Pilot Course Proposal

Submitted by: **Nathan Maddox** Building: **Hazen High School**

Proposed Course Title: **Algebra II-A Extension**

Grade Level: **9 - 12** Department: **Mathematics**

PLEASE ATTACH THE FOLLOWING:

1. **Description of course content and how this course will meet current needs not being met by other courses. Description must also include the needs assessment data.**
    - **Specifically, what will the student know and be able to do as a result of this course?**

Course description:

Algebra II-A Extension: Algebra II-A Extension is a course in which students will extend their knowledge of functions. Students will expand and deepen their understanding of polynomial and rational functions as well apply prior learning of exponent properties to explore radical functions.

Course Notes: This course can be taken as a 3rd year Math Credit

Prerequisites: Algebra I-B or Algebra 1-2 Standard
Co-requisites: Algebra II-A, Algebra II-B

This course meets the following needs not met by other courses:
This course would be the middle trimester of a re-paced, three trimester series of courses (Algebra II-A, Algebra II-A Extension, Algebra II-B). The re-pacing of Algebra 2 standards over three trimesters would allow students additional time for questions, practice, and explorations of connections between and among Algebra 2 topics, prior mathematics learning, and practical/interdisciplinary applications.

2. **Upon completion of this course students will be able to meet the following Washington State K-12 Learning Standards**

HSN-RN.A.1 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. For example, we define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3 = 5^{(1/3)^3}$ to hold, so $(5^{1/3})^3$ must equal 5.

HSN-RN.A.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents.

HSN-CN.C.8(+) Extend polynomial identities to the complex numbers. For example, rewrite $x^2 + 4$ as $(x + 2i)(x - 2i)$.

HSN-CN.C.9(+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.

HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context

HSA-SSE.A.1.a Interpret parts of an expression, such as terms, factors, and coefficients.

HSA-SSE.A.1.b Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret $P(1+r)^n$ as the product of P and a factor not depending on P.

HSA-SSE.A.2 *Use the structure of an expression to identify ways to rewrite it. For example, see $x^4 - y^4$ as $(x^2)^2 - (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 - y^2)(x^2 + y^2)$.*

HSA-SSE.B.3 *Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*

HSA-APR.A.1 *Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.*

HSA-APR.B.2 *Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x - a is p(a), so p(a) = 0 if and only if (x - a) is a factor of p(x).*

HSA-APR.B.3 *Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.*

HSA-APR.C.5 *(+) Know and apply the Binomial Theorem for the expansion of $(x + y)^n$ in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle.*

HSA-APR.D.6 *Rewrite simple rational expressions in different forms; write $a(x)/b(x)$ in the form $q(x) + r(x)/b(x)$, where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.*

HSA-APR.D.7 *(+) Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.*

HSA-CED.A *Create equations that describe numbers or relationships*

- *HSA-CED.A.1* *Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*
- *HSA-CED.A.2* *Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*
- *HSA-CED.A.3* *Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*
- *HSA-CED.A.4* *Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.*

HSA-REI.A.2 *Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.*

HSF-IF.B.4 *For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.*

HSF-IF.B.5 *Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*

HSF-IF.C.7 *Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*

HSF-IF.C.7.b *Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.*

HSF-IF.C.7.c *Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.*

HSF-IF.C.7.d *(+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.*

HSF-IF.C.9 *Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.*

HSF-BF.A.1 *Write a function that describes a relationship between two quantities*

HSF-BF.B.3 *Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.*

3. **What are the assessments that will be used to determine student achievement of the goals of this course? (Attach to this proposal.)**
   Formative assessments may include (but are not limited to): In class practice, presentations, warm-up problems, exit tickets, white board work, and group investigations.

   Summative assessments include (but are not limited to): Quizzes, projects, unit tests (Polynomial Functions, Rational Functions, Radical Functions), and a final exam.

   In addition, the re-pacing of the Algebra 2 curriculum will allow time in Algebra II-B for students to engage in "capstone" activities and projects, using their knowledge of all the function types studied in Algebra 2 to select the appropriate type to model real-world data and situations.

   Sample assessments are attached.

4. **Describe how this course will address:**
   - **Alignment with Common Core State Standards (CCSS) and/or WA State Essential Academic Learning Requirements (EALRs)**
     In addition to Common Core Mathematics Content Standards addressed by this course outlined above, the Standards of Mathematical Practice listed below will be integrated into the study of the content standards. In this way, the course will be in alignment with recommended best practices by the National Council of Teachers of Mathematics and students will have the opportunity to become proficient practitioners of the discipline of mathematics.
     - MP1: Make sense of problems and persevere in solving them
     - MP2: Reason abstractly and quantitatively
     - MP3: Construct viable arguments and critique the reasoning of others
     - MP4: Model with mathematics
     - MP5: Use appropriate tools strategically
     - MP6: Attend to precision

- MP7: Look for and make use of structure
- MP8: Look for and express regularity in repeated reasoning

Please see above and/or attached Scope and Sequence for specific mathematics content standards.

- **Integration of technology**

  As mentioned above, the Standards of Mathematical Practice include MP5: Use appropriate tools strategically, which includes appropriate use of technology to model, investigate, and generate examples of mathematical content standards. In particular, the TI-84 graphing calculators allow students to quickly generate graphs and tables from equations to make connections between multiple representations of functions. Applications like Desmos, available on student Chromebooks, allow instructors to create or select from a wide collection of mathematical tasks shared by other educators pertinent to the exploration of functions. Students can self-pace through these activities and the instructor can monitor student inputs and progress in real time. Finally, it is standard practice for all math courses to have an online Canvas page for students to reference for assignments, due dates, and additional study materials at any time.

- **Infusion of diversity/multicultural perspectives**

  The study of mathematics and mathematical advances lend themselves to stories of discoveries by people all over the world. Their stories will continue to be integrated into this course. As ever, teachers of this course will employ a variety of instructional strategies that allow for students with diverse learning styles and home cultures to have a comfortable way to engage with essential materials, including encouraging and highlighting student voice and collaboration. Teachers will strive to include multiple ways of assessment and allow students choice in how they provide evidence of their learning. Students will engage in “low floor-high ceiling” tasks to accommodate the diverse range of mathematical abilities in the classroom. And, as always in Renton School District, translation services and materials in multiple languages will be available as needed.

- **Integration with other subject areas**

  Algebra 2 is an introduction to higher mathematics and is foundational to any mathematics and science courses in a STEM field. Branches of study like Pre-Calculus, Trigonometry, Calculus, Statistics, Linear Algebra, Differential Equations, Topography, Analytic Geometry, Number Theory, Analysis, Physics, Chemistry, Biology, and Medicine all rely on the mathematical concepts introduced in Algebra 2. Algebra 2 requires students to grapple with numeracy, abstraction, multiple mathematical representations, and inductive and deductive reasoning. As such, it is a required course for anyone applying to university and essential for anyone pursuing a career in STEM fields.

