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How to Use This Addenda

Make sure you're ready to teach by noting the **Necessary Materials and Pre-Lesson Prep** you will need to gather or complete prior to the lesson

Find high-leverage instructional moves in the **Lesson Look Fors**. This is what leaders should see when observing your instruction

Note how your lesson objective ties to your state **Standards**

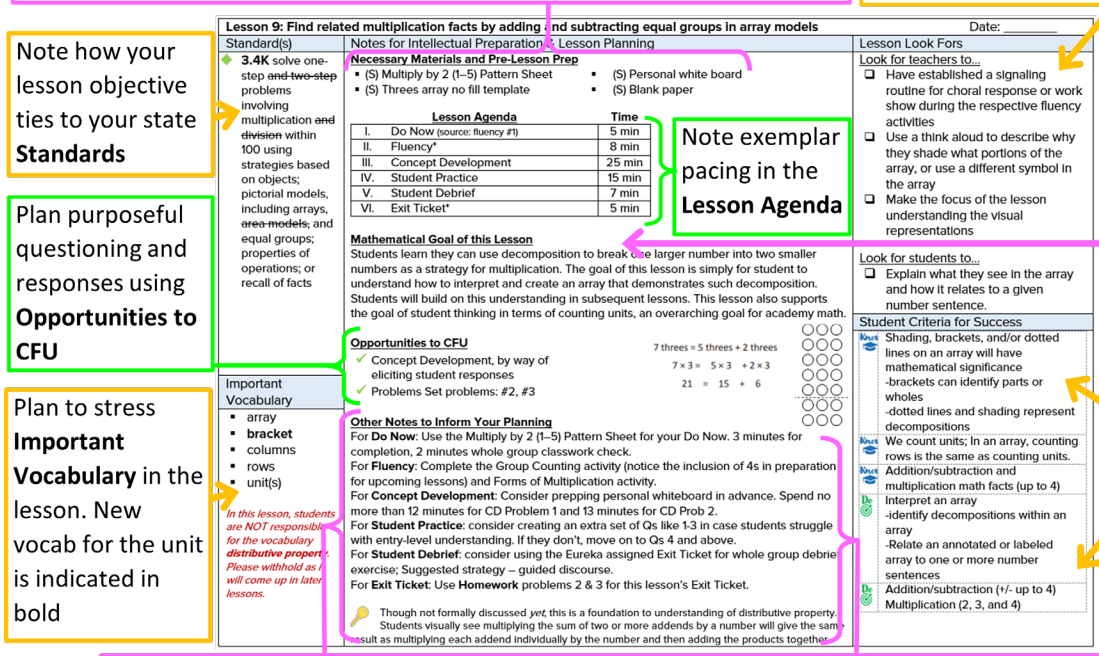
Note exemplar pacing in the **Lesson Agenda**

Use the **Mathematical Goal of the Lesson** to keep you focused on the appropriate student outcome

Plan purposeful questioning and responses using **Opportunities to CFU**

Plan instruction around what students need to Know & Do to be successful on the Exit Ticket using the identified **Student Know/Do Chart**

Plan to stress **Important Vocabulary** in the lesson. New vocab for the unit is indicated in bold



Find recommended lesson modifications, content knowledge boosters, and/or high-leverage instructional moves that may not be in your Teacher Edition located in **Other Notes to Inform Your Planning**

UNIT SYNOPSIS

In Algebra I, students simplified polynomials and explored quadratic functions and equations (also during Unit 4 this year). During this unit, students describe and analyze the square root function, including the restriction(s) on domain/range, graph and zeros of the function. Students graph the function $f(x) = \sqrt{x}$, and analyze the key attributes such as domain, range, intercepts, and symmetries as well as graph transformations of the parent function. Students solve square root equations, including equations written with rational exponents, and identify extraneous solutions of square root equations. Students create square root equations from tables of data, solve the square root equations, and justify the solution in terms of the problem situation, identifying extraneous solutions.

Solving Equations and Inequalities: Solving an equation is the process of rewriting the equation to make what it says about its variable(s) as simple as possible. Properties of numbers and equality can be used to transform an equation (or inequality) into equivalent, simpler equations (or inequalities) in order to find solutions. Useful information about equations and inequalities (including solutions) can be found by analyzing graphs or tables. The numbers and types of solutions vary predictably, based on the type of equation.

