Real Numbers and Their Properties

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| Standards | | |
|  | *What do you want students to learn?* | **Common Core Standards**  N.RN.1 Explain how the definition of the meaning of rational exponents following from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.  N.RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents.  N.RN.3 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 nonzero rational number and an irrational number is irrational.  A.CED.1 Create equations and inequalities in one variable and use them to solve problems.  **Standards for Practice**   1. Make sense of problems and persevere in solving them 2. Reason abstractly and quantitatively 3. Construct viable arguments and critique the reasoning of others 4. Model with mathematics 5. Use appropriate tools strategically 6. Attend to precision 7. Look for and make use of structure 8. Look for and express regularity in repeated reasoning  Look for and express regularity in repeated reasoning |
| *How does this content build on what your students have already learned?* | Students should come in with a background in Algebra II, where students have worked with functions, equations, formulas, etc. Students should be familiar with the properties of real numbers and have worked with them on multiple levels. This content is increasing the level at which the students are working with real numbers by using more complicated expressions. |
| Standards Based Content and Language Goals | | |
|  | *What do you want students to learn? What will they understand? What will they be able to do?* | Students should be familiar with the properties of real numbers and how those properties are applied in multiple contexts. These include sequencing, classification, evaluation, application with exponents, interval notation/representations, and factorization. Students will understand how to use properties of real numbers to simplify expressions with rational exponents and then subsequently factor these kinds of expressions. Through these lessons, students should be able to master the Accelerated Math Objectives listed below:   1. Determine if numbers are irrational 2. Classify real numbers 3. Order of operations 4. Operations with rational numbers 5. Evaluate expressions for given values 6. Prime factorization 7. Simplify expressions with rational exponents 8. Factor expressions with rational exponents 9. Rationalize denominators 10. Cube an fourth roots 11. Write square roots as exponential expressions 12. Simplify nth roots |
| *What language do students need to access and demonstrate understanding of this content?* | Students will need to be able to justify their results by listing supporting evidence with their claims. Students will need to be able to describe numbers in terms of their properties |
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| Essential Questions | | |
|  | *What large questions do you want your students to discuss or consider throughout the unit?* | How do we use the properties of real numbers in higher contexts?  How do the properties of a number influence the result of its evaluation?  What real numbers are easier or harder to use with exponent rules?  How do I represent an interval using an inequality, number line, bracket notation, and verbal description?  How do I factor exponents with different kinds of real numbers? |
| Performance Based Language Assessment | | |
|  | *What evidence will you use to assess language learning? How does it align with your instructional goals?*  *How will your students demonstrate that they have achieved your desired results?* | Students will be informally assessed on a daily basis based upon verbal conversations, quick note checks, and exit tickets. Students will be assessed formally through mastery of homework objectives using the Accelerated Math Program, as well as through formal quizzes and tests. |
| Lesson Overview | | |
|  | *How will the overall learning goals be divided throughout the course of the unit? What will you achieve in each lesson?* | Lesson 1: Classification and ordering of real numbers  Lesson 2: Multiple representations of intervals  Lesson 3: Evaluation using real numbers  Lesson 4: Exponent Rules with Real Numbers  Lesson 5: Factoring with Real Numbers |
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Real Numbers and Their Properties: Lesson 1

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| Name: Mattea Juengel | Date: |
| School: Lincoln High School | Grade/Subject: Pre-Calculus |

