



# Township of Ocean Schools

Assistant Superintendent  
Office of Teaching and Learning

## **SPARTAN MISSION:**

*Meeting the needs of all students with a proud tradition of academic excellence.*

DEPARTMENT Mathematics

COURSE Pre AP Algebra II

### Curriculum Development Timeline

**School:** Ocean Township High School

**Course:** Pre-AP Algebra II

**Department:** Mathematics

| Board Approval | Supervisor      | Notes                             |
|----------------|-----------------|-----------------------------------|
| July 2008      | Janet Bluefield | Born Date                         |
| July 2012      | Janet Bluefield | Revisions                         |
| August 2017    | Nichole Kerney  | Revisions                         |
| March 2019     | Nichole Kerney  | Review                            |
| August 2022    | Gerard Marrone  | Alignment to Standards            |
| August 2025    | Greg Colon      | Alignment to Standards            |
| August 2026    | Greg Colon      | Alignment to Standards & Revision |

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| Township of Ocean Pacing Guide |                                                        |      |                                       |
|--------------------------------|--------------------------------------------------------|------|---------------------------------------|
| Week                           | Marking Period 1                                       | Week | Marking Period 3                      |
| 1                              | Recognizing Linear, Quadratic, & Exponential Functions | 22   | Exponential & Logarithmic Functions   |
| 2                              | Making Predictions & Evaluating with Linear Models     | 23   | Polynomial Functions                  |
| 3                              | Modeling Non-Linear Data with Exponential Functions    | 24   | Polynomial Functions                  |
| 4                              | Modeling Data with Quadratic Functions                 | 25   | Polynomial Functions                  |
| 5                              | Modeling Data with Quadratic Functions                 | 26   | Polynomial Functions                  |
| 6                              | Rate of Change                                         | 27   | Polynomial Functions                  |
| 7                              | Piecewise Functions                                    | 28   | Polynomial Functions                  |
| 8                              | Function Compositions                                  | 29   | Rational Functions                    |
| 9                              | Function Compositions                                  | 30   | Rational Functions                    |
| 10                             | Function Compositions                                  | 31   | Rational Functions                    |
| Week                           | Marking Period 2                                       | Week | Marking Period 4                      |
| 11                             | Transformations                                        | 32   | Rational Functions                    |
| 12                             | Transformations                                        | 33   | Rational Functions                    |
| 13                             | Inverting Functions                                    | 34   | Square & Cube Root Functions          |
| 14                             | Inverting Functions                                    | 35   | Square & Cube Root Functions          |
| 15                             | Exponential & Logarithmic Functions                    | 36   | Radian Measure & Sinusoidal Functions |
| 16                             | Exponential & Logarithmic Functions                    | 37   | Radian Measure & Sinusoidal           |

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|    |                                     |    |                                                   |
|----|-------------------------------------|----|---------------------------------------------------|
|    |                                     |    | Functions                                         |
| 17 | Exponential & Logarithmic Functions | 38 | Radian Measure & Sinusoidal Functions             |
| 18 | Exponential & Logarithmic Functions | 39 | Radian Measure & Sinusoidal Functions             |
| 19 | Exponential & Logarithmic Functions | 40 | Tangent Functions & Other Trigonometric Functions |
| 20 | Exponential & Logarithmic Functions | 41 | Tangent Functions & Other Trigonometric Functions |
| 21 | Exponential & Logarithmic Functions | 42 | Inverting Trigonometric Functions                 |

### Core Instructional & Supplemental Materials including various levels of Texts

Core Instruction: Big Ideas Algebra II Textbook and Ebook (Cengage) & College Board Pre-AP Algebra 2