- You can use technology to formulate and solve square root equations.
- Solving a square root equation may require that you square each side of the equation. This can introduce extraneous solutions.

Transformations: Transformations are mathematical functions that model concrete operations with figures. Transformations may be described geometrically or by coordinates. Symmetries of figures may be defined and classified by transformations.

- The graph of any square root function is a transformation of the graph of the square root parent function, $f(x) = \sqrt{x}$.

Misconceptions:

- Some students may think that when solving a square root equation all calculated solutions are true solutions rather than checking each solution to identify extraneous solutions.

Underdeveloped Concepts:

- To be functions, square root functions have a limited domain based on the range of their inverse counterpart quadratic functions.
- Square root functions are often the first function family that students work with that has a strictly limited domain. Students may be used to a function's domain being all real numbers.

Key Questions:

- What graphs, key attributes, and characteristics are unique to square root functions?
- What types of square root equations produce extraneous solutions, and why are the solutions considered extraneous?
- What methods can be used to write square root equations?
- What kinds of mathematical and real-world situations can square root functions model?
- What are the real-world meanings of the key attributes of a square root function model?
- How can the key attributes of a square root function be used to make predictions and critical judgments?

CONTENT STANDARDS

Below are the standards addressed in this unit.

Readiness Standards	Supporting Standards
2A.2A Graph the functions $f(x) = \sqrt{x}$, ~~$f(x) = 1/x$, $f(x) = x^3$, $f(x) = \sqrt[3]{x}$, $f(x) = b^x$, $f(x) = \lvert x \rvert$,~~ and ~~$f(x) = \log_b(x)$ where b is 2, 10, and e~~, and, when applicable, analyze the key attributes such as domain, range, intercepts, symmetries, asymptotic behavior, and maximum and minimum given an interval.	**2A.4H** Solve ~~quadratic~~ square root inequalities. (*alignment to AP Calculus skill)
2A.4C Determine the effects on the graph of $f(x) = \sqrt{x}$ when $f(x)$ is replaced by $af(x)$, $f(x) + d$, $f(bx)$, and $f(x - c)$ for specific positive and negative values of a, b, c, and d.	**2A.8B** Use regression methods available through technology to write a ~~quadratic~~ square root function from a given set of data. (*alignment to AP Statistics skill)
2A.4F Solve ~~quadratic and~~ square root equations.	

Focus on Disciplinary Literacy	
	Mathematical Process Standard (F) – Analyze mathematical relationships to connect and communicate mathematical ideas.
	Mathematical Process Standard (G) – Display, explain, and justify mathematical ideas and arguments using precise mathematical language in written or oral communication.

LEARNING SUPPORTS BY LESSON

There is a checkmark for the math support if the lesson	Lessons → Math Supports	L1	L2	L3	L4	L5	L6
makes a connection to prior content or from a previous unit or academic year	Access Prior Knowledge	✓	✓			✓	✓
uses familiar contexts or experiences to make the learning relevant to students	Real-World Connections		✓	✓		✓	✓
makes use of graphic organizers	Graphic Organizers			✓	✓		✓
includes tools like rulers, protractors, patty paper, algebra tiles, etc.	Tools or Manipulatives	✓					
incorporates tables, reference charts, displays, pictures, models, or color-coding	Visual Aids		✓	✓	✓		✓
includes definitions, examples vs. nonexamples, cognates, etc.	Vocabulary Supports	✓	✓	✓	✓	✓	✓
includes strategies that support language development							
asks students to discuss with their partner to prepare for whole class discussion	- Turn and Talk	✓	✓		✓		✓
teacher facilitates a whole class discussion to debrief key learnings	- Guided Discussion	✓	✓	✓	✓	✓	✓
asks students to think independently, test their idea with a partner, and share whole group	- Think, Pair, Share			✓			
includes sentence stems to support students with explanations	- Sentence Stems			✓			✓
provides opportunities for students to work with a partner or a group	Peer Collaboration	✓	✓	✓	✓	✓	✓
uses mnemonics such as SohCahToa	Mnemonics						
includes websites or equipment that enhances the lesson	Technological Support	✓	✓	✓	✓		✓
content can be presented in different forms							
uses hands-on tools or manipulatives to represent the math	- Concrete						
uses drawings to represent the math	- Pictorial	✓	✓	✓	✓	✓	✓
uses numbers and number sentences to represent the math	- Abstract	✓	✓	✓	✓	✓	✓

The EFFL Model

Before You EFFL!

