, Attachment A, to students.
- Assign each member of the group a specific task (i.e., recorder, facilitator, communicator and timer).
- Set a timer for eight minutes (give students a two-minute warning) and allow each group to discuss and complete the "K" (what they know) and "W" (what they want to know) columns of the KWL chart. The "L" column is used for summarizing new learning about numbers at the end of the lesson. Observe group discussions, focusing on individual comments and participation to identify students who have little or no prior knowledge or show misunderstanding and misconceptions of parts or all of the related content. Take anecdotal notes to record misconceptions or misunderstandings presented in discussion. Also, record names of students who appear to have little or no prior knowledge of the content.
- Facilitate presentations by each group on the topics from their KWL charts.
- Record information on the large KWL charts.
- Expand and/or clarify ideas with the class as a whole.
- Have each group of four break into two pairs and discuss the following questions:
  1. Why do we use scientific notation?
  2. Who uses scientific notation?
  3. What does a nonzero number raised to the zero power equal? Why?
  4. What is the purpose of exponents?
  5. What is meant by a power of 10?
- Follow up with class discussion to clarify ideas and correct misconceptions students may have.

Instructional Tip:
The list of sample discussion questions is not an all encompassing list. Develop and ask additional questions as needed based on the results of the KWL discussion and misconceptions presented by students. A well-developed discussion will take approximately 10 to 15 minutes of class time.

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Scoring Guidelines:
Identify the strengths and weaknesses of the class by circulating throughout the 10 minutes provided for the students to complete the KWL chart. Take anecdotal notes to record misconceptions, misunderstandings and names of students who appear to have little or no prior knowledge related to the content.

Part Two

- Distribute Attachment B, *Exponents and Scientific Notation Calculations*. Students need paper, pencil, colored pencils or markers.

Instructional Tip:
A sampling of problems is included in *Exponents and Scientific Notation Calculations,* Attachment B. Choose the problems for the needs of the students rather than assigning all of the problems. Decide if the use of a calculator is appropriate at this time.

- Students complete the assigned exercises on *Exponents and Scientific Notation Calculations.*
- Ask students to share responses and provide explanations. If the correct answer is not stated, ask other students if they agree or disagree.
- Collect the papers to analyze individual results.

Scoring Guidelines:
Use a checklist to informally identify the strengths and weaknesses of the class by circulating throughout the room while students work. Place a checkmark in the box if students appear to be answering the questions in the number grouping correctly. Collect the papers once the students grade and correct them and append the checklist, if necessary. An answer key is provided in Attachment C, *Exponents and Scientific Notation Calculations Answer Key*.

Name	Exponents (1-3)	Exponent of Zero (4-6)	Negative Exponents (7-9)	Scientific Notation (10-12)	Place Value (13-20)	Place Value Power of 10 (21-22)

Post-Assessment:
Each student should individually complete the post assessment, *Writing and Comparing Numbers in Scientific Notation – Post-Assessment,* Attachment D. Calculators may be used. The answer key and scoring guidelines are in *Writing and Comparing Numbers in Scientific Notation – Post-Assessment Answer Key and Scoring Guidelines,* Attachment E.

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Instructional Procedures:

Part One

1. Complete the Pre-Assessment.
2. Distribute *The Power of 10,* Attachment F, to students.
   a. Divide students into pairs.
   b. Allow five to seven minutes for the pairs to make conjectures to answer the questions listed.
   c. Discuss the correct solutions to the questions posed on *The Power of 10,* Attachment F. An answer key is provided on Attachment G.

Instructional Tips:

- The patterning shown in *The Power of 10,* Attachment F, can be applied to any base. If the pre-assessment shows that students do not understand negative exponents or the exponent of zero, additional sample tables could be created using 2, 3, 5, etc. as a base.
- Students needing intense intervention can be presented models or visual representation of numbers using base-ten blocks or visual representations of base-ten blocks. Begin by having students represent whole numbers with the models or visual representations. Relate the size of the blocks to the exponent; a cube (1 unit) representing the zero power, a rod (10 units) representing the first power, a flat (100 units), representing the second power and a large cube (1000 units), representing the third power. Scaffold understanding by having them represent numbers in scientific notation. Continue the use of models and representations with all students as the lessons progress. Although the blocks have limitations, they provide access to understanding the basis of the concept for a variety of learning preferences.