- **Provision of appropriate experiences for learners of varying abilities**

  These provisions are the same as with any course, and, in fact, the entire reason for this course is so that students with varying abilities who need additional support, practice, reasoning time, or questions have the opportunity to meet those needs during class time. The additional time that Algebra II-A Extension allows for students to grapple with Algebra 2 standards will allow them to engage with key mathematical concepts in a larger variety of ways than in the accelerated pace of Algebra II-A/II-B.

  Students who qualify for special education services in math have had the opportunity to take Algebra 2 in the co-taught setting at Hazen for the past two years. These students’ number one complaint is that the course goes too fast and “as soon as I start to get it, we move on to something new.” With the current speed the class is taught at, students struggle to form a deeper conceptual understanding of the

topics and end up gaining more procedural and rote knowledge of the topics. Students need extra time to process information, extra time to practice, and more individualized check-ins/reteaching. This becomes difficult to provide when content is moving quickly. Currently to find success students often need to seek out regular additional support outside of the classroom (during lunch, before school, after school, during open period). This impacts our students differently based on their outside requirements such as caring for siblings, not having access to transportation outside of the buses, having to work, involvement in sports, etc. Algebra II-A Extension will allow for additional time to be built into the pacing of Algebra 2 standards, allowing for more remediation to take part during the school day.

For multi-language students who are not yet proficient in English, the rigorous and intentional use of multilingual learning strategies (including SIOP strategies and translation services) will be employed in Algebra II-A Extension, just as they are in the current Algebra II-A, II-B courses.

- **Development of higher level thinking and processing skills**

  As previously stated, Algebra 2 standards are foundational to higher level mathematics. In Algebra 2, students need to make connections between and among different representations and types of functions. They need to compare and contrast different types of functions (including identifying domains, end behavior, and discontinuities) and choose what function types are appropriate for different scenarios. In Algebra 2, students utilize learning from previous math courses, grapple with abstraction (in both concepts and reasoning), analyze mathematical relationships, and devise strategic approaches and evaluate solution strategies for various problems. Students engage in productive struggle and the objectives of the course promote levels of thinking beyond memorization and application, helping to develop and nurture critical thinking skills. Algebra 2 encourages logical reasoning and the exploration of multiple solution paths, fostering adaptability in problem solving. Students are expected to explain their processes and reasoning behind their solutions. Algebra II-A Extension allows students more time and opportunities to engage in higher order thinking and processing skills.

- **Articulation of scope and sequences across grades K-12. Will this course replace an existing curriculum? If so, which course? Current Scope and Sequence**

  Students could choose to take the course sequence Algebra II-A, Algebra II-A Extenston, and Algebra II-B in lieu of Algebra II-A and Algebra II-B, but the new sequence would not replace Algebra II-A/II-B. The three trimester sequence (containing Algebra II-A Extension) would have different pacing and additional activities compared to the two trimester version, but would address the same standards. Both course sequences would be available in the Course Catalog and, if this proposal is approved, we plan to run both sequences at Hazen HS in 2025-26. The amount of sections for each course sequence will be determined by student requests.

  Upon completion of the Algebra II-A, Algebra II-A Extenston, and Algebra II-B sequence, students will be prepared for the same subsequent math courses (most often, Math Analysis A/B and Trigonometry or Bridge to College Math A/B) as those who complete the two-trimester sequence. There is no tracking of students; students will self-select into one of the Algebra 2 sequences and each sequence is completed within the same school year.

  Proposed scope and sequences for Algebra II-A Extension and the co-curricular modified Algebra II-A and Algebra II-B are attached.

5. **Statement of impact:**
   Negligible fiscal impact. Students who choose to take Algebra II-A, Algebra II-A Extension, and Algebra II-B are those who would have taken Algebra II-A/II-B in the current model. In essence, they are adding a math elective credit (albeit one that counts as 3rd year math credit), and as such, Algebra II-A Extension would be taken in lieu of another elective course. It will shift FTE into the math department to cover the additional elective courses, but it will simultaneously reduce the demand on non-mathematics elective courses, making the course FTE neutral for the school.

6. **Instructional materials and cost (include titles, names of publishers and copyright).**
   Algebra 2 - Big Ideas Math
   Authors: Ron Larson, Laurie Boswell
   Big Ideas Learning
   Copyright 2015 Big Ideas Learning, LLC.

   Algebra 2 - Big Ideas Math is the current adopted text for Algebra II-A/II-B, and students taking Algebra II-A Extension are those who would have taken Algebra II-A/II-B in our current system. As the total number of students making use of the Algebra 2 text is not increasing (aside from normal year-to-year fluctuations), there are no additional materials costs for the pilot course.

   All students enrolled in Algebra II-A, Algebra II-A Extension, and Algebra II-B would have access to an online version of the textbook, an in-class hard copy version of the textbook, and the option to check out a hard copy of the text for use at home. Based on recent levels of demand for hard copies of the text, we anticipate having sufficient copies with what is currently in the building.

SIGN-OFF FOR PILOT COURSE RECOMMENDATION

	Signature **Date**
1. Department Head (Secondary) **Accepts □ Rejects □**	_____
2. Principal **Accepts □ Rejects □**	_____
3. District Content Facilitator **Accepts □ Rejects □**	_____
4. Curriculum Director **Accepts □ Rejects □**	_____

Return original to the Director of Curriculum and Instruction. Copies to Principal and Course Originator.

Algebra II-A (3 Trimester) Scope and Sequence

2025-26 [Big Ideas Algebra 2]

<table>
<tr><th>Days</th><th>Unit</th><th>Standards</th></tr>
<tr><td rowspan="4">15</td><td colspan="2">Unit 1: Introduction to Functions, Parent Functions, and Transformations</td><td>A-SSE.1,2; A-CED.2,3; A-REI.10; F-IF.1,2,4,5,9; F-BF.3</td></tr>
<tr><td colspan="3">Instructional Overview:
The introductory unit to Algebra 2.1 revisits the definition of function, function notation, parent functions, Number sets, and Domain and Range. The overarching story of Algebra 2 is the story of functions, and this unit revisits and establishes foundation knowledge that will be used throughout the course. Since this class will typically be offered at the beginning of the school year, it’s also important to spend time during this unit setting up group norms, classroom policies and student expectations. Algebra 2 is a step up in rigor, abstraction, and cognitive demand for students, so it is important to establish student expectations and student support structures early.</td></tr>
<tr><td>Suggested Lessons:

Big Ideas 1.1 - Parent Functions and Transformation
Big Ideas 1.2 - Linear and Absolute Value Functions

CPM 1.1.3 – Domain and Range
CPM 2.2.1 – Transforming other Parent Graphs
CPM 2.2.3 – Transforming Functions
CPM 2.2.5 – Transforming Piecewise-Defined Functions

*CPM Core Connections Algebra 2 is an approved supplementary resource for this course</td><td colspan="2">Objectives:
• Students will understand the Properties of Real Numbers, Number Sets and Closure.
• Students will understand and apply the definition of a function across multiple representations.
• Students will identify the Domain and Range of a function across multiple representations.
• Students will make appropriate use of function notation and interval notation.
• Students will identify parent functions from both graphs and equations and identify and perform transformations on parent functions.
• Students will graph and create equations for piecewise functions.</td></tr>
<tr><td colspan="3">Instructional Notes:
Teachers need to be aware of students’ prior knowledge to make the best use of this introductory unit.
Teachers may also want to make use of free supplemental resources, such as Illustrative Mathematics for additional curricular support on this introductory unit</td></tr>
</table>

25	**Unit 2:** Quadratics	N-CN.7; A-SSE.1,2; A-SSE.3a,b; A-REI.4,7; F-IF.7a,8a,9

Instructional Overview:

This unit revisits quadratic topics learned in Algebra I-B and builds upon them. In Algebra I-B, students have learned about the basics of quadratics: factoring $ax^2 + bx + c$, special factoring patterns, greatest common factor, solving by factoring, solving with square roots, solving by completing the square, and solving with the quadratic formula. In addition, they should have some experience with the quadratic parent function, relevant vocabulary for quadratics (including domain and range), plus graphing and application problems related to quadratics written in Standard Form and Intercept Form. Students may or may not have prior knowledge of complex numbers.

Suggested Lessons:

Big Ideas 2.1 – Transformations of Quadratic Functions
Big Ideas 2.2 – Characteristics of Quadratic Functions
Big Ideas 2.4 – Modeling with Quadratic Equations
Big Ideas 3.1, 3.3-3.6

CPM 2.1.2* – Parabola Investigation
CPM 2.1.3 – Graphing a Parabola without a Table
CPM 2.1.4 – Rewriting in Graphing Form
CPM 2.1.5 – Mathematical Modeling with Parabolas
**CPM Core Connections Algebra 2 is an approved supplementary resource for this course*

Objectives:

- Students will solve quadratic equations with real or non-real solutions using roots, the quadratic formula, and by completing the square.
- Students will solve quadratic equations algebraically and contextually.
- Students will define and make use of the imaginary number.
- Students will identify key features of quadratic graphs and explain their meaning in context.
- Students will be able to write a quadratic equation in Vertex Form.
- Students will be able to translate between the three forms of a quadratic (standard, vertex, and intercept), identify key features of each form, and connect each form to a graph and table.
- The student will solve non-linear systems (linear + quadratic and quadratic + quadratic).

Instructional Notes:

Teachers need to be aware of students' prior knowledge to make the best use of this review unit. Students who took Algebra 1-B may have seen CPM CCA2 2.1.2-2.1.5, so consider using variations of those lessons if you are going to use CPM as a resource. Factoring by grouping will be addressed in the Polynomials unit, but it may be worthwhile to introduce/review (depending on students' prior knowledge) that here.

20	**Unit 3**: Polynomial Functions 1	N-CN.1,2; A-SSE.1,2; A-APR.1,2,3,4,5,6; A-CED.2; F-IF.4,5
	Instructional Overview: In Unit 3 students will begin to develop their understanding of polynomial functions. Students will graph polynomial functions with and without technology, exploring the relationship between the degree of a polynomial and its end behavior. Students will perform operations on polynomials including with complex numbers.	
	Suggested Lessons: **Big Ideas 3.2 –** Operations on Complex Numbers **Big Ideas 4.2 –** Adding, Subtracting, and Multiplying Polynomials **Big Ideas 4.3 –** Dividing Polynomials **Big Ideas 4.4 –** Factoring Polynomials **CPM 10.3.1 –** Pascal's Triangle and the Binomial Theorem **CPM 8.3.1 –** Polynomial Division **CPM 8.2.3 –** More Complex Numbers and Equations	**Objectives:** • Students will interpret polynomial expressions and rewrite expressions in equivalent forms. • Students will add, subtract, multiply, and divide polynomials. • Students will understand closure properties of polynomials. • Students will prove polynomial identities and extend them to complex numbers. • Students will be able to perform operations on complex numbers. • Students will factor polynomials.
	Instructional Notes: Review for a comprehensive final exam for Algebra 2.1 should be included in Unit 3.	

Algebra II-A Extension Scope and Sequence

2025-26 [Big Ideas Algebra 2]

<table>
<tr><th>Days</th><th>Unit</th><th>Standards</th></tr>
<tr><td rowspan="4">20</td><td>Unit 4: Polynomial Functions II</td><td>N-CN.8,9; A-SSE.A.1,2; A-APR.1,2,3,4,5,6; A-CED.2; F-IF.4,5,7c; F-BF.3</td></tr>
<tr><td colspan="2">Instructional Overview:
In Unit 4 students will continue to develop their understanding of polynomial functions. Students will graph polynomial functions with and without technology, exploring the relationship between the degree of a polynomial and its end behavior. Students will also use different polynomial theorems to explore polynomial functions and solve polynomial equations, including finding imaginary solutions.</td></tr>
<tr><td>Suggested Lessons:

Big Ideas 4.1 – Graphing Polynomial Functions
Big Ideas 4.5 – Solving Polynomial Equations
Big Ideas 4.6 – The Fundamental Theorem of Algebra
Big Ideas 4.7 – Transformations of Polynomial Functions
Big Ideas 4.8 – Analyzing Graphs of Polynomial Functions
Big Ideas 4.9 – Modeling with Polynomial Functions

CPM 8.1.1* – Sketching Graphs of Polynomial Functions
CPM 8.1.2 – More Graphs of Polynomials
CPM 8.1.3 – Stretch factors for polynomial Functions