Here are helpful resources that you guide you in the right direction before your EFFL lesson!

Why Should We EFFL?

The article advocates for the Experience First, Formalize Later (EFFL) teaching model, emphasizing its effectiveness in fostering deep understanding and flexible thinking in students. The author compares traditional teaching to a game of "Simon Says," where students merely mimic instructions without grasping underlying concepts. In contrast, EFFL encourages students to engage actively with problems, enhancing their ability to understand and apply math concepts creatively.

Tips for Lesson Planning

The article offers practical advice for effective lesson planning beyond the exhaustive and overly detailed approaches often emphasized during teacher training. It underscores the importance of thoughtful preparation but rejects the notion that teachers need to script every minute or detail of a class session.

Making the Most of Your EFFL Lesson Debrief

The article discusses the significance of the debriefing phase in the Experience First, Formalize Later (EFFL) lesson model, emphasizing its role in reinforcing learning and highlighting student contributions. The debrief session is seen as crucial for integrating academic vocabulary, emphasizing key lesson understandings, and valuing students' mathematical insights.

While You EFFL!

While each lesson may be unique in context and skills, all lessons benefit from the following practices:

Teacher Look Fors:

- ❑ Utilizing the Do Now to spark students' interest in the Activity.
- ❑ Use questioning to promote small group discussion and exploration, guided by monitoring questions.
- ❑ Connects Experience First to formal concepts using a colored pencil/pen to take notes along the margin during the Debrief.
- ❑ Facilitates whole-class discussions for students to reflect, share insights, and provides feedback that reinforces key concepts.
- ❑ Tracks time to adapt lesson pacing and support based on student response and engagement.

Students Look Fors:

- ❑ In the Activity, students engage in group work and discourse.
- ❑ Exploring the activity, testing hypotheses and approaches (trial & error).
- ❑ Take notes on key ideas and concepts using different colored pencil/pen to take notes along the margin.
- ❑ Share thoughts and ideas that demonstrate their approach to their work.

Other considerations

- During the **Experience First** phase, if most of your students seem stuck or disengaged, take a moment to pause, reset, and provide clear instructions. Some problems of the Activity are more suitable to do a whole-class discussion as a means to save some instructional time for Student Practice or the Exit Ticket. You are encouraged to adapt the EFFL (Experience First, Formalize Later) process to meet your students' needs while maintaining a focus on student-centered instruction.

ROADMAP

AT A GLANCE: Unit 5 – Square Root Functions and Equations			
Day	Date	Lesson	Lesson Title
1		1	Square Root Functions and Reflections
2		2	Solving Square Root Equations
3		3	Applying and Interpreting Square Root Equations
4		4	Solving Square Root Inequalities
5		5	Graphing Square Root Inequalities
6		6	Square Root Regression
7			*Unit 5 Success Day 1 – Use as needed based on your data*
8			*Unit 5 Success Day 2 – Unit Assessment Review*
9			End of Unit 5 Assessment

Date: _____

Lesson 1: Square Root Functions and Equations

Standard(s)

- **2A.2A** Graph the functions $f(x) = \sqrt{x}$, ~~$f(x) = 1/x$~~, ~~$f(x) = x^3$~~, ~~$f(x) = \sqrt[3]{x}$~~, ~~$f(x) = b^x$~~, ~~$f(x) = |x|$~~, and ~~$f(x) = \log_b(x)$~~ where ~~b~~ is 2, 10, and ~~e~~, and, when applicable, analyze the key attributes such as domain, range, intercepts, symmetries, asymptotic behavior, and maximum and minimum given an interval.
- **2A.4C** Determine the effects on the graph of $f(x) = \sqrt{x}$ when $f(x)$ is replaced by $af(x)$, $f(x) + d$, $f(bx)$, and $f(x - c)$ for specific positive and negative values of a, b, c, and d.

Important Vocabulary

- **square root parent function**
- **radical**
- horizontal/vertical translation
- reflection
- horizontal/vertical stretch
- horizontal/vertical compression

Notes for Intellectual Preparation & Lesson Planning

Necessary Materials and Pre-Lesson Prep

- SE workbook
- Desmos or Graphing calculator

Lesson Structure:

- Do Now (5 min)
- INM (20 min)
- Debrief (10 min)
- Student Practice (20 min)
- Exit Ticket (5 min)

Mathematical Goal of this Lesson

In this lesson, students will graph square root functions and determine the domain and range. Students will also reflect a function over the x or y axis and explain the effects on its equation and graph.

