Unit 3: Integer Exponents & Scientific Notation

Cluster: Work with radicals and integer exponents.

Nevada Academic Content Standard	What does this standard mean that a student will know and be able to do? (adapted from North Carolina *8th Grade Standards, Unpacked Content*)
8.EE.A.1 Know and apply the properties of integer exponents to generate equivalent numerical expressions. *For example,* $3^2 \times 3^{-5} = 3^{-3} = \frac{1}{3^3} = \frac{1}{27}$	**8.EE.1** In 6th grade, students wrote and evaluated simple numerical expressions with whole number exponents (ie. $5^3 = 5 \cdot 5 \cdot 5 = 125$). Integer (positive and negative) exponents are further developed to generate equivalent numerical expressions when multiplying, dividing or raising a power to a power. Using numerical bases and the laws of exponents, students generate equivalent expressions. Students understand: • Bases must be the same before exponents can be added, subtracted or multiplied. *(Example 1)* • Exponents are subtracted when like bases are being divided. *(Example 2)* • A number raised to the zero (0) power is equal to one. *(Example 3)* • Negative exponents occur when there are more factors in the denominator. These exponents can be expressed as a positive if left in the denominator. *(Example 4)* • Exponents are added when like bases are being multiplied. *(Example 5)* • Exponents are multiplied when an exponents is raised to an exponent. *(Example 6)* • Several properties may be used to simplify an expression. *(Example 7)* *Example 1:* $\frac{2^3}{5^2} = \frac{8}{25}$ *Example 2:* $\frac{2^2}{2^6} = 2^{2-6} = 2^{-4} = \frac{1}{2^4} = \frac{1}{16}$ *Example 3:* $6^0 = 1$ Students understand this relationship from examples such as $\frac{6^2}{6^2}$. This expression could be simplified as $\frac{36}{36} = 1$. Using the laws of exponents, this expression could also be written as $6^{2-2} = 6^0$. Combining these gives $6^0 = 1$. *Example 4:* $\frac{3^{-2}}{2^4} = 3^{-2} \times \frac{1}{2^4} = \frac{1}{3^2} \times \frac{1}{2^4} = \frac{1}{9} \times \frac{1}{16} = \frac{1}{144}$ *Example 5:* $(3^2)(3^4) = (3^{2+4}) = 3^6 = 729$ *Example 6:* $(4^3)^2 = 4^{3x2} = 4^6 = 4{,}096$ *Example 7:* $\frac{(3^2)^4}{(3^2)(3^3)} = \frac{3^{2x4}}{3^{2+3}} = \frac{3^8}{3^5} = 3^{8-5} = 3^3 = 27$

8.EE.A.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.*	**8.EE.3** 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. Likewise, if the exponent decreases by one, the value decreases 10 times. Students solve problems using addition, subtraction or multiplication, expressing the answer in scientific notation. *Example 1:* Write 75,000,000,000 in scientific notation. *Solution:* 7.5×10^{10} *Example 2*: Write 0.0000429 in scientific notation. *Solution:* 4.29×10^{-5} *Example 3:* Express 2.45×10^5 in standard form. *Solution:* 245,000 *Example 4:* How much larger is 6×10^5 compared to 2×10^3? *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: 2×10^6 or 9×10^5? *Solution:* 2×10^6 because the exponent is larger
8.EE.A.4 Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.	**8.EE.4** 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:* 2.45E23 is 2.45×10^{23} and 3.5E⁻4 is 3.5×10^{-4} (NOTE: There are other notations for scientific notation depending on the calculator being used.) Students add and subtract with scientific notation. *Example 2:* In July 2010 there were approximately 500 million Facebook users. In July 2011 there were approximately 750 million Facebook 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 → 2.5×10^8 Students use laws of exponents to multiply or divide numbers written in scientific notation, writing the product or quotient in proper scientific notation. *Example 3:* $(6.45 \times 10^{11})(3.2 \times 10^4) = (6.45 \times 3.2)(10^{11} \times 10^4)$ *Rearrange factors* $= 20.64 \times 10^{15}$ *Add exponents when multiplying powers of 10* $= 2.064 \times 10^{16}$ *Write in scientific notation*

Example 4: $\frac{0.824 \times 10^5}{1.6 \times 10^{-2}} = 0.515 \times 10^{5-(-2)}$ *Subtract exponents when dividing powers of 10*

$= 0.515 \times 10^7$ *Write in scientific notation*

$= 5.15 \times 10^6$

Example 5:

$(0.0025)(5.2 \times 10^4) = (2.5 \times 10^{-3})(5.2 \times 10^5)$ *Write factors in scientific notation*

$= (2.5 \times 5.2)(10^{-3} \times 10^5)$ *Rearrange factors*

$= 13 \times 10^2$ *Add exponents when multiplying powers of 10*

$= 1.3 \times 10^3$ *Write in scientific notation*

Example 6:

The speed of light is 3×10^8 meters/second. If the sun is 1.5×10^{11} meters from earth, how many seconds does it take light to reach the earth? Express your answer in scientific notation.

