UNIT TITLE:
Exponents

SUGGESTED UNIT TIMELINE:
2-3 Weeks

ESSENTIAL QUESTION(S):
How can we use properties of exponents to relate radical expressions to expressions with rational exponents?
How can the properties of exponents be used to develop a meaning for powers that are not integers?
What does an negative exponent mean and how does it apply in the real world?
What is simplest form?
What does it really mean to “cancel!” when simplifying?

WHAT DO WE WANT STUDENTS TO KNOW, UNDERSTAND, AND BE ABLE TO DO?

<table>
<thead>
<tr>
<th>REFERENCE/STANDARD #</th>
<th>STANDARDS:</th>
<th>MAJOR STANDARD (M)</th>
<th>SUPPORTING STANDARD (S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N-RN.1</td>
<td>Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.</td>
<td>✓</td>
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<tr>
<td>N-RN.2</td>
<td>Rewrite expressions involving radicals and rational exponents using the properties of exponents.</td>
<td>✓</td>
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<tr>
<td>N-RN.3</td>
<td>Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.</td>
<td>✓</td>
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UNIT DESCRIPTION
Students will simplify expressions with exponents and powers with rational exponents.
- Explain why the exponent rules work and demonstrate they still work with rational exponents.
- Rewrite and simplify expressions with radicals as expressions with rational exponents and vice versa.
- Use basic properties and equivalent forms of rational exponents with numerical and variable bases to simplify expressions.
- Simplify square root and perfect higher-order roots.

UNIT VOCABULARY
Base, exponent, power, coefficient, radical, rational exponent, exponent rules, order of operations, radicand, root, root index, cube root, square root

HOW DO WE KNOW STUDENTS HAVE LEARNED?

UNIT ASSESSMENT BLUEPRINT

UNIT SCORING GUIDE
## FACILITATING ACTIVITIES
### Strategies and methods for teaching and learning

<table>
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<tr>
<th>STAND-ARD #</th>
<th>TEACHER INSTRUCTION</th>
<th>STUDENT LEARNING</th>
<th>INTER-VENTIONS</th>
<th>EXTEN-SIONS</th>
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</table>
| N.RN.1      | Connect Rational Exponents to Radicals: Review of exponent properties:  
- Product rule  
- Power of a Power Rule  
- Negative Exponents  
- Quotient Rule  
- Zero Power  
- Power of a Quotient Rule  
- Power of a Product Rule  

Algebra 1 Textbook: (7.1-7.2) Multiplying/Dividing Monomials  
CCSS Crosswalk: Lesson 8-Rational Exponents p 26-32  
BoardWorks – HS Algebra I Exponential Laws – 20 Slides: Exponent notation, multiplying and dividing terms with the same base, exponents in parentheses and raising numbers to the power of zero or one  
Teaching Lesson – Exponents: Learning from Patterns Use a chart to help students see the patterns developed when looking at negative exponents.  
Teaching Lesson - Exponential Rules – Same Base, Power of a Product and Power of a Power  
Teaching Lesson - More with Exponential Rules: Power of a Fraction, Subtracting Exponents and Negative Exponents  
Teaching Lesson - Rules of Exponents – Instruction with practice problems and numerous worksheets  
SMART Board Lesson – Negative Exponents  
Worksheet - Properties of Exponents 30 easier problems with answer key  
Worksheet - Properties of Exponents 22 more challenging problems with answer key.  
Exponent Review Game Who Wants to Be a Millionaire (Referred to as Algebra I Unit 9 ReviewActivity)  
Activity 44 – Laws of Exponents  
Exponent Worksheets and Activities - Interactive worksheets and quizzes-need computer access  
SMART Board Lesson: Review of Exponential  
Review operations of fractions  
Algebra 1 Textbook (0.4 - 0.5) | | | | |
**Rational Exponents:**
In order to understand the meaning of rational exponents, students can initially investigate them by considering the pattern such as: \(2^4 = 16, \ 2^2 = 4, \ 2^1 = 2, \ 2^{\frac{1}{2}} = ?\)

What is the pattern of the simplified value? Each successive value is the square root of the previous.

**Relate Rational Exponents to Properties:** product rule, power of a power rule, negative exponents, quotient rule, power of a quotient rule, power of a product rule

Verify the properties of integer exponents holds true for rational exponents.

Ex. \(3^{\frac{1}{2}} \cdot 3^{\frac{1}{2}} = 3^{\frac{1}{2} + \frac{1}{2}} = 3^1 \ since \ \sqrt{3} \cdot \sqrt{3} = \sqrt{9} = 3\)

Ex. \((5^{\frac{1}{2}})^3 = 5^{\frac{3}{2}} = 5^1 \ since \ (\sqrt{5})^3 = 5\)

Ex. \(\frac{x^{\frac{1}{5}}}{x^{\frac{1}{5}}} = x^{\frac{1-1}{5}} = x^0 = 1\)

**BoardWorks – HS Algebra I:**
**Negative & Rational Exponents – 15 slides**
Expressions with negative exponents, reciprocals, expressions with fractional exponents and square and cube roots

**Teaching Lesson** - Restrictions When Evaluating Radicals - \(\sqrt{(x^2)}, \) simplifying powers and fractional radicand

**Worksheet** Simplifying basic square roots
30 problems with answer key
NRN.2 | Simplify Numerical and Algebraic Expressions Involving Exponents:
- Convert expressions between radical and exponential forms (show equivalent forms)
- Simplify rational exponents and radicals (square roots and perfect higher roots only) \( \sqrt[3]{32}, \sqrt[3]{8}, 16^{\frac{3}{2}} \)
- Use properties of exponents to rewrite expressions involving rational exponents and expressions using radicals.
- Ex. Simplify the following.
  a. \( \frac{3}{\sqrt{5}} \cdot 5^6 \)
  b. \( x^{\frac{1}{3}} \cdot \sqrt{9x^6} \)
  c. \( x^{\frac{1}{3}} \cdot x^{\frac{2}{3}} \)
  d. \( 4^{\frac{1}{2}} \cdot 16^{\frac{1}{3}} \)