CPM 8.3.2 – Factors and Integral Roots
CPM 8.3.3 – An Application of Polynomials

*CPM Core Connections Algebra 2 is an approved supplementary resource for this course</td><td>Objectives:
Students will interpret polynomial expressions and rewrite expressions in equivalent forms.
Students will graph polynomial functions describing end behavior.
Students will know and apply the Remainder Theorem.
Students will identify zeros of polynomials by factoring.
Students will make connections between the zeros of a polynomial, the roots, and the solutions to a polynomial equation.
Students will know the Fundamental Theorem of Algebra and show that it is true for quadratic polynomials.
Students will graph transformations of polynomial functions and describe key features of the graphs.
Students will understand the Rational Root Theorem and use it to find solutions to a polynomial equation.
Students will use the Rational Root Theorem and the Fundamental Theorem of Algebra to find all roots of polynomial, including imaginary roots.</td></tr>
<tr><td colspan="2">Instructional Notes:
The work with transformations of polynomial functions is preparing students for content in later courses. Earlier lessons in the course will prepare students for working with the Fundamental Theorem of Algebra. Graphing calculators are an important tool for students to use during this unit to investigate functions, for example teachers might shorten the focus of lessons 4.7, 4.8, and 4.9 by using the graphing calculators more and only focusing on h and k. Teachers might consider different strategies to use to help students with the vocabulary in this unit.</td></tr>
</table>

22	**Unit 5:** Rational Functions	A-CED.1,2,3,4; A-APR.6,7; A-REI.2,11; F-IF.4; F-BF.3,4
	Instructional Overview: In Unit 5 students will learn about inverse variation. Students will graph rational functions and identify horizontal and vertical asymptotes by looking at a rational equation. Simple transformations of rational functions will be performed. Students will add, subtract, multiply, and divide rational expressions as well as simplify rational expressions. Students will solve rational equations identifying when extraneous solutions occur and simplify complex fractions.	
	Suggested Lessons: **Big Ideas 7.1 –** Inverse Variation **Big Ideas 7.2 –** Graphing Rational Functions **Big Ideas 7.3 –** Multiplying and Dividing Rational Expressions **Big Ideas 7.4 –** Adding and Subtracting Rational Expressions **Big Ideas 7.5 –** Solving Rational Equations **CPM 3.2.1** – Investigating Rational Functions **CPM 3.2.2** – Simplifying Rational Expressions **CPM 3.2.3** – Multiplying and Dividing Rational Expressions **CPM 3.2.4** – Adding and Subtracting Rational Expressions	**Objectives:** • Students will learn about direct and inverse variation and write equations. • Students will graph rational functions and identify key features of the graph. • Students will graph transformations of simple rational functions. • Students will rewrite rational expressions in equivalent forms. • Students will understand closure properties of rational expressions. • Students will add, subtract, multiply, and divide rational expressions. • Students will solve rational equations identifying when extraneous solutions occur. • Students will simplify complex fractions.
	Instructional Notes: Some of the work in this unit will prepare students for their work with radical functions and connections can be made between rational and radical functions. When having students complete problems that are in context be sure to cover restricted domains with students. Teachers will likely need to supplement when adding and subtracting rational expressions.	

18	**Unit 6:** Radical Functions	N-RN.1,2; A-SSE.2; A-CED.2,3,4; A-REI.2; F-IF.4, 5,7b,9; F-BF.1,3,4

Instructional Overview:
Unit 6 begins by having students make connections between their previous work with the properties of exponents to now include rational exponents. Later students will graph radical functions including their transformations and will use the graphs to help think about the solutions to radical equations and inequalities. The unit closes by having students undo functions to explore the inverse of a function.

Suggested Lessons:

Big Ideas 5.1 – *n*th Roots and Rational Exponents
Big Ideas 5.2 – Properties of Rational Exponents and Radicals
Big Ideas 5.3 – Graphing Radical Functions
Big Ideas 5.4 – Solving Radical Equations and Inequalities

CPM 4.1.2 – How Can I Use a Graph to Solve?
CPM B.2.1—Curve Fitting and Fractional Exponents

Objectives:

- Students will extend the properties of exponents to include rational exponents allowing students to rewrite expressions involving radicals and rational exponents.
- Students will graph radical functions and note the key features of these graphs.
- Students will complete transformations on the parent square root function to model data and to formulate equations arising from the square root functions.
- Students will solve radical equations and give examples showing how extraneous solutions may arise.
- Students will simplify radical expressions

Instructional Notes:
Many of the lessons in Big Ideas mention using a graphing calculator to help students develop their understanding of radical functions. The graphing intro is expected to be an overview on graphing calculators and therefore students do not need to be precise or use tables. Teachers might consider reviewing exponent properties with students on a short day or could combine with properties of radicals. CPM B.2.1 is a supplement in the CPM CCA2 book to help remind students how to switch between radicals and rational exponents.

Review for a comprehensive final exam for Algebra 2.2 should be included in Unit 6.

Algebra II-B (3 Trimester) Scope and Sequence

2025-26 [Big Ideas Algebra 2]

<table>
<tr><th>Days</th><th>Unit</th><th>Standards</th></tr>
<tr><td rowspan="4">15</td><td colspan="2">Unit 7: Inverses and Function Operations</td><td>A.CED.4, F.IF.4,5, F.BF.1b,c,4a,b</td></tr>
<tr><td colspan="3">Instructional Overview:
In this unit, students will learn how to perform operations on functions, function compositions, and how to find the inverses of functions.</td></tr>
<tr><td>Suggested Lessons:
BI 5.5: Function Operations
BI 5.6: Inverse Functions

CPM 5.1.1* – Undo Equations
CPM 5.1.2—Using a graph to find an inverse
CPM 5.1.3—Finding Inverses and Justifying Algebraically
CPM 5.2.5—Investigating Compositions of Functions

*CPM Core Connections Algebra 2 is an approved supplementary resource for this course</td><td colspan="2">Objectives:
Students will perform operations on functions (add, subtract, multiply, and divide).
Students will perform compositions of functions.
Students will learn about the inverse relationships between square roots and quadratic functions and then use the relationship to solve equations.
Students will solve an equation of the form $f(x) = c$ for a simple function f that has an inverse and write an expression for the inverse (includes simple radical, rational, and polynomial functions).
Students will interpret the inverse in the context of the problem.
Students will use function composition to prove functions are inverses.
Students will identify the Domain of a function and its inverse and restrict the Domains, as necessary.</td></tr>
<tr><td colspan="3">Instructional Notes:</td></tr>
</table>

12	**Unit 8:** Exponential Functions	A-SSE.1,2,4; A-CED.1,2,3,4; A-REI.11; F-IF.7e,8b,9; F-BF.1,2,3,4

Instructional Overview:
Unit 8 explores exponential functions. The natural base *e* is introduced and used in application problems. Students will use exponential functions to model growth and decay and compare it to linear growth. Students will make connections between the patterns of exponential growth and geometric sequences.