Solution: 5×10^2

(light)(x) = sun, where x is the time in seconds

$(3 \times 10^8)x = 1.5 \times 10^{11}$

$x = \frac{1.5 \times 10^{11}}{3 \times 10^8}$

Students understand the magnitude of the number being expressed in scientific notation and choose an appropriate corresponding unit.

Example 7:

3×10^8 is equivalent to 300 million, which represents a large quantity. Therefore, this value will affect the unit chosen.

Approximate Time Frame: *3 – 4 weeks*

Terms:

- ✓ base
- ✓ exponent
- ✓ power
- ✓ order of operations
- ✓ scientific notation
- ✓ magnitude

Resources

MGH – McGraw Hill, Glencoe Math (2015)
ML – McDougal Littell, Pre-Algebra Book; Larson, 2005
EX – Explorations in Core Math (Holt McDougal)
NY – *Engage* New York
MAP – Math Assessment Project (MARS)

	Suggested Topics for Lessons	***Possible Resources***
8.EE.A.1	Integer Exponents	➢ MGH 1.2 *Powers and Exponents* (page 15) ➢ ML 1.2 *Powers and Exponents* (page 10) ➢ EX 3-1 *Integer Exponents* (page 83) ➢ Learn Zillion Video Lessons: *Evaluate expressions with Exponents* ➢ NY Module 1 Lesson 1: *Exponential Notation*
8.EE.A.1	Properties of Exponents SBAC Evidence—The student: 1. Generates equivalent numerical expressions by applying the properties of integer exponent.	➢ MGH 1.3 *Multiply and Divide Monomials* (page 23) ➢ MGH 1.4 *Powers of Monomials* (page 31) ➢ MGH 1.5 *Negative Exponents* (page 43) ➢ ML 4.5 *Rules of Exponents* (page 194) ➢ ML 4.6 *Negative and Zero Exponents* (page 199) ➢ EX 3-2 *Properties of Exponents* (page 87) ➢ MAP: *Applying Properties of Exponents* ➢ Learn Zillion Video Lessons: *Know/apply properties of integer exponents* ➢ NY Lesson 2: *Multiplication of Numbers in Exponential Form* ➢ Learn Zillion Video Lessons: *Understand negative exponents and bases* ➢ NY Lesson 3: *Numbers in Exponential Form Raised to a Power* ➢ NY Lesson 4: *Numbers Raised to the Zeroth Power* ➢ NY Lesson 5: *Negative Exponents and the Law of Exponents*
8.EE.A.3	Scientific Notation SBAC Evidence—The student: 4. States how many times as large or as small one number, written as a single digit times a power of 10, is than another, to estimate very large or very small quantities.	➢ MGH 1.6 *Scientific Notation* (page 51) ➢ ML 4.7 *Scientific Notation* (page 204) ➢ EX 3-3 *Scientific Notation* (page 93) ➢ VA Lesson: *Scientific Notation* ➢ Learn Zillion Video Lessons: *Understand scientific notation* ➢ Learn Zillion Video Lessons: *Estimate and compare with integers to the power of 10* ➢ University of Wyoming Lesson: Scientific Notation ➢ NY Lesson 7: *Magnitude* ➢ NY Lesson 9: *Scientific Notation*
8.EE.A.4	Operating with Scientific Notation SBAC Evidence—The student: 5. Performs operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used.	➢ MGH 1.7 *Compute with Scientific Notation* (page 59) ➢ MGH 1.7, Inquiry Lab, *Scientific Notation Using Technology* (page 67) ➢ ML 4.7 *Using Scientific Notation Tech Activity* (page 209) ➢ EX 3-4 *Operating with Scientific Notation* (page 99) ➢ MAP: *Estimating Length Using Scientific Notation* ➢ Learn Zillion Video Lessons: *Perform operations with numbers in scientific notation* ➢ Foldable: *Operations with Numbers in Scientific Notation* ➢ NY Lesson 8: *Estimating Quantities*

		➢ NY Lesson 10: *Operations with Numbers in Scientific Notation* ➢ NY Lesson 11: *Efficacy of the Scientific Notation* ➢ NY Lesson 12: *Choice of Unit* ➢ NY Lesson 13: Comparison of Numbers Written in Scientific Notation; Using Technology