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| Objective | | | Materials: |
| Orally justify **the classification and order of real numbers** to a partner by identifying **specific number traits** with a partner.   1. Mapping the number on the number diagram and using the sentence frame, “\_\_\_\_\_\_ is a \_\_\_\_\_\_, because it \_\_\_\_\_\_” and “\_\_\_is (less than/more than) \_\_\_\_\_\_\_, because \_\_\_\_\_\_\_\_\_\_.” 2. Use the sentence frames “\_\_\_\_\_\_ is a \_\_\_\_\_\_, because it \_\_\_\_\_\_” and “\_\_\_is (less than/more than) \_\_\_\_\_\_\_, because \_\_\_\_\_\_\_\_\_\_.” 3. Give three reasons for your classification   Success Criteria  ~ Create a map of the different number classifications using key features  ~ Use inequality notation to compare numbers | | | Promethean Board, Knowledge Rating Worksheet. |
| Common Core Standards Addressed: | | | Length of Lesson |
| N.RN.3 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 nonzero rational number and an irrational number is irrational. | | | 2 class periods |
| Key Vocabulary: | | |  |
| Vocabulary: natural, whole, integer, rational, irrational, real, less than, greater than, equal to | | | |
| Grouping: |  | | |
| Pairs, grouped alphabetically for the time being. |  | | |
| Assessment | |  | |
| Formative: Exit Ticket (see below)  Summative: Quiz #1 and Chapter Test | |  | |

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| Prepare: | Time: |
| Knowledge Rating (From Lesson 1) – talk about vocabulary and relate it to everyday experiences [part 1] | 5-8 minutes |

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| Interact: | Time: |
| Mini-lecture – talk about different number classifications (use ppt to provide notes)  Create poster for number classification  Practice Problems (sort)  Have students literally place numbers in the diagram drawn and write out the entire classification. The number \_\_\_ is a \_\_\_ because it \_\_\_\_\_.  **Key Questions:**  What is the classification and why?  Can a number be both and integer and a natural number? Give an example.  Completely classify 0. Defend your classification. (possible exit ticket if time)  Think-Pair-Share  Your younger sibling tells you that 5 pennies are worth more than 1 dime because 5 is more than 1. How would you explain to your sibling why one dime is worth more than 5 pennies?  **Key Questions:**  How does this relate to place value?  When to zeros increase the value of a number? Decrease?  Practice Problems: AM – work in pairs. Pairs must use sentence frames to order numbers. Pairs will be randomly called upon to share their answer.  **Key Questions:**  Agree or disagree and why? All students must give thumbs up or thumbs down.  What difference does the repeating bar make on the value of a number? | 15 minutes  15-20 minutes  Exit Ticket 3 minutes  10 minutes  20 minutes |

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| Extend: | Time: |
| Exit Ticket that has practice quiz problem – complete as a group and turn in at end of class period.  **Key Questions:**  Students who struggle may need to use the diagram for real numbers. Turn partners to their notes and other classroom resources.  Do you agree with your partner? Why or why not?  Give me reasons for your classification. | 10 minutes |

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| Corresponding Homework: |
| Accelerated Math Objectives #5-8 |

Real Numbers and Their Properties: Lesson 2

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| Name: Mattea Juengel | Date: |
| School: Lincoln High School | Grade/Subject: Pre-Calculus |

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| Objective | | | Materials: |
| Read **a representation of given range of numbers and** translate into other representations **including** a graph, interval, inequality, or verbal description.   1. Model and use graphic organizer 2. Use sentence frames and word bank to write verbal descriptions 3. Write verbal descriptions using mathematical symbols   Success Criteria  ~ Differentiate the mathematical meaning of parenthesis and brackets  ~ Differentiate the mathematical meaning of open and closed circles  ~ Differentiate the mathematical meaning of < and <  ~Identify the corresponding components each representation | | | Graphic Organizer, power point with promethean board |
| Common Core Standards Addressed: | | | Length of Lesson |
| A.CED.1 Create equations and inequalities in one variable and use them to solve problems. | | | 1 class period |
| Key Vocabulary: | | |  |
| interval, inequality, number line, equivalent, bounded, unbounded, endpoints | | | |
| Grouping: |  | | |
| Pairs grouped strategically (can use group of 4 when necessary) |  | | |
| Assessment | |  | |
| Formative: Exit Ticket – create your own interval with specific characteristics  Summative: Quiz and Unit Test | |  | |

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| Prepare: | Time: |
| Think-Pair-Share – Think of something that is bounded. What makes it bounded? How would you make it unbounded? | 5 minutes |