Opportunities to CFU

- ✓ INM #1-4
- ✓ Debrief
- ✓ Student Practice

Other Notes to Inform Your Planning

In this lesson we're introducing a function family (square roots) and a transformation (reflections). Students can work through the entire activity before the debrief. We recommend using Desmos for graphing, but if you don't have devices for that, graphing calculators will work fine also. You'll probably need to add an extra 5 minutes for this.

Focus on Disciplinary Literacy

INM #5 & Student Practice #3-5

In addition to square root functions and reflections, we are also focusing on domain and range today.

Lesson Look Fors

Look for teachers to…

- ❑ Use the guiding questions from the TE while students work in groups.
- ❑ Build on students' prior knowledge of reflecting functions from Algebra 1 and Geometry.

Look for students to…

- ❑ Identify the attributes of the parent function and use the rules of reflection on them.
- ❑ Recognize connections between square root functions and parabolas from Unit 4.

Student Know/Do Chart

Students can

Do Describe the reflections of a square root function across the x or y-axis.

Do Graph square root functions and identify their domain and range.

Know Vertical reflections are over the x-axis: $f(x) \rightarrow -f(x)$
Horizontal reflections are over the y-axis: $f(x) \rightarrow f(-x)$

Know The Square Root Parent Function is $y = \sqrt{x}$ and it has Domain: $x \geq 0$ and Range: $y \geq 0$.

Date: _____

Lesson 2: Solving Square Root Equations

Standard(s)

◆ **2A.4F** Solve ~~quadratic and~~ square root equations.

Important Vocabulary

- radical
- **radicand**
- **extraneous solutions**
- isolate
- zero product property

Notes for Intellectual Preparation & Lesson Planning

Necessary Materials and Pre-Lesson Prep

- SE workbook
- Graphing calculator or Desmos

Lesson Structure:

- Do Now (5 min)
- INM (25 min)
- Debrief (5 min)
- Student Practice (20 min)
- Exit Ticket (5 min)

Mathematical Goal of this Lesson

In this lesson, students will learn how to solve square root equations, identify extraneous solutions, and form a connection between the solutions of the equations and the intersection of the graph of the two sides of the equation.

This lesson only focuses on solving square root equations, but the steps can be used generally to solve other radical equations such as cube root equations.

Opportunities to CFU

✓ INM problems #3-4
✓ Debrief
✓ Student Practice #7-10

Other Notes to Inform Your Planning

Students will solve square root equations using opposite operations as they have other types of equations. Be sure students understand to check all solutions back in the original equation to check for extraneous solutions. This standard is continued in the next lesson.

Focus on Disciplinary Literacy

INM #4 & Student Practice #7-9

Lesson Look Fors

Look for teachers to…

❑ Create an anchor chart for solving square root equations and checking their solution.
❑ Challenge students to be able to apply what they have used to solve a square root equation with a radical on each side of the equal sign.

Look for students to…

❑ Solve square root equations by isolating the radical term, squaring both sides, and then solve and check for extraneous solutions.

Student Know/Do Chart

Students can

Do: Solve a square root equation and check for extraneous solutions.

Know: An extraneous solution can be introduced when you square both sides of an equation to eliminate the square root. Therefore, an extraneous solution does not satisfy the original equation and is not included in the final answer.

Date: _____

Lesson 3: Applying and Interpreting Square Root Equations

Standard(s)

◆ **2A.4F** Solve ~~quadratic and~~ square root equations.

Important Vocabulary

- extraneous solutions
- **interpret in context**
- isolate
- radical
- radicand
- zero product property

Notes for Intellectual Preparation & Lesson Planning

Necessary Materials and Pre-Lesson Prep

- SE workbook
- Graphing calculator or Desmos

Lesson Structure:

- Do Now (5 min)
- INM (25 min)
- Debrief (5 min)
- Student Practice (20 min)
- Exit Ticket (5 min)

Mathematical Goal of this Lesson

In this lesson, students will continue to practice solving square root equations but also apply the solutions to a scenario and interpret them in context.

Opportunities to CFU

✓ INM problems #2-3

✓ Student Practice #1-2

Other Notes to Inform Your Planning

Students will apply square root equations to real-world scenarios. Make sure students fit the solution to the scenario while still checking for extraneous solutions.