3. Use scientific notation to express large numbers and small numbers. Elicit the procedures for this task through discussion by asking students to provide the steps and procedures for writing a number in scientific notation. Ask the following questions to clarify understanding:
   - Explain the relationship between the exponent in scientific notation and the number of places the decimal has been moved.
   - When will the exponent be negative? When it will be positive?
4. Distribute the *Pairs Check,* Attachment H, for writing numbers in scientific notation and have students complete in pairs. Discuss the correct answers as a class following the completion of the worksheet.
5. Direct students to find examples of scientific notation in a newspaper or magazines. Large numbers may be found in articles with statistics related to unemployment, the deficit, population, lottery winnings, stock market, scientific findings and measurements, etc. Have students cut out the article, list the numbers in the article and rewrite them in scientific notation.

Instructional Tip:

Provide newspapers and magazines for students who do not have access to these resources.

6. Assign the following prompts and tell students to write an exit tickets or write responses in their journals (allow the use of models and visual representations for students not meeting standard):
   a. What are two situations where scientific notation would be useful? Why?
   b. Write one very large number and show the proper conversion into scientific notation.
   c. Write one very small number and show the proper conversion into scientific notation.

Part Two *Comparing Numbers in Scientific Notation*

Instructional Tip:

Prior to the lesson, copy *Partner Squares,* Attachment J, on heavy-weight paper and cut out the cards. Copy *Line Up,* Attachment K, on heavy weight paper and cut out the cards. Hang a clothesline in three corners of the room labeled "Dirt Road," "Paved Road" and "Highway."

7. Distribute *Partner Squares* cards, Attachment J, that have numbers written in either decimal notation or standard notation, to students as they enter the room. Add additional cards that represent numbers visually or cards that have both numeric and visual representations for students not meeting standard at this point of instruction.
   a. After students enter, explain that they should find the person who has the same number written on his/her card but in the opposite notation. (i.e. the student who has 500 would look for the student who has 5×10^{2})
   b. After the partner is found, the pair sits together and shares the cards with the class.
8. Launch into pair-share using newspaper article summaries and the numbers they wrote from the article with their partner. Instruct the students to comment on anything that seems unclear with the summaries and offer a correction if the numbers are not put into scientific notation correctly. Select a few students to share what their partner chose for their articles and the numbers they selected.
9. Pose the following questions orally or on the board. Choral responses are acceptable.
   - Which is smaller, 500 or 5000?
   - Which is smaller, 5×10^{2} or 5×10^{3}?
   - Which is larger, 5×10^{2} or 5×10^{1}?
   - Which is smaller, 5×10^{2} or 4×10^{2}?
   - Which is larger, 5×10^{2} or 5×10^{-2}?
   - Which is smaller, 5×10^{-2} or 5×10^{-4}?
   - Which is smaller, 5×10^{-2} or 4×10^{-2}?
10. Attachment K, *Line Up*
    a. Give each group the pack of cards (Attachment K) for their group name ("Dirt Road," "Paved Road" and "Highway").
    b. Tell the groups to distribute a card to each student and that talking is not allowed for this activity.
    c. Group members hang their cards in ascending order on the clothesline.
    d. Students should then do a silent walk around to determine if the order on each of the clotheslines is correct.

The "Dirt Road" cards should be ordered 2.3×10^{-10}, 3×10^{-3}, 3×10^{-1}, 5, 2×10^{2}, 2.3×10^{2}, 2.4×10^{2} and 2.3×10^{4}.
The "Paved Road" cards should be ordered 4×10^{-2}, .05, 5×10^{-1}, .05, 40, 4×10^{2}, 500, 4000 and 5×10^{4}.
The "Highway" cards should be ordered .00052, 5.23×10^{-4}, .05, 5.22×10^{-2}, 5.23×10^{-2}, 5.24×10^{-2}, .0525 and 5.24.

Instructional Tip:
If students do not feel comfortable saying that they do not understand the concept, they can write self-evaluations and give them to the teacher. To increase learning success, the teacher can use these evaluations to group students by abilities.