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| Interact: | Time: |
| Mini-lecture: Four equivalent notations (inequality, interval, number line, and verbal)  Student-led examples with four representations (use graphic organizer)  **Key Questions:**  Is the interval open or closed?  How can you use each representation to write the other?  What does the interval (2, 2) include? [2,2]?  Unbounded v. Bounded: definition and student-led examples (use graphic organizer)  **Key Questions:**  How does this relate to the bounded and unbounded things you brainstormed at the beginning of the lesson?  How can you tell if something is bounded or unbounded by looking at each representation?  Can you be bounded and open? Give an example  Can you be unbounded and closed? Give an example | 10-15 minutes  10-15 minutes |

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| Extend: | Time: |
| With a partner, create an interval with given characteristics (last one is partner exit ticket) | 10 minutes |

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| Corresponding Homework: |
| No AM problems for this section. Practice Quiz as homework |

Real Numbers and Their Properties: Lesson 3

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| Name: Mattea Juengel | Date: |
| School: Lincoln High School | Grade/Subject: Pre-Calculus |

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| Objective | | | Materials: |
| Listen to and critique the justification of **the evaluation of an expression for given values** with cited properties of algebra using a graphic organizer.  a) Flow chart with word bank  b) Flow chart  c) Drawing a diagram and labeling steps  Success Criteria  ~ Identify the commutative and associative property of addition and multiplication  ~ Identify the identity and inverse property  ~ Identify the distributive property  ~ Describe closure with respect to the real number system | | | Target Vocabulary Sheet |
| Common Core Standards Addressed: | | | Length of Lesson |
| N.RN.3 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 nonzero rational number and an irrational number is irrational. | | | 2 class periods |
| Key Vocabulary: | | |  |
| associative, commutative, identity, inverse, distributive, closure | | | |
| Grouping: |  | | |
| Pairs grouped strategically (can use group of 4 when necessary) |  | | |
| Assessment | |  | |
| Formative: Practice Quiz Problem  Summative: Quiz and Unit Test constructed response | |  | |

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| Prepare: | Time: |
| Brainstorming Activity  Take 2 minutes to write down everything you know about the following words both in and out of math. If you don’t know anything, make an educated guess.  associative, commutative, identity, inverse, distributive, closure | 5 minutes |

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| Interact: | Time: |
| Mini-lecture - Properties of Algebra and Closure (students take notes and have quick think-pair-shares with each property to provide numeric examples)  Practice Accelerated Math Problems (in pairs)  Solve AM Practice problems in partners and write out answers using sentence frames  **Key Questions:**  How can you tell the difference between commutative and associative property?  Why don’t these same properties apply to division and subtraction? Provide a counterexample.  Why is it important to specify the operation with the property? | 10-15 minutes |

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| Extend: | Time: |
| Academic Conversation: Cite the Property – students will solve an equation using as many properties as possible. Student will then have an ‘academic conversation’ using the following protocol.   * Partner A – blue and pink * Partner B – green and purple * Partner A will take the presenter role   + Discuss the problem   + Explain the properties that you used at each step   + Correctly use target vocabulary * Partner B will take the Active Listener Role   + Listen attentively   + Ask two questions   + Keep a tally of the use of the target vocabulary   Practice Quiz Problem (in pairs) | 15-20 minutes |

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| Corresponding Homework: |
| AM Objective #7 |

Real Numbers and Their Properties: Lesson 4

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| School: Lincoln High School | Grade/Subject: Pre-Calculus |