Focus on Disciplinary Literacy

INM & Student Practice

This lesson requires the pre-requisite skill of solving equations involving square roots. Students will work with equations involving multiple variables and will isolate a specific variable with the information provided.

Lesson Look Fors

Look for teachers to…

- ❑ Have students work through the problems in the INM and share their process with their groups.
- ❑ Guide students through the 4-step problem solving method.

Look for students to…

- ❑ Interpret the meaning of their answer in the context of the scenario.
- ❑ Identify what the variable represents by rereading the scenario.

Student Know/Do Chart

Students can

Do — Write a sentence relating the solution and the meaning of the variable in context of the scenario.

Do — Solve a square root equation in context for a specific variable.

Know — Know the 4-step problem solving method: analyze given information, formulate a plan, determine the solution, and justify the solution.

Date: _____

Lesson 4: Solving Square Root Inequalities

Standard(s)

2A.4H Solve ~~quadratic~~ square root inequalities. (*alignment to AP Calculus skill)

Important Vocabulary

- **square root inequality**
- solution set (inequality)
- test point
- **sign chart**

Notes for Intellectual Preparation & Lesson Planning

Necessary Materials and Pre-Lesson Prep

- SE workbook
- Graphing calculator or Desmos

Lesson Structure:

- Do Now (5 min)
- INM (25 min)
- Debrief (5 min)
- Student Practice (20 min)
- Exit Ticket (5 min)

Mathematical Goal of this Lesson

In this lesson, students will solve square root inequalities which follows a very similar process to solving square root equations. Students will then use a sign chart via a number line to verify the solution set.

Opportunities to CFU

- ✓ INM problems #1-3
- ✓ Debrief
- ✓ Student Practice #5-6

Other Notes to Inform Your Planning

This standard is continued in the next lesson. Students will apply what they have used in the last two lessons and apply it to inequalities. Because the radicand must not be negative, there are two restrictions for students to find.

Focus on Disciplinary Literacy

Student Practice #6

Lesson Look Fors

Look for teachers to…

- ❑ Connect solving square root inequalities to the work students have done in recent lessons with square root equations.
- ❑ Model for students how to create a sign chart for an inequality.

Look for students to…

- ❑ Create a sign chart to determine the solution set for the inequality.
- ❑ Solve a variety of square root inequalities.

Student Know/Do Chart

Students can

Do: Solve a square root inequality and graph the solution on a number line.

Know: Know that < and > are represented with an open circle on a number line and $\leq$ and $\geq$ are represented by a solid circle.

Date: _____

Lesson 5: Graphing Square Root Inequalities

Standard(s)

- **2A.4H** Solve ~~quadratic~~ square root inequalities. (*alignment to AP Calculus skill)

Important Vocabulary

- square root inequality
- solution (shaded) region
- boundary line (or curve)
- dotted curve
- solid curve

Notes for Intellectual Preparation & Lesson Planning

Necessary Materials and Pre-Lesson Prep

- SE workbook
- Graphing calculator or Desmos

Lesson Structure:

- Do Now (5 min)
- INM (26 min)
- Debrief (5min)
- Student Practice (18 min)
- Exit Ticket (5 min)

Mathematical Goal of this Lesson

In this lesson, students will graph square root inequalities. The process is identical to graphing quadratic inequalities previously learned. Students will then verify their solution region is correctly shaded by using a test point either within their solution region or outside their solution region.

Opportunities to CFU

- ✓ INM problems #1-4
- ✓ Debrief
- ✓ Student Practice #1-2

Other Notes to Inform Your Planning

In this lesson, students will graph the square root inequalities on the coordinate plane. Remind students that some inequality graphs are solid and some are dotted and they should shade where the original statement is true.

Focus on Disciplinary Literacy

Student Practice #5

Lesson Look Fors

Look for teachers to…

- ❑ Connect students to their prior experiences with graphing quadratic inequalities in Unit 4 to graphing square rot inequalities.

Look for students to…

- ❑ Graph square root inequalities on the coordinate plane and correctly make them solid or dotted and shade the solution region.

Student Know/Do Chart

Students can

Do: Graph the solution set for a square root inequality in two variables.

Know: If you pick a point in your solution region, the point should create a true statement when you substitute the point into your inequality. If you pick a point outside your solution region, the point should create a false statement when you substitute the point into your inequality.