11. Students complete Attachment L, *Movie Earnings.*

Instructional Tip:
Attachment L can either be assigned as seat work or as homework. The correct answers for *Movie Earnings* should be discussed prior to students completing the post assessment activity.

12. Have each student write as a *Mathematics Exit Ticket* or a journal entry a step-by-step outline or flow chart demonstrating how to compare numbers written in scientific notation.
13. Complete the post assessment activity, *Writing and Comparing Numbers in Scientific Notation – Post-Assessment,* Attachment D. See the answer key and the scoring guidelines on Attachment E.

Differentiated Instructional Support:
Instruction is differentiated according to learner needs, to help all learners either meet the intent of the specified indicator(s) or, if the indicator is already met, to advance beyond the specified indicator(s).

- This standard can be differentiated for students that are challenged by the content and those that experience success immediately by the size of numbers used and by the number of problems learners complete.
- Students that experience success early in the lesson can evaluate when scientific notation would be useful and when it would not make sense to use. Once this evaluation occurs, students research specific examples such as space explorations, exponential growth or decay to back up their evaluations.
- Students experiencing difficulties with concepts can be presented with adjusted assignments to meet their needs. Adaptations for this lesson could include a partially-completed Power of 10 table or a newspaper article with a minimal selection of numbers to be converted into scientific notation.
- Cooperative learning strategies make all students accountable and provide auditory and kinesthetic learners ways to access the content.
- Present students needing intense intervention models of numbers using base-ten blocks or visual representations of base-ten blocks. Begin by having students represent whole numbers

with the models or visual representations. Relate the size of the blocks to the exponent: a cube (1 unit), representing the zero power, a rod (10units), representing the first power, a flat (100 units), representing the second power and a large cube (1000 units), representing the third power. Scaffold understanding by having them represent numbers in scientific notation. Continue the use of models and representations with all students as the lessons progress. Although the blocks have limitations, they provide access to understanding the basis of the concept for a variety of learners.

- Provide additional computational problems for students in need of assistance.

Extensions:

- Students create a model of the solar system. Distances from each planet to the sun and the circumference of the sun could be researched. Students could then scale those measurements and physically build the solar system with appropriate proportions. Students can also research why there is a problem with using Pluto in this model.
- Students research both the national debt and world population. Students examine the growth of each and display their conclusions graphically which could lead into a discussion about exponential growth.

Home Connections and Homework Options:

- Assign Attachment L, *Movie Earnings,* following Part Two of the lesson.
- Students research a topic, using very large and small numbers, on the internet and create questions involving adding, subtracting, multiplying and dividing numbers in scientific notation. Science-related articles using measurements will commonly contain very large and very small numbers.

Interdisciplinary Connections:

Science: Students can use scientific notation to express small weights in grams and lengths in meters, the speed of light, diameters of various cells, magnifications, and moles per liter.

Materials and Resources:

The inclusion of a specific resource in any lesson formulated by the Ohio Department of Education should not be interpreted as an endorsement of that particular resource, or any of its contents, by the Ohio Department of Education. The Ohio Department of Education does not endorse any particular resource. The Web addresses listed are for a given site's main page, therefore, it may be necessary to search within that site to find the specific information required for a given lesson. Please note that information published on the Internet changes over time, therefore the links provided may no longer contain the specific information related to a given lesson. Teachers are advised to preview all sites before using them with students.

For the teacher: Clothes lines, clothes pins, card stock, markers, chart paper, timer, newspaper articles or magazine articles with either large or small numbers

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For the student: Calculators, markers or colored pencils

Vocabulary:
- base
- coefficient
- factor
- mantissa
- power
- scientific notation

Technology Connections:
- Use Web sites which collect large numbers of statistical data relevant to eighth graders such as highest grossing movies and albums, attitudinal surveys, current events, etc.

Research Connections:
Cawletti, Gordon. *Handbook of Research on Improving Student Achievement.* Arlington, Va: Educational Research Service, 1999.

Marzano, Robert J., Jane E. Pollock and Debra Pickering. *Classroom Instruction that Works: Research-Based Strategies for Increasing Student Achievement*, Alexandria, Va: Association for Supervision and Curriculum Development, 2001.

Ogle, Donna M. "The Know, Want To Know, Learn Strategy." In K. D. Muth (Ed.) *Children's Comprehension of Text: Research into Practice*, 205-223, Newark, De: International Reading Association, 1986.