Suggested Lessons:

Big Ideas 6.1 – Exponential Growth and Decay Functions
Big Ideas 6.2 – The Natural Base *e*
Big Ideas 6.6 – Solving Exponential and Logarithmic Equations
Big Ideas 6.7 – Modeling with Exponential and Logarithmic Functions
Big Ideas 8.1 – Defining and Using Sequences and Series
Big Ideas 8.3 – Analyzing Geometric Sequences and Series

CPM 10.3.2 – The Number *e* (**problems 10-164 & 10-165 only**)
CPM 6.2.3 – Writing Equations of Exponential Functions
CPM 10.1.4 – Summation Notation and Combinations of Series
CPM 10.2.1 – Geometric Series

Objectives:
- Students will model situations involving exponential growth and decay, including compound growth.
- Students will numerically and graphically use exponential functions with the base *e* to model a quantity that compounds continuously.
- Students will use exponential functions to model situations and then interpret the solutions.
- Students will compare linear functions and exponential growth and decay.
- Students will extend the recursive pattern of exponential growth/decay to define a geometric sequence.
- Students will find explicit formulas, recursive processes and sums of geometric sequences.

Instructional Notes:
In Lesson 6.1, students will review what they learned in Algebra I about exponential growth and decay functions. Connections can be made between transformations of other functions and the functions in this unit. Teachers will need to supplement for compound growth.
This unit investigates geometric sequences and series, but not arithmetic sequences or series. If time permits, teachers can also discuss arithmetic sequences and series from Section 8.2 in Big Ideas.
Note: An introduction to geometric sequences and series is sufficient if other units run long; this topic is covered in more depth in Math Analysis B.

18	**Unit 9:** Logarithmic Functions	A-SSE.1,2,4; A-CED.1,2,3,4; A-REI.11; F-IF.7e,8b,9; F-BF.1,3,4; F-LE.4

Instructional Overview:
Unit 9 explores logarithmic functions. The natural base *e* is used as the base of the natural logarithm. Students will extend their work with transformations to now include transformations of exponential and logarithmic functions. Students will extend their work on inverses to include the inverse of an exponential function. Students will investigate and apply properties of logarithms. The unit finishes by having students solve exponential and logarithmic equations using different approaches.

Suggested Lessons:

Big Ideas 6.3 – Logarithms and Logarithmic Functions
Big Ideas 6.4 – Transformations of Exponential and Logarithmic Functions
Big Ideas 6.5 – Properties of Logarithms
Big Ideas 6.6 – Solving Exponential and Logarithmic Equations
Big Ideas 6.7 – Modeling with Exponential and Logarithmic Functions

CPM 5.2.1 – Finding the Inverse of an Exponential Function
CPM 5.2.2 – Defining the Inverse of an Exponential Function
CPM 5.2.3 – Investigating the Family of Logarithmic Functions
CPM 5.2.4 – Transformations of Logarithmic Functions
CPM 6.2.1 – Using Logarithms to Solve Exponential Equations
CPM 6.2.2 – Investigating the Properties of Logarithms

Objectives:
- Students will model situations involving exponential growth and decay, including compound growth.
- Students will numerically and graphically use exponential functions with the base *e* to model a quantity that compounds continuously.
- Students will find the inverse of exponential and logarithmic functions and describe how they are related.
- Students will evaluate logarithmic expressions and convert between the exponential form of an equation and the logarithmic form.
- Students will develop properties of logarithms and use these properties to solve problems algebraically.
- Students will graph exponential and logarithmic functions showing intercepts and end behavior.
- Students will use exponential and logarithmic functions to model situations and then interpret the solutions.

Instructional Notes:
Connections can be made between transformations of other functions and the functions in this unit. Calculators will be needed when students are evaluating logarithms and time may need to be spent showing students how to use the calculator.

15	**Unit 10:** Synthesis of Functions	F-IF.1,2,4,5,7a-e,9; F-BF.1; F-LE.1,5
	Instructional Overview: Unit 10 is a capstone unit of the course in which students will review all function types investigated over the course of Algebra 2.1, 2.2, and 2.3 (quadratic, polynomial, rational, radical, exponential, logarithmic) as well as linear functions from Algebra 1.	
	Suggested Lessons: **CPM 2.1.1 –** Modeling non-linear data	**Objectives:** • Student will solve non-linear systems. • Students will identify Domain on all function types given any one of the four representations of functions. • Students will use technology to run regressions on sets of data to determine which type of function best models the data.
	Instructional Notes: Review for a comprehensive final exam for Algebra 2.3 should be included in Unit 10. The comprehensive final may take the form of a capstone project in which students compare and contrast all of the function types learned over the span of Algebra 2.1, 2.2, and 2.3	

Sample Assessments for Algebra II-A Extension

Name: _____ Date: _____ Period: _____

Share Your Knowledge Another Way!

This project is an opportunity to share your knowledge of what you have learned this year in Algebra 2. You have the ability to choose how to present this knowledge, but here are some sample ideas:

- *Write and perform a song for our mathematical musical*
- *Perform a skit about the objective*
- *Video Project – music video or commercial*
- *Create a cartoon or piece of artwork that demonstrates the objective*
- *Create a "CliffNotes" Guide for your objective*
- *Game or Review Activity for groups or the whole class*
- *Make-up your own way!*

This is an opportunity to impress and convince me that you have mastered the many objectives of this course. Your work will be assessed on the use of vocabulary, notation, and essential curriculum content. All groups must be prepared to present on ***Monday, June 12th***.

Thank you for a truly outstanding year,

Ms. Ryan

Topics

- Simplifying Expressions*
- Adding, Subtracting, Multiplying and Dividing Expressions*
- Solving Equations*
- Comparing and Contrasting different Functions and their Graphs
- Transformations of Functions (Exploring equations, graphs, and tables)
- Inverses of Functions (and Function Composition)
- Solving Systems of Non-Linear Equations*
- Exploration of Applications
- Recommend your own topic (Only if all other topics are covered)

* Topics can be taught by 2 groups

Presentation Expectations:

1) Each presentation should last between 12 – 18 minutes (Depending on the number of groups within each class)

2) Your objective should be clearly stated and the presentation should include a summary of the main ideas, vocabulary and notation

3) Each presentation explores the topic within the major chapters throughout 2nd Semester (at least one example from each unit)
    i. Rational Equations
    ii. Radical Equations
    iii. Exponential Equations
    iv. Logarithmic Equations

4) All members of the group contribute equally to the final presentation and present in front of the class

5) Content is presented in a creative way that engages the audience

6) The presentation contains at least one visual that supports learning

7) The audience leaves with a resource to study

8) The presentation includes an assessment to ensure that the intended learning has occurred

*Remember, you are responsible for reviewing your content for the district final exam! Make sure you are taking this role seriously and you are setting your peers up for success!