Date: _____

Lesson 6: Square Root Regression

Standard(s)

◆ **2A.8B** Use regression methods available through technology to write a ~~quadratic~~ square root function from a given set of data. (*alignment to AP Statistics skill)

Important Vocabulary

- **square root regression**
- **coefficient of determination (R^2)**

Notes for Intellectual Preparation & Lesson Planning

Necessary Materials and Pre-Lesson Prep

- SE workbook
- Graphing calculator or Desmos

Lesson Structure:

- Do Now (5 min)
- INM (25 min)
- Debrief (5 min)
- Student Practice (20 min)
- Exit Ticket (5 min)

Mathematical Goal of this Lesson

In this lesson, students will find and use a square root model for a given set of real data to draw conclusions in context by creating a regression model.

Opportunities to CFU

✓ After the INM
✓ Debrief
✓ Student Practice #1-3

Other Notes to Inform Your Planning

The Do Now begins with recalling the graphs of a few parent functions, examining data to sketch a best fit curve, and spiraling back to content from the earlier part of the unit by solving a square root equation. The INM transitions to using Desmos to create a scatterplot and a curve of best fit. Understanding which parent function and translations to incorporate and analyzing the accuracy of the curve of best fit by using the R-squared value. After settling on a curve of best fit, students are asked to apply the equation in different ways and interpret their answers.

Focus on Disciplinary Literacy

INM #2 & Student Practice

Lesson Look Fors

Look for teachers to…

- ❑ Support students as they use Desmos or graphing calculators to set up the square root regressions for the sets of data given.
- ❑ Explain the importance of R-squared and help students understand what different values mean.

Look for students to…

- ❑ Use Desmos or graphing calculators to find the square root regression curve for a set of real data.
- ❑ Interpret the R-squared for a set of data to determine how close the data fits the curve.

Student Know/Do Chart

Students can

Do Use square root regression to find the curve of best fit for given sets of data.

Know The shape of the scatterplot can help you determine which function to use. Data in a straight line indicates a linear regression, data in a curve that comes down indicates a quadratic regression, and data that curves slightly in the end indicates a square root regression.

Recommended Unit 5 Success Days Material and Resources

Date: _____

To review topics taught in Unit 5, use the following resources. Your exit ticket data should be used to determine individualized needs. The resources can be used in small groups, whole groups, or independent groups and be integrated with other classroom routines, like computer-aligned practice and teacher-led groups.

To review or practice square root functions and reflections, use...

Desmos Interactive Applets:

- Transformations of a Radical Function
- Transformed Square Root Function Activity

Sample Activities & Tasks:

- Radical Transformations TI-Calculator Exploration
- Graphing Square Root Functions Practice (answers)

Content Video Lessons:

- Square Root Functions (SB)
- Square Root Functions and Their Graphs

To review or practice solving square root equations, use...

Sample Activities & Tasks:

- Extraneous Solutions TI-Calculator Activity
- Solving Radical Equations Practice (answers)
- Multiple Radical Challenge (answers) OMIT #8 and #10

Content Video Lessons:

- Solving Equations Containing Radicals

To review or practice applying and interpreting square root equations, use...

Sample Activities & Tasks:

- Applying and Interpreting Square Root Equations Additional Practice

Content Video Lessons:

- Solving Square Root Equation Word Problems

To review or practice solving square root inequalities, use...

Content Video Lessons:

- Solving Radical Inequalities
- Solving Inequalities with Radicals

To review or practice graphing square root inequalities, use...

Desmos Interactive Applets:

- Square Root Inequality

Sample Activities & Tasks:

- Graphing Square Root Inequalities Practice (answers)

Content Video Lessons:

- Graph Square Root Inequalities
- Graphing Square Root Inequalities
- Graphing Square Root Inequality and Finding Domain and Range

To review or practice square root regression, use...