Attachments:
Attachment A, *What I Know about Numbers*
Attachment B, *Exponents and Scientific Notation Calculations*
Attachment C, *Exponents and Scientific Notation Calculations Answer Key*
Attachment D, *Writing and Comparing Numbers in Scientific Notation, Post-Assessment*
Attachment E, *Writing and Comparing Numbers in Scientific Notation Answer Key*
Attachment F, *The Power of 10*
Attachment G, *The Power of 10 Answer Key*
Attachment H, *Pairs Check*
Attachment I, *Pairs Check Answer Key*
Attachment J, *Partner Squares*
Attachment K, *Line Up*
Attachment L, *Movie Earnings*
Attachment M, *Movie Earnings Answer Key*

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Attachment A
What I Know About Numbers KWL – Pre-Assessment

Name(s) _____ **Date**_____

For each topic listed in the left column of the table below, list everything you already know in the column labeled K.
For each topic listed in the left column of the table below, list everything you want to know (are unsure of or need clarified) in the column marked W.
The L column will be used at the conclusion of this lesson. At the conclusion of the lesson, you will list everything you have learned in the L column.

TOPIC	K	W	L
Scientific Notation			
Negative Exponents			
Place Value and Power of 10			
Exponent of Zero			

Attachment B
Exponents and Scientific Notation Calculations – Pre-Assessment

Name_____ **Date**_____

Evaluate each of the following.

1. $5^2 =$
2. $2^3 =$
3. $\left(\frac{1}{2}\right)^2 =$
4. $5^0 =$
5. $2^0 =$
6. $\left(\frac{1}{4}\right)^0 =$
7. $5^{-2} =$
8. $2^{-3} =$
9. $\left(\frac{1}{2}\right)^{-2} =$

Rewrite each of the following in scientific notation.

10. 5000
11. 25000
12. 300,000

Answer each of the following.

13. In the number 324,157.98 what number is in the tens place?

14. In the number 324,157.98 what number is in the ones place?

15. In the number 324,157.98 what number is in the tenths place?

16. In the number 324,157.98 what number is in the hundreds place?

17. In the number 324,157.98 what number is in the hundredths place?

18. Write a number that has a 4 in the thousands place.

19. Write a number that has a 4 in the thousandths place.

20. Write 1,000 as a power of 10.

21. Write 0.1 as a power of 10.

22. Write 1 as a power of 10.

Attachment C
Exponents and Scientific Notation Calculations
Answer Key

1. $5^2 =$ 25

2. $2^3 =$ 8

3. $\left(\frac{1}{2}\right)^2 = \frac{1}{4}$

4. $5^0 =$ 1

5. $2^0 =$ 1

6. $\left(\frac{1}{4}\right)^0 = 1$

7. $5^{-2} = \frac{1}{25}$

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

9. $\left(\frac{1}{2}\right)^{-2} = 4$

10. 5000 5×10^3

11. 25000 2.5×10^4

12. 300,000 3×10^5

13. In the number 324,157.98 what number is in the tens place? 5

14. In the number 324,157.98 what number is in the ones place? 7

15. In the number 324,157.98 what number is in the tenths place? 9

16. In the number 324,157.98 what number is in the hundreds place? 1

17. In the number 324,157.98 what number is in the hundredths place? 8

18. Write a number that has a 4 in the thousands place. *Answers will vary.*

19. Write a number that has a 4 in the thousandths place. *Answers will vary.*

20. Write 1,000 as a power of 10. 10^3

21. Write 0.1 as a power of 10. 10^{-1}

22. Write 1 as a power of 10. 10^0

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Attachment D
Writing and Comparing Numbers in Scientific Notation – Post-Assessment

Name_____ Date_____

Directions: Complete the following exercises and problems.

Rewrite in scientific notation.

1. 0.000357 _____ 2. 0.00127 _____

For each problem below, place the proper sign (<, >, =) in the space provided.

3. 5,100 _____ 5.1×10^3 4. 4.3×10^{-4} ——— 4.32×10^{-4}

5. 7.8×10^{-7} ——— 7.8×10^{-8} 6. 3.2×10^{-10} ——— 3.2×10^{10}

7. Suppose the table below displays data for the top 10 prime-time television shows for a given week in the year. Complete the empty column in the table by converting the number of households into scientific notation.