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| Objective | | | Materials: |
| Write an explanation, using a sequence of supporting exponent rules, **the simplification of an expression with rational exponents**   1. using a flow chart/graphic organizer 2. using sentence stems. “First, I used the \_\_\_\_\_\_\_\_ rule to change \_\_\_\_\_\_\_\_\_\_ to \_\_\_\_\_\_\_\_\_\_” 3. using complete sentences   Success Criteria   * Define the product rule and identify when it applies to an expression * Define the quotient rule and identify when it applies to an expression * Define the power rule and identify when it applies to an expression | | | Exponent Rules Graphic Organizer |
| Common Core Standards Addressed: | | | Length of Lesson |
| N.RN.1 Explain how the definition of the meaning of rational exponents following from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.  N.RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents. | | | 2 class periods |
| Key Vocabulary: | | |  |
| base, exponent, power rule, quotient rule, product rule | | | |
| Grouping: |  | | |
| Pairs and groups of four, arranged heterogeneously by practice ACT results |  | | |
| Assessment | |  | |
| Formative: Teacher will check on solutions to practice problems in the pairs  Summative: Quiz and Unit Test | |  | |

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| Prepare: | Time: |
| Students will scan Accelerated Math homework from previous night | 5 minutes |

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| Interact: | Time: |
| Mini-lecture – Properties of Exponents  Students will take notes on the properties, highlighting key terms and generating numerical examples of each property.  **Key Questions:**  What are the conditions for the base and exponents?  What are examples of numbers that cannot be in the exponents?  Complete sample AM problems with a partner, filling out sentence frames and reading them aloud to one another. Students may use graphic organizer to help with sequential thinking.  **Key Questions:**  Is there more than one way you could do this problem?  Is there an order that would make this problem easier? Why?  What is the largest power of x?  How do coefficients play a role in factoring expressions with exponents? | 20-25 minutes  25-30 minutes |

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| Extend: | Time: |
| Practice Quiz Problem (in pairs)  Once pairs finish, students will be asked to present solutions to the class, using flow chart format to explain which property is being used at each step. | 15-20 minutes |

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| Corresponding Homework: |
| AM Objectives #8-10 |

Real Numbers and Their Properties: Lesson 5

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| Name: Mattea Juengel | Date: |
| School: Lincoln High School | Grade/Subject: Pre-Calculus |

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| Objective | | | Materials: |
| * Orally justify your **sorting and labeling of properties of radicals** using the key words common, exponent and base, *n*throot, principal *n*th root, radical expression, index, and radicand with a partner.   + A) Using a graphic organizer to sort   + B) Using sentence frames with word bank   + C) Using examples from the exponent rules * **Success Criteria**   + Define nth root and corresponding vocabulary   + Identify common features in exponent and radical properties   + Brainstorm examples of radical properties with numbers | | | Property Cards, Word Bank with Sentence Frames, Sorting Matrix, Notes Sheet |
| Common Core Standards Addressed: | | | Length of Lesson |
| N.RN.1 Explain how the definition of the meaning of rational exponents following from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.  N.RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents. | | | 1 class periods |
| Key Vocabulary: | | |  |
| common, exponent and base, *n*throot, principal *n*th root, radical expression, index, radicand | | | |
| Grouping: |  | | |
| Pairs and groups of four, arranged heterogeneously by practice ACT results |  | | |
| Assessment | |  | |
| Formative:  AM Homework Problems, Check AM Samples worked on in pairs  Summative: Unit Test | |  | |

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| Prepare: | Time: |
| Scan AM  Provide Mini-Lecture on radical notation | 10 minutes |

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| Interact: | Time: |
| Sort and Label   * You will receive cards with the 7 properties we have learned so far and 6 new rules involving radicals. * Your task is to match properties you think correspond to one another (act the same). Use the key vocabulary words and sentence frames to guide your discussion. * Hint: Not every property has a match, so you can decide that it belongs by itself. * Once you’ve matched the properties, give the property a name your partner and you agree on. * When you’re done, let your teacher know.   **Key Questions:**  Where did you place the property? Why?  What is the same? What is different?  Why do these properties not go together? | 15 minutes  10 minutes |

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| Extend: | Time: |
| Notes Sheet – providing number examples and correlating base to radicand, exponent to index.  **Key Questions:**  How do you apply this to numbers? | 10 minutes |

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| Corresponding Homework: |
| AM Objectives #11-15 |