Supplemental: IXL, NJGPA Released Questions, Desmos

Special Education and ELL Supplemental: Video Tutor-bigideasmath.com

|                                                                                                                                                                                                                                     |                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| Time Frame                                                                                                                                                                                                                          | 1 cycle (3 ~ 56 minute blocks) |
| Topic                                                                                                                                                                                                                               |                                |
| Recognizing Linear, Quadratic, and Exponential Relationships                                                                                                                                                                        |                                |
| Alignment to Standards                                                                                                                                                                                                              |                                |
| <b>F.IF.4 – Interpret Functions That Arise in Applications in Terms of the Context</b><br>For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities. |                                |
| <b>F.IF.5 – Interpret Functions That Arise in Applications in Terms of the Context</b><br>Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.                        |                                |
| <b>F.IF.6 – Interpret Functions That Arise in Applications in Terms of the Context</b><br>Calculate and interpret the average rate of change of a function over a specified interval.                                               |                                |

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### **F.IF.7a – Analyze Functions Using Different Representations**

Graph linear and quadratic functions and show intercepts, maxima, and minima.

### **F.IF.8b – Analyze Functions Using Different Representations**

Use the properties of exponents to interpret expressions for exponential functions.

### **F.IF.9 – Compare Properties of Two Functions Each Represented in a Different Way**

Compare properties of two functions represented algebraically, graphically, numerically, or verbally.

### **F.BF.1 – Build a Function That Models a Relationship Between Two Quantities**

Write a function that describes a relationship between two quantities.

### **F.LE.1 – Distinguish Between Situations That Can Be Modeled with Linear and Exponential Functions**

Distinguish between situations that can be modeled with linear functions and with exponential functions.

### **F.LE.2 – Construct Linear and Exponential Functions**

Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, description, or input-output pairs.

### **F.LE.3 – Observe Using Graphs and Tables That a Quantity Increasing Exponentially Eventually Exceeds a Quantity Increasing Linearly or Quadratically**

### **A.CED.2 – Create Equations That Describe Numbers or Relationships**

Create equations in two or more variables to represent relationships between quantities.

### **A.SSE.1a – Interpret the Structure of Expressions**

Interpret parts of an expression in terms of context.

## Learning Objectives and Activities

### **SWBAT answer the following questions:**

- How can patterns in tables, graphs, and equations help identify different function families?
- What characteristics distinguish linear, quadratic, and exponential relationships?
- How does the rate of change differ among linear, quadratic, and exponential functions?
- Why is it important to represent functions in multiple ways?
- How can real-world situations be modeled using different types of functions?
- How do graphs reveal important information about a function's behavior?

### **SWBAT demonstrate understanding of the following:**

- Linear relationships have a constant rate of change.
- Quadratic relationships have a constant second difference and form parabolas.
- Exponential relationships involve repeated multiplication and constant ratios.
- Functions can be represented verbally, numerically, graphically, and algebraically.
- Different families of functions model different real-world situations.
- Tables, graphs, and equations provide different perspectives for analyzing relationships.





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- Comparing rates of change helps determine the most appropriate model for a situation.
- Exponential growth eventually exceeds linear and quadratic growth.

### **Learning Activities:**

- Review prerequisite function vocabulary and representations
- CBL Activity – Match tables, graphs, and equations to function families
- Desmos exploration comparing linear, quadratic, and exponential graphs
- Analyze real-world scenarios and determine best-fit function types
- Use graphing calculators to compare rates of change
- Create tables to identify first differences, second differences, and common ratios
- Card sort activity: identify characteristics of each function family
- Small-group analysis of multiple representations of functions
- Dry erase board practice identifying functions from graphs and tables

### **Assessments**

#### **Formative:**

- Classwork
- Teacher Observation
- Entrance/Exit Tickets
- Function Identification Practice
- Group Discussions

#### **Summative:**

- Mid-unit Quiz
- Topic Test
- Performance Task Comparing Function Families

#### **Alternative:**

- Desmos Activity Summary
- Kahoot/Quizizz
- Create a real-world scenario modeled by each function family

### **Interdisciplinary Connections**

#### **Science:**

**HS-LS2-1** – Use mathematical representations to support explanations of factors affecting populations.

Students analyze linear, quadratic, and exponential growth models in population studies and environmental science.