Rank	Number of Households	Number of Households (written in scientific notation)
1	16,600,000	
2	14,400,000	
3	12,400,000	
4	11,800,000	
5	11,400,000	
6	11,200,000	
7	11,000,000	
8	10.900,000	
9	10,500,000	
10	10,300,000	

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Attachment D (continued)
Writing and Comparing Numbers in Scientific Notation – Post-Assessment

Name_____ Date_____

8. Suppose the data below is from television prime-time ratings for a given week during the year. Place the given information in the correct order in the table below and then convert the numbers into scientific notation.

- Program A had 13,300,000 households view it during the week.
- Program B had 13,980,000 households view it during the week.
- Program C had 15,700,000 households view it during the week.
- Program D had 13,900,000 households view it during the week.
- Program E had 16,500,000 households view it during the week.
- Program F had 13,100,000 households view it during the week.
- Program G had 15,600,000 households view it during the week.
- Program H had 13,400,000 households view it during the week.
- Program I had 20,100,000 households view it during the week.
- Program J had 13,700,000 households view it during the week.

Rank	Program Name	Number of Viewing Households
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

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Attachment E
Writing and Comparing Numbers in Scientific Notation – Post-Assessment Answer Key and Scoring Guide

Rubric: Questions 1-6

4 points	• All six problems are completed correctly.
3 points	• Five of the six problems are completed correctly.
2 points	• Four of the six problems are completed correctly AND • One problem from question one and two is completed correctly.
1 point	• Two to three of the six problems are completed correctly AND • At least one problem from questions one and two is completed correctly and at least one problem from questions three through six is completed correctly. OR • Four of six problems are completed correctly but both question one and two are completed incorrectly.
0 points	• One problem or fewer is completed correctly.

Answer Key:

1. 3.57×10^{-4}
2. 1.27×10^{-4}
3. =
4. <
5. >
6. <

Rubric: Question 7

4 points	• All 10 rankings are converted into scientific notation correctly.
3 points	• Eight to nine of the 10 rankings are converted into scientific notation correctly. OR • One minor error that indicates a minor gap in understanding is made repeatedly throughout the 10 rankings.
2 points	• Five to seven of the 10 rankings are converted into scientific notation correctly. OR • Two minor errors that indicate a minor gap in understanding are made repeatedly throughout the 10 rankings.
1 point	• One to four of the 10 rankings are converted into scientific notation correctly. OR • One major error that indicates a major gap in understanding is made repeatedly.
0 *points*	• None of the rankings is converted into scientific notation correctly.

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Attachment E (continued)
Writing and Comparing Numbers in Scientific Notation – Post-Assessment
Answer Key and Scoring Guide

Answer Key:

Rank	Number of Households	Number of Households *(written in scientific notation)*
1	16,600,000	1.66×10^7
2	14,400,000	1.44×10^7
3	12,400,000	1.24×10^7
4	11,800,000	1.18×10^7
5	11,400,000	1.14×10^7
6	11,200,000	1.12×10^7
7	11,000,000	1.10×10^7
8	10.900,000	1.09×10^7
9	10,500,000	1.05×10^7
10	10,300,000	1.03×10^7

Rubric: Question 8

4 points	• All programs are ranked in the correct order.
3 points	• Eight or nine of 10 programs are ranked in the correct order. OR • One minor error that indicates a minor gap in understanding is made repeatedly throughout the 10 rankings.
2 points	• Five, six or seven of the 10 programs are ranked in the correct order. OR • Two minor errors that indicate a minor gap in understanding are made repeatedly throughout the 10 rankings.
1 point	• One, two, three or four of the programs are ranked in the correct order. OR • One major error that indicates a major gap in understanding is made repeatedly.
0 points	• None of the programs is ranked in the correct order.