Sample Activities & Tasks:

- Square Root Regression TI-Nspire Lab Activity

Content Video Lessons:

- Square Root Regression

Date: _____

Unit 5 Exam

Standard(s)	Notes for Intellectual Preparation & Lesson Planning
◆ **2A.2A** Graph the functions $f(x) = \sqrt{x}$, ~~$f(x) = 1/x$, $f(x) = x^3$, $f(x) = \sqrt[3]{x}$, $f(x) = b^x$, $f(x) = \lvert x \rvert$, and $f(x) = \log_b(x)$ where b is 2, 10, and e~~, and, when applicable, analyze the key attributes such as domain, range, intercepts, symmetries, asymptotic behavior, and maximum and minimum given an interval. **Problems #8,9c** ◆ **2A.4C** Determine the effects on the graph of $f(x) = \sqrt{x}$ when $f(x)$ is replaced by $af(x)$, $f(x) + d$, $f(bx)$, and $f(x - c)$ for specific positive and negative values of a, b, c, and d. **Problems #6,9ab** ◆ **2A.4F** Solve ~~quadratic and~~ square root equations. **Problems #1,2,3,4,7** ◆ **2A.4H** Solve ~~quadratic~~ square root inequalities. **Problems #5,6** ◆ **2A.8B** Use regression methods available through technology to write a ~~quadratic~~ square root function from a given set of data. **Problems #10abc**	**Necessary Materials and Pre-Lesson Prep** ▪ Algebra 2 Unit 5 Exam ▪ Assessment Companion for Algebra 2 Unit 5 Exam found on Curriculum Corner **Notes to Inform Your Planning** Review the Unit 5 Exam on Curriculum Corner. Internalize & create an exemplar for the assessment prior to teaching the unit as part of unpacking the unit. Use the exemplar to spar with the answer key provided on Curriculum Corner. Administer the Unit 5 Exam following guidance on the Scope & Sequence to ensure the scoring deadline is met.

UNPACKED STANDARDS

Focus standards for this unit.

Standards Clarification		
Standards	**Specificity**	**Notes/Explanations/Examples**
2A.2A Graph the functions $f(x) = \sqrt{x}$, ~~$f(x) = 1/x$, $f(x) = x^3$, $f(x) = \sqrt[3]{x}$, $f(x) = b^x$, $f(x) = \lvert x \rvert$, and $f(x) = \log_b(x)$ where b is 2, 10, and e~~, and, when applicable, analyze the key attributes such as domain, range, intercepts, symmetries, asymptotic behavior, and maximum and minimum given an interval.	Graph: Including, but not limited to: • Representations of functions, including graphs, tables, and algebraic generalizations o Square root, $f(x) = \sqrt{x}$ • Connections between representations of families of functions • Comparison of similarities and differences of families of functions Analyze: Including, but not limited to: • Domain and range of the function o Domain – set of input values for the independent variable over which the function is defined o Range – set of output values for the dependent variable over which the function is defined o Representation for domain and range o Domain and range of the function versus domain and range of the contextual situation • Key attributes of functions o Intercepts/Zeros • Use key attributes to recognize and sketch graphs • Application of key attributes to real-world problem situations	• Grade Level(s): o The notation $\mathfrak{R}$ represents the set of real numbers, and the notation Z represents the set of integers. o Algebra I studied parent functions f(x) = x, f(x) = x^2, and f(x) = b^x and their key attributes. o Precalculus will study polynomial, power, trigonometric, inverse trigonometric, and piecewise defined functions, including step functions. o Various mathematical process standards will be applied to this student expectation as appropriate.
2A.4C Determine the effects on the graph of $f(x) = \sqrt{x}$ when $f(x)$ is replaced by $af(x)$, $f(x) + d$, $f(bx)$, and $f(x - c)$ for specific positive and negative values of a, b, c, and d.	Including, but not limited to: • General form of the square root function o $f(x) = \sqrt{x}$ • Representations with and without technology o Graphs o Tables o Verbal descriptions o Algebraic generalizations • Effects on the graph of $f(x) = \sqrt{x}$, when parameters a, b, c, and d are changed in $f(x) = a\sqrt{b(x - c) + d}$ o Effects on the graph of $f(x) = \sqrt{x}$, when $f(x)$ is replaced by $af(x)$ with and without technology o Effects on the graph of $f(x) = \sqrt{x}$, when $f(x)$ is replaced by $f(bx)$ with and without technology o Effects on the graph of $f(x) = \sqrt{x}$, when $f(x)$ is replaced by $f(x - c)$ with and without technology o Effects on the graph of $f(x) = \sqrt{x}$, when $f(x)$ is replaced by $f(x) + d$ with and without technology	• Grade Level(s): o Algebra I determined effects on the graphs of the parent functions, $f(x) = x$ and $f(x) = x^2$ when $f(x)$ is replaced by $af(x)$, $f(x) + d$, $f(x - c)$, $f(bx)$ for specific values of a, b, c, and d. o Algebra II introduces the square root parent function and its transformations. o Various mathematical process standards will be applied to this student expectation as appropriate.