Name: _____ Date: _____ Period: ___

Partner Name: _____ Partner Name: _____

Mathematical Modeling Project

For this project, you will work independently or with one/two partner(s) to explore different models of a data set you select/find. You should research a data set that explores a topic that you are passionate about! Make sure that your data is accurate (must have a REAL source) and has at least 6 data points. (Your model will be more accurate with additional data points!) You will use the modeling skills you acquired this week to find a realistic and accurate model of the data and use it to make predictions. You will include all of this information in a letter to an "interested" party. An interested party might be a politician, business owner, community member, or principal depending on the topic you select.

Your letter must include the following aspects for full credit:

*Grades for each category will be assigned based on the quality and accuracy of the work.

- □ Title of the person you are sending the letter to (5 points)
- □ Description of your data and where its source (10 points)
- □ A labeled graph with your data and best regression equation (10 points)
    - o Graph can be on graph paper, Excel, or Desmos Online Graphing Calculator screen shot
- □ The best regression equation that models the data (and justification) (10 points)
- □ A brief explanation of why your regression equation would be useful (10 points)
- □ An appropriate domain and range for your data (and justification) (10 points)
- □ Use your model to make a prediction that your "interested" party would be interested in! (haha) (10 points)
- □ A brief explanation of why your model may be inaccurate (its limitations) (10 points)
- □ Communicates mathematics clearly with a logical sequencing of ideas (15 points)
- □ Must be within one/two typed pages with appropriate grammar and spelling (10 points)

Modeling Project Total Score:

Comments:

Name: _____ Date: _____ Period: _____

Functions Group Project

Complete the following project with your group collaboratively. To receive full credit on your presentation, make sure you EXPLAIN how you got your answers using key vocabulary, accurate notation and rich conceptual understanding.

Part 1:

As a group choose two different functions, then check with a teacher to get them approved.

Linear: *f(x)* = _____ Non-polynomial: *g(x)* = _____

Teacher Approval: _____

A. Find the following quantities. If the value is undefined, explain why.

   a. $(f + g)(3)$

   b. $(g - f)(-2)$

   c. $(f \cdot f)(-7)$

   d. $(\frac{f}{g})(4)$

B. Find the following new function by performing the indicated operation and then describe the domain of each. Remember to simplify when possible.

   a. $(g + f)(x)$

   b. $(f - g)(x)$

   c. $(f \cdot g)(x)$

   d. $(\frac{f}{g})(x)$

   e. $(f \circ f)(x)$

f. $(f \circ g)(x)$

g. $(g \circ f)(x)$

C. In your work above, did $(f \circ g)(x) = (g \circ f)(x)$ for all values of *x?* Explain.

Part 2:

Linear: *f(x)* = _____

A. Find the inverse of *f(x)*.

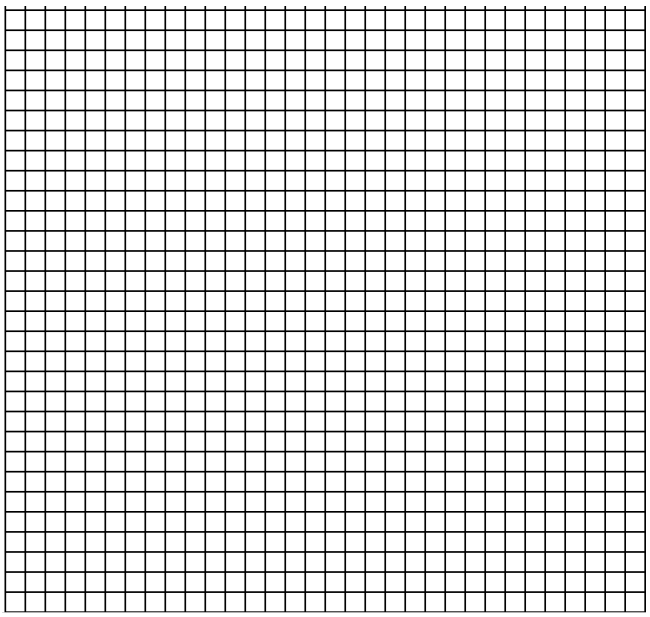
B. Complete the following tables.

x	$f(x)$

x	$f^{-1}(x)$

C. Graph $f(x)$ and $f^{-1}(x)$ on the same coordinate plane.

D. Identify the domain and range of $f(x)$ and $f^{-1}(x)$.



E. Prove algebraically that $f(x)$ and $f^{-1}(x)$ are inverses of each other.

Non-polynomial: *g(x)* = _____

A. Find the inverse of $g(x)$.

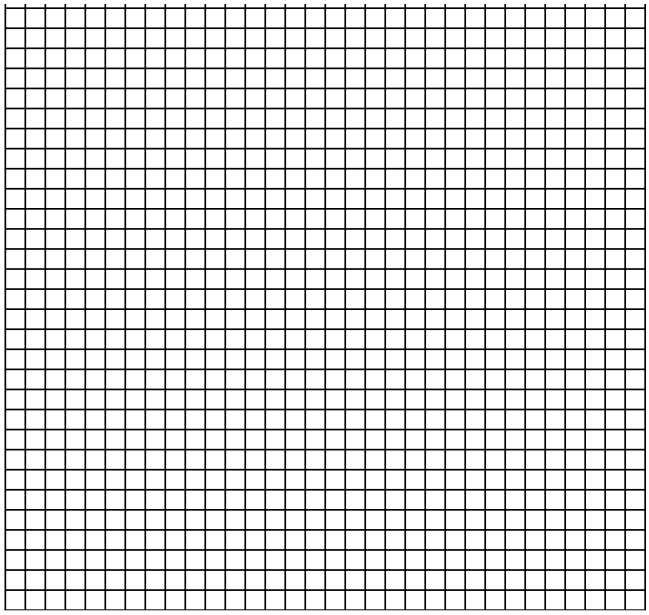
B. Complete the following tables.

x	$g(x)$

x	$g^{-1}(x)$

C. Graph $g(x)$ and $g^{-1}(x)$ on the same coordinate plane.

D. Identify the domain and range of $g(x)$ and $g^{-1}(x)$.



E. How can you tell from a table that two functions are inverses of each other? How can you tell from a graph that two functions are inverses of each other? How are these questions connected?

Challenge: Prove algebraically that $g(x)$ and $g^{-1}(x)$ are inverses of each other.

Name: _____ **Date:** _____ **Period:** _____

Polynomial Equations Unit Test

Directions: Work independently on the questions below. Be sure to show all of your work for full credit. Make sure you are using correct mathematical notation and provide the best possible answer.