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Attachment E (continued)
Writing and Comparing Numbers in Scientific Notation – Post-Assessment
Answer Key and Scoring Guide

Answer Key Question 8::

Rank	Program Name	Number of Viewing Households
1	*I*	2.01×10^7
2	*E*	1.65×10^7
3	*C*	1.57×10^7
4	*G*	1.56×10^7
5	*B*	1.398×10^7
6	*D*	1.39×10^7
7	*J*	1.37×10^7
8	*H*	1.34×10^7
9	*A*	1.33×10^7
10	*F*	1.31×10^7

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Attachment F
The Power of 10

Name(s) _____ **Date**_____

Directions: Use the table to help answer the questions below.

Exponential Form	Factored Form	Number (in decimal form)	Words
10^6		1,000,000	One million
10^5	$10\times10\times10\times10\times10$	100,000	One hundred thousand
10^4	$10\times10\times10\times10$		Ten Thousand
$10^?$		1,000	One thousand
$10^?$		100	One hundred
$10^?$	10	10	Ten
10^0		1	One
10^{-1}	$\frac{1}{10}$	.1	One tenth
$10^?$	$\frac{1}{10}\times\frac{1}{10}$	.01	One hundredth
$10^?$		.001	One thousandth
$10^?$			One ten thousandth
10^{-5}	$\frac{1}{10}\times\frac{1}{10}\times\frac{1}{10}\times\frac{1}{10}\times\frac{1}{10}$	.00001	One hundred thousandth

1. What seems to be the pattern in the first column? Use your conjecture to fill in the missing exponents in the first column.

2. The following values are in the third column of the table: 1000, 100, 10, 1, .01, and .001. What mathematical operation explains the pattern?

3. What seems to be the relationship between the exponent and the number written in factored form? Use your conjecture to complete the factored form column.

4. What appears to be the relationship between the exponent and the number written in decimal form? Use your conjecture to complete the column.

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Attachment G

The Power of 10 – Answer Key

Exponential Form	Factored Form	Number (in decimal form)	Words
10^6	$10\times10\times10\times10\times10\times10$	1,000,000	One million
10^5	$10\times10\times10\times10\times10$	100,000	One hundred thousand
10^4	$10\times10\times10\times10$	10,000	Ten Thousand
10^3	$10\times10\times10$	1,000	One thousand
10^2	10×10	100	One hundred
10^1	10	10	Ten
10^0		1	One
10^{-1}	$\frac{1}{10}$	.1	One tenth
10^{-2}	$\frac{1}{10}\times\frac{1}{10}$	.01	One hundredth
10^{-3}	$\frac{1}{10}\times\frac{1}{10}\times\frac{1}{10}$	.001	One thousandth
10^{-4}	$\frac{1}{10}\times\frac{1}{10}\times\frac{1}{10}\times\frac{1}{10}$	.0001	One ten thousandth
10^{-5}	$\frac{1}{10}\times\frac{1}{10}\times\frac{1}{10}\times\frac{1}{10}\times\frac{1}{10}$	.00001	One hundred thousandth

1. What seems to be the pattern in the first column? Use your conjecture to fill in the missing exponents in the first column. *Students should note that the exponents decrease by one as they look down the column.*

2. The following values are in the third column of the table:
   1000, 100, 10, 1, .01, .001
   What mathematical operation explains the pattern? *Students should note that dividing the previous value by 10 yields the current value.*

3. What seems to be the relationship between the exponent and the number written in factored form? Use your conjecture to complete the factored form column. *Students should note that the exponent tells how many times the base is used as a factor.*

4. What appears to be the relationship between the exponent and the number written in decimal form? Use your conjecture to complete the column. *Students should note that the exponent tells how many places the decimal was moved to the left or right. Students may not be able to express this in words at this point.*

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Attachment H

Pairs Check

Name(s) _____ **Date**_____

Directions:

- Choose a partner. Choose a column and insert your name at the top of the column. Put your partner's name in the other column.
- The person whose name is in the left column will rewrite the number using scientific notation. The person on the right will serve as the coach. When the coach decides that the problem in the left column has been calculated correctly, the coach will put a checkmark in the right column.
- Following question six, the roles should be reversed and the same process followed.