Algebra 2 Textbook (7.6)

CCSS Crosswalk: Lesson 8-Rational Exponents p 26-32

- **Teaching Lesson - The Fractional Exponent**: What does it mean? Convert from exponential to radical form. Apply the Exponential Rules to fractional exponents
- **Teaching Lesson - The Fractional Exponent**: Examples, connection to graph and practice problems using the fractional exponent
- **SMART Board Lesson** – Rational Exponents
- **Teaching Lesson - Introduction to Radicals**: Rational and Irrational Numbers, Square Roots

<p>| NRN.2 | Simplify Numerical and Algebraic Expressions Involving Exponents: Radicals ◀▶ Exponents | <strong>Worksheet</strong> – Simplify Rational Exponents 22 problems with answer key. |</p>
<table>
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<tr>
<th>CCSS Crosswalk: Lab 19 - Simplifying Nth Root Expressions p 58-59</th>
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<tr>
<td><strong>Teaching Lesson</strong> - Simplify Fractional Exponents</td>
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<tr>
<td><strong>Teaching Lesson</strong> - The Nth Root: Explains the relationship between roots and exponents, application of operations and properties. Includes examples and practice problems</td>
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<tr>
<td><strong>Teaching Lesson</strong> - Roots of Real Numbers: Power Point presentation, notes outline, video, classwork handout and homework WS</td>
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<tr>
<th>N.RN.3</th>
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<tr>
<td>Explain Why the Sum or Product of Rational and Irrational Numbers are Rational or Irrational</td>
</tr>
<tr>
<td><strong>CCSS Crosswalk:</strong> Lab 18 - Rational and Irrational Numbers p 57</td>
</tr>
<tr>
<td><strong>Teaching Lesson</strong> - Multiplying and Adding Rational and Irrational Numbers – Very Basic; practice included</td>
</tr>
<tr>
<td><strong>Teaching Lesson</strong> - Sum of Rational and Irrational is Irrational – Task with dialog about the sum of rational and irrational numbers</td>
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<tr>
<th>Radicals: Simplifying and Performing Operations</th>
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<tr>
<td>• Adding and Subtracting</td>
</tr>
<tr>
<td>• Multiplying and Dividing</td>
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<tr>
<td>• Rationalizing Denominator</td>
</tr>
<tr>
<td><strong>Algebra I Textbook</strong> (10.2-10.4)</td>
</tr>
<tr>
<td><strong>BoardWorks – HS Algebra I: Radicals - 23 Slides</strong></td>
</tr>
</tbody>
</table>

| Worksheet – Simplify Rational Exponents 18 problems |
| Worksheet – More Simplifying Rational Exponents. |
| Worksheet – Evaluate rational exponents and simplify radical expressions |

| Worksheet – Rational or Irrational 10 problems; pretty basic |

| Interactive Student Activity - Simplifying Radicals: Adding and subtracting similar radicals |
| Worksheet – Adding and Subtracting radicals 28 problems with answer key. |
| Worksheet – Multiplying Radical Expressions 28 problems with answer key |
definition of a radical, simplifying radicals, operations on radicals and rationalizing the denominator.

**Teaching Lesson** - The Definition of the Square Root Radical:
Formal rule, power of a product of factors, rationalizing the denominator, and the set of real numbers vs. imaginary

**SMART Board Lesson** – Power Point: Simplifying Radicals

**SMART Board Lesson** – Simplifying Radical Expressions with Variables

**SMART Board Lesson** – Simplifying Radicals by Removing Perfect Squares

**SMART Board Lesson** – Adding Radical Expressions

**SMART Board Lesson** – Subtracting Radical Expressions

**SMART Board Lesson** – Rationalizing the Denominator

**Teaching Lesson** - Simplifying Radicals: To Simplest Form

**Teaching Lesson** - Simplifying Radicals: Adding and Subtracting Similar Radicals

**Teaching Lesson** - Multiplying and Dividing Radicals:
Simplify and Use of Conjugate Pairs

**Teaching Lesson** – Rationalizing the Denominator

**Radicals** – Use pages 1-9 for Teaching Lesson/Notes with examples, practice problems and sample test questions on following topics: Review radicals, estimate value, simplify, evaluate, perform operations, rationalize denominator

**Worksheet – Dividing Radical Expressions:**
Includes rationalizing denominator and use of conjugate pairs. 22 problems with answer key

**Worksheet – Rationalizing the Denominator**
Examples, practice, challenge and answers

**Worksheet – Rationalizing the Denominator**
Examples, practice, challenge and answers

**5 Worksheets – Simplifying Radicals, Operations on Radicals, and Review;** all with practice, challenge and answers

**Radical Review - Practice Test** – Multiple Choice and free response

**ADDITIONAL UNIT RESOURCES**

- **Kuta Software Worksheets (Algebra 1 and Algebra 2)**
- **Illustrative Mathematics**
- **Math is Fun – Exponents:** Lessons on many topics in the exponents unit. Step by step how to do lessons with questions at the end of each lesson
- **The Math Page – Algebra:** Numerous teaching lessons
- **Soft Schools Math – Algebra:** Worksheets, quizzes and activities
- **Complete Teaching Module – Radicals:** 3 Complete Lessons on Radicals with PP Notes, Interactive Notes, Classwork WS, Practice WS, Review and Quiz