1. Perform the indicated operation. Write your answer in standard form.

a. $\left(6x^4 - 3x^3 + 12x^2 + 9x + 10\right) + (3x^4 - 7x^2 - 9x - 19)$

b. $\left(10x^4 - 3x^2 + 7x - 12\right) - \left(3x^4 - 7x^3 + 14x + 3\right)$

c. $(2x - 5)^3$

d. $(x^3 + 2x^2 - 9x - 18) \div (x - 2)$

2. Factor the following polynomials using the method of your choice. Make sure you factor completely and write your final answer on the line.

a. $3t^5 - 48t^3 =$ _____

b. $2x^4 + 16x^2 + 24 =$ _____

c. $m^3 - 5m^2 - 9m + 45 =$ _____

d. $8w^3 - 27 =$ _____

3. a. Divide the polynomials using long division and show all of your work.

$$(2x^3 - 3x + 4) \div (x - 1)$$

b. Check your answer to the long division problem with synthetic division. Did you get the same result?

4. Decide whether each statement is true or false.

a. If $f(x)$ is a polynomial and *f(2)=0,* then the Factor Theorem tells us that $(x + 2)$ is a factor of *f(x).*

_____(True or False)

b. The equation $x^3 + 7x - 9 = 0$ must have at least one real solution.

_____(True or False)

c. The Fundamental Theorem of Algebra tells us that if a polynomial *f(x)* has a degree of five, then *f(x)* has five x-intercepts.

_____(True or False)

5. Use the appropriate method to solve the equations below for *x*. Make sure to include **ALL** possible solutions (real or imaginary)!
   a. $x^4 + x^2 - 12 = 0$

   b. $x^3 + 1 = 0$

   c. $x^3 - 2x^2 + 4x - 8 = 0$

6. Write a polynomial *f(x)* of least degree that has rational coefficients, a leading coefficient of 1 and zeros -3 and $4i$. Write your final answer in standard form.

7. Describe the $f(x) = 2x^3 - 3x^2 - 11x + 6$ below.

a. Leading Coefficient: Constant:

Degree: Type:

End Behavior: y-intercept:

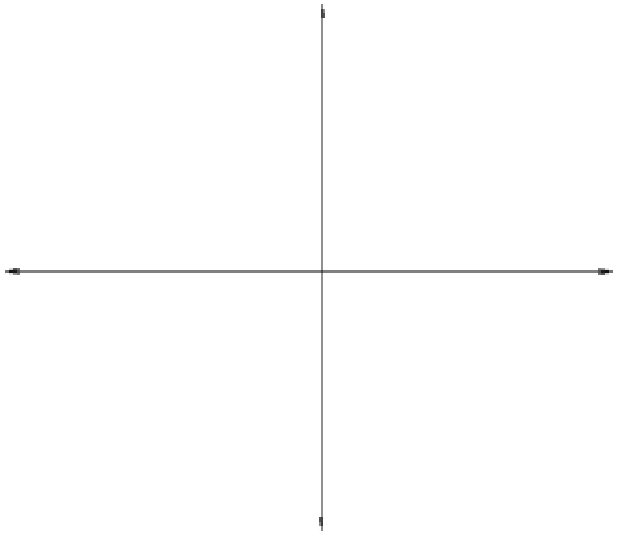
b. List the possible rational zeros of *f(x)* using the Rational Zero Theorem.

c. Use synthetic division and the Rational Zero Theorem to write *f(x)* in factored form. Show all of your work! [Hint: Use your graphing calculator as a tool!]

Factored Form: *f(x)* = _____

d. Identify **ALL** zeros of *f(x)*. *x* = _____

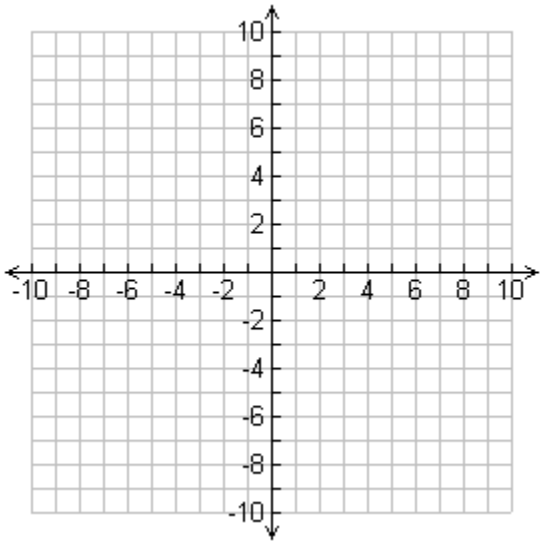
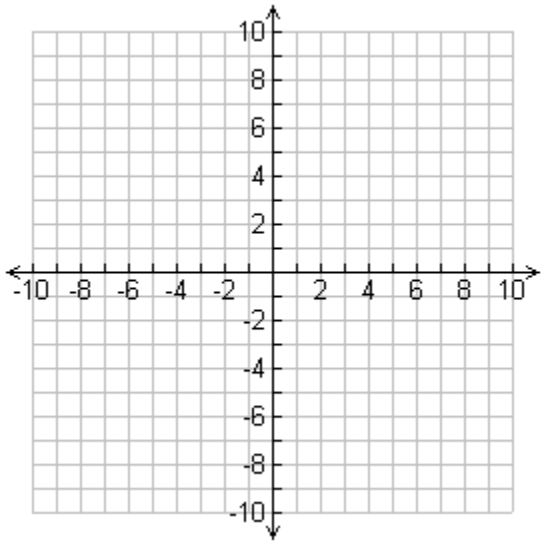
e. Use the information above to **sketch** the graph of *f(x)*.



Name: _____ Date: _____ Period: _____

Radical Functions Unit Test: Performance Task

1. A. Graph the two equations below and describe the key components of the graphs.

$f(x) = -2\sqrt{x-1}+4$	$g(x) = -2(x-1)^{\frac{1}{3}}+4$
<table><tr><th>x</th><th>$f(x)$</th></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table>	<table><tr><th>x</th><th>$g(x)$</th></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table>
	
Domain: Range: x-intercept(s): y-intercept(s):	Domain: Range: x-intercept(s): y-intercept(s):

B. Describe in detail how *f(x)* and *g(x)* are similar or different from each other.

Similarities:	Differences:
1. 2. 3.	1. 2. 3.

2. When does a radical function have a restricted domain? **Why?** Explain using specific examples of functions with restricted and non-restricted domains. These could be equations, graphs, and/or tables. Write an explanation for your future self to understand and remember domain restrictions on radical functions in a future math class.