(Insert name)	(Insert name)
1. 400	
2. 4251	
3. 2092673	
4. 0.02	
5. 0.00039	
6. 0.00437	
(Insert name)	(Insert name)
7. 358	
8. 250000	
9. 4028	
10. 0.25	
11. 0.00027	
12. 0.005678	

Writing and Comparing Numbers in Scientific Notation – Grade Eight

Attachment I

Pairs Check Answer Key

(Insert name)	(Insert name)
1. 400	4×10^{2}
2. 4251	4.251×10^{3}
3. 2092673	2.092673×10^{6}
4. 0.02	2×10^{-2}
5. 0.00039	3.9×10^{-4}
6. 0.00437	4.37×10^{-3}
(Insert name)	(Insert name)
7. 358	3.58×10^{2}
8. 250000	2.5×10^{5}
9. 4028	4.028×10^{3}
10. 0.25	2.5×10^{-1}
11. 0.00027	2.7×10^{-4}
12. 0.005678	5.678×10^{-3}

Writing and Comparing Numbers in Scientific Notation – Grade Eight

Attachment J
Partner Squares

528	5.28×10^{2}	4,780
4.78×10^{3}	478	4.78×10^{2}
0.478	4.78×10^{-1}	0.0478
4.78×10^{-2}	0.00478	4.78×10^{-3}

Writing and Comparing Numbers in Scientific Notation – Grade Eight

Attachment J (continued)

Partner Squares

5,280	5.28×10^{3}	0.528
5.28×10^{-1}	0.0528	5.28×10^{-2}
0.00528	5.28×10^{-3}	528,000,000
5.28×10^{8}	5,280,000,000	5.28×10^{9}

Writing and Comparing Numbers in Scientific Notation – Grade Eight

Attachment K
Line Up

Dirt Road

5	2×10^{2}
3×10^{-1}	2.3×10^{2}
3×10^{-3}	2.3×10^{4}
2.4×10^{2}	2.3×10^{-10}

Writing and Comparing Numbers in Scientific Notation – Grade Eight

Attachment K (continued)
Line Up

Paved Road

.05	4×10^{-2}
5×10^{-1}	4×10^{2}
40	5×10^{4}
4000	500

Writing and Comparing Numbers in Scientific Notation – Grade Eight

Attachment K (continued)
Line Up

Highway

5.23×10^{-2}	5.24×10^{-2}
5.22×10^{-2}	.05
.0525	.00052
5.23×10^{-4}	5.24

Writing and Comparing Numbers in Scientific Notation – Grade Eight

Attachment L
Movie Earnings

Name_____ Date _____

Directions: Suppose the table below shows data for the earnings of the top ten ranked movies for a given week in the year. Complete the empty column in the table by converting the number of households into scientific notation.

Rank	Earnings Data	Earnings Data *(written in scientific notation)*
1	$26,700,000	
2	$19,400,000	
3	$11,500,000	
4	$10,400,000	
5	$9,300,000	
6	$8,400,000	
7	$8,200,000	
8	$6,000,000	
9	$4,200,000	
10	$1,600,000	

Suppose the data below is movie earnings data for a given week during the year. Compare the amounts in the table below. Then convert the numbers into scientific notation and rank the earnings from greatest to least.

Rank	Movie Name	Amount Earned	Amount Earned in Scientific Notation
	A	$2,500,000	
	B	$16,000,000	
	C	$8,000,000	
	D	$2,010,000	
	E	$32,100,000	
	F	$11,900,000	
	G	$2,020,000	
	H	$18,200,000	
	I	$5,400,000	
	J	$3,100,000	

Writing and Comparing Numbers in Scientific Notation – Grade Eight

Attachment M
Movie Earnings Answer Key

Rank	Earnings Data	Earnings Data *(written in scientific notation)*
1	$26,700,000	2.67×10^7
2	$19,400,000	1.94×10^7
3	$11,500,000	1.15×10^7
4	$10,400,000	1.04×10^7
5	$9,300,000	9.3×10^6
6	$8,400,000	8.4×10^6
7	$8,200,000	8.2×10^6
8	$6,000,000	6.0×10^6
9	$4,200,000	4.2×10^6
10	$1,600,000	1.6×10^6
Rank	**Movie Name**	**Amount Earned**
1	E	3.21×10^7
2	H	1.82×10^7
3	B	1.60×10^7
4	F	1.19×10^7
5	C	8.0×10^6
6	I	5.4×10^6
7	J	3.1×10^6
8	A	2.5×10^6
9	G	2.02×10^6
10	D	2.01×10^6