Standards Clarification		
Standards	**Specificity**	**Notes/Explanations/Examples**
	Connections between the critical attributes of transformed function and $f(x) = \sqrt{x}$ ○ Determination of parameter changes given a graphical or algebraic representation ○ Determination of a graphical representation given the algebraic representation or parameter changes ○ Determination of an algebraic representation given the graphical representation or parameter changes Descriptions of the effects on the domain and range by the parameter changes Effects of multiple parameter changes ○ Mathematical problem situation ○ Real-world problem situations	
2A.4F Solve ~~quadratic and~~ square root equations.	Including, but not limited to: • Data collection activities with and without technology ○ Data modeled by square root functions • Real-world problem situations ○ Real-world problem situations modeled by square root functions • Data tables with at least three data points • Technology methods ○ Transformations of $f(x) = \sqrt{x}$ ○ Quadratic regression ○ Inverse relationships combined with quadratic regression	• Grade Level(s): ○ Algebra I solved quadratic equations having real solutions using tables, graphs, factoring, completing the square, quadratic formula, and technology. ○ Algebra I wrote, using technology, quadratic functions that provide a reasonable fit to date to estimate solutions and make predictions for real-world problems. ○ Various mathematical process standards will be applied to this student expectation as appropriate.

VERTICAL STANDARDS

This section details the **progression** of key student expectations (SEs) in the courses **before** and **after** this course. This will help you understand what **prior knowledge skills to build upon** and guide you in knowing what **skills you are preparing your students** for in the subsequent course.

Algebra 1	Algebra 2	Pre-Calculus
• **A.6A** Determine the domain and range of quadratic functions and represent domain and range using inequalities. • **A.7A** Graph quadratic functions on the coordinate plane and use the graph to identify key attributes, if possible, including x-intercept, y-intercept, zeros, maximum values, minimum values, vertex, and the equation of the axis of symmetry. • **A.7C** Determine the effects on the graph of the parent function $f(x) = x^2$ when $f(x)$ is replaced by $af(x)$, $f(x) + d$, $f(x - c)$, and $f(bx)$ for values of a, b, c, d. • **A.8A** Solve quadratic equations having real solutions by factoring, taking square roots, completing the square, and applying the quadratic formula. • **A.8B** Write, using technology, quadratic functions that provide a reasonable fit to data to estimate solutions and make predictions for real-world problems. **A.11A** Simplify numerical radical expressions involving square roots.	• **2A.2A** Graph the functions $f(x) = \sqrt{x}$, ~~$f(x) = 1/x$~~, ~~$f(x) = x^3$~~, ~~$f(x) = \sqrt[3]{x}$~~, ~~$f(x) = b^x$~~, ~~$f(x) = \lvert x \rvert$~~, and ~~$f(x) = \log_b(x)$ where b is 2, 10, and e~~, and, when applicable, analyze the key attributes such as domain, range, intercepts, symmetries, asymptotic behavior, and maximum and minimum given an interval. • **2A.4C** Determine the effects on the graph of $f(x) = \sqrt{x}$ when $f(x)$ is replaced by $af(x)$, $f(x) + d$, $f(bx)$, and $f(x - c)$ for specific positive and negative values of a, b, c, and d. • **2A.4F** Solve ~~quadratic and~~ square root equations. • **2A.4H** Solve ~~quadratic~~ square root inequalities. • **2A.8B** Use regression methods available through technology to write a ~~quadratic~~ square root function from a given set of data.	• **(2.G)** Graph functions, including exponential, logarithmic, sine, cosine, rational, polynomial, and power functions and their transformations, including $af(x)$, $f(x) + d$, $f(x - c)$, $f(bx)$ for specific values of a, b, c, and d in mathematical and real-world problems. • **(2.I)** Determine and analyze the key features of exponential, logarithmic, rational, polynomial, power, trigonometric, inverse trigonometric, and piecewise defined functions, including step functions such as domain, range, symmetry, relative maximum, relative minimum, zeros, asymptotes, and intervals over which the function is increasing or decreasing. • **(5.J)** Solve polynomial equations with real coefficients by applying a variety of techniques in mathematical and real-world problems. • **(5.K)** Solve polynomial inequalities with real coefficients by applying a variety of techniques and write the solution set of the rational inequality in interval notation in mathematical and real-world problems.