Scoring Rubric:

+1 Even verse Odd Index

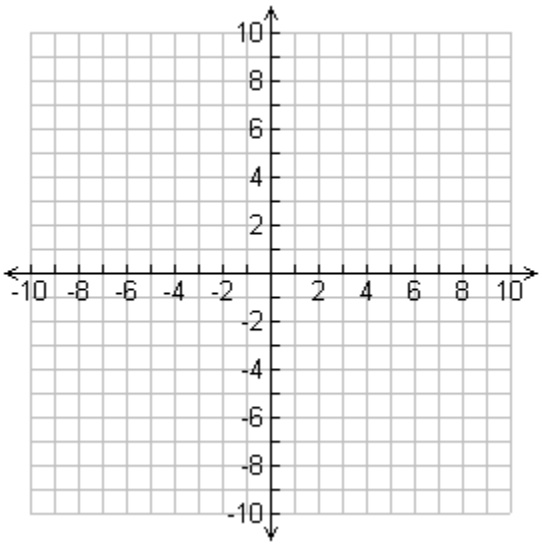
+1 Impact of taking an even root of a negative number

+2 Reference to specific example/non-example

+1 Appropriate vocabulary terms – imaginary numbers, index, radicand, root…

+1 Coherent explanation

3. A. Two students are working together to solve the equation $x + 4 = \sqrt{x - 1} + 7$. One student solves the equation algebraically and finds two solutions. The other student solves the equation graphically and finds one solution. Recreate the work for both students.

Solving Algebraically – Possible Work for Student 1	Solving Graphically – Possible Work for Student 2
$x + 4 = \sqrt{x - 1} + 7$ Solutions:	On the same coordinate point, graph: $y = x + 4$ $y = \sqrt{x - 1} + 7$  Solutions:

B. What is the correct solution(s) to the equation $x + 4 = \sqrt{x - 1} + 7$? Explain. (How do you know?)

Scoring Rubric:

+1 Correct Solution

+1 Checking Answers Algebraic

+1 Coherent explanation

C. Why did the different methods of solving produce a different number of solutions?

Scoring Rubric:

+1 Appropriate vocabulary terms – imaginary numbers, index, radicand, root…

+2 Coherent explanation

4. A. Solve the following equations.

Equation and Algebraic Work to Solve	Check Your Answers and Final Solutions
$(x + 8)^{\frac{1}{4}} + 1 = 0$	
$\sqrt[3]{7x - 9} + 11 = 14$	
$\sqrt{4x} = x - 8$	

$(2x + 6)^{\frac{1}{2}} = 4$	

B. Given these examples, what generalizations would you make about which types of radical functions have might extraneous solutions, and why?

Scoring Rubric:

+1 Appropriate vocabulary terms – imaginary numbers, index, radicand, root…

+2 Coherent explanation

Name: _____ Date: _____ Period: _____

Simplifying Radicals and Rational Exponent Expressions Quiz - PRACTICE

Directions: Work independently to answer the questions below. Make sure your final answers are simplified completely and show your work for full credit.

1. a. Write the following radical as an expression with a rational exponent.

$$\sqrt[7]{x^3} =$$

b. Write the follow expression as a radical.

$$5^{4/3} =$$

2. Perform the indicated operation and simplify each expression completely.

1. $\sqrt{72x^3y^6}$	2. $2\sqrt[3]{4x^2} \cdot -3\sqrt[3]{12x}$
3. $4(5)^{\frac{1}{3}} + 7(5)^{\frac{1}{3}}$	4. $\sqrt{36x^5} - x\sqrt{x^3}$
5. $\sqrt[3]{\frac{216}{x^2}}$	6. $\frac{5}{\sqrt[4]{8x^2}}$
7. $\frac{x^{\frac{5}{3}}y}{xy^{-\frac{1}{2}}}$	8. $\left(y \cdot y^{\frac{1}{4}}\right)^{\frac{4}{3}}$

Name: _____ Date: _____ Period:_____

Solving Rational Equations and Operations on Rational Expressions Quiz

Directions: Solve the following equations below. Remember to check for extraneous solutions and show your work below. Please box your final answer.

1. $\frac{2(x-2)}{x^2-10x+16} = \frac{2}{x+2}$

Check:

2. $\frac{18}{x^2-3x} - \frac{6}{x-3} = \frac{5}{x}$

Check:

3. $\frac{2(x+7)}{x+4} - 2 = \frac{2x+20}{2x+8}$

Check:

4. $\frac{x}{2x+7} = \frac{x-5}{x-1}$

Check:

Simplify the following expressions completely. Show your work neatly below and box your final answer.

5. $\frac{x^3-5x^2-3x+15}{x^2-8x+15}$

6. $2+\frac{2x}{x-2}$

7. $\left(\frac{1}{2x-5}-\frac{7}{8x-20}\right)\div\frac{x}{2x-5}$

8. $\frac{x}{x^2-5x+6}-\frac{3}{x-3}$

9. $\frac{x^2-9}{x^2+5x+6}\div\frac{2x-6}{5x+10}$

10. $\frac{\frac{x^3+8}{x^2-2x}}{\frac{x^2-2x+4}{x^2-4x+4}}$

Name: _____

Date: _____ Period: _____

Algebra 2A: Factoring Quadratic Expressions – Skills Quiz #3

Pre-Test!

Directions: Work independently and silently to complete the following problems to the best of your ability.

Skill #3: You will be able to factor quadratic expressions completely.

1. $x^2 + 3x - 10 =$ _____

2. $2x^2 - 7x + 3 =$ _____

3. $x^2 + 7x + 10 =$ _____

4. $32x^2 + 2 =$ _____

5. $x^2 + 3x - 70 =$ _____

6. $6x^2 - x - 5 =$ _____

7. $2x^2 - 3x - 35 =$ _____

8. $x^2 - 25 =$ _____

9. $4x^2 - 49 =$ _____

10. $x^2 - 17x + 72 =$ _____

Name: _____ Date: _____
Period: ____

Algebra 2A: Exponent Numeracy Check – Skills Quiz #5

Directions: Work independently and silently to complete the following problems to the best of your ability. Make sure to answer the question fully and **check your work**! Please **show all the necessary work** to receive maximum credit.

Skill #5: You will be able to evaluate expressions quickly and accurately. Remember to simplify completely!

1. $3^4 =$

2. $4^{-2} =$

3. $(81)^{\frac{1}{2}} =$

4. $10^4 =$

5. $1^{45} =$

I feel confident with my ability to solve problems using this skill. (I understand the key concepts and reliably get the correct solution.) Circle your response below.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

What resources, activities or study techniques helped you improve on this Skill over the last trimester?