#### **ELA:**

**NJSLSA.W2** – Write informative/explanatory texts to examine and convey ideas clearly.

Students explain how different functions model real-world situations and justify why a model is appropriate.

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**SL.11-12.1** – Initiate and participate effectively in collaborative discussions.  
Students compare and defend reasoning when classifying functions and interpreting data.

### Career Readiness, Life Literacies, and Key Skills

#### **9.4.12.CI.2:**

Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

#### **9.4.12.CT.2:**

Develop multiple solutions to a problem and evaluate short- and long-term impacts of each.

### Technology Integration

All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaboratively and to create and communicate knowledge.

**9.4.8.TL.6:** Collaborate to develop and publish work that provides perspectives on a real-world problem.

Students will access the Big Ideas online ebook and Desmos activities to investigate characteristics of functions.

**9.4.8.TL.3:** Select appropriate tools to organize and present information digitally.

Students will use Quizizz, Kahoot, and Quizlet Live to reflect on understanding of function families.

**9.4.5.CT.3:** Describe how digital tools and technology may be used to solve problems.

Supplemental instruction and math games will be presented using IXL Math and Video Tutor.

**9.4.12.TL.1:** Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task.

Students will use Google Classroom and collaborative platforms to analyze and compare functions.

**9.4.12.TL.4:** Collaborate in online learning communities or virtual worlds to analyze and propose a resolution to a real-world problem.

Students will use graphing calculators and Desmos to compare behaviors of linear, quadratic, and exponential models.

**9.4.8.IML.3:** Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping.

### Career Education

**9.4.12.CI.1:** Demonstrate use of technical knowledge and skills.

**9.4.12.CT.2:** Explain the value of academic and technical skills in the workplace.

**9.4.12.TL.3:** Use digital tools to enhance productivity.

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**9.4.12.IML.5:** Evaluate and select digital tools for effective communication and collaboration.

|                                                                                                                                                                                                                                                    |                                |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| Time Frame                                                                                                                                                                                                                                         | 1 cycle (3 ~ 56 minute blocks) |
| Topic                                                                                                                                                                                                                                              |                                |
| Making Predictions & Evaluating with Linear Models                                                                                                                                                                                                 |                                |
| Alignment to Standards                                                                                                                                                                                                                             |                                |
| <b>F.IF.4 – Interpreting Functions</b><br><b>Standard:</b> For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities.                                               |                                |
| <b>F.IF.5 – Interpreting Functions</b><br><b>Standard:</b> Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.                                                                      |                                |
| <b>F.IF.6 – Interpreting Functions</b><br><b>Standard:</b> Calculate and interpret the average rate of change of a function over a specified interval; estimate the rate of change from a graph.                                                   |                                |
| <b>F.IF.9 – Interpreting Functions</b><br><b>Standard:</b> Compare properties of two functions represented in different ways (algebraically, graphically, numerically in tables, or by verbal descriptions).                                       |                                |
| <b>F.LE.1b – Linear, Quadratic, and Exponential Models</b><br><b>Standard:</b> Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.                                                        |                                |
| <b>F.LE.2 – Linear, Quadratic, and Exponential Models</b><br><b>Standard:</b> Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs. |                                |
| <b>F.LE.5 – Linear, Quadratic, and Exponential Models</b><br><b>Standard:</b> Interpret the parameters in a linear or exponential function in terms of a context.                                                                                  |                                |
| <b>A.CED.2 – Creating Equations</b><br><b>Standard:</b> Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.                                        |                                |
| <b>S.ID.6a–c – Interpreting Categorical and Quantitative Data</b>                                                                                                                                                                                  |                                |

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**Standard:** Represent data on two quantitative variables and describe how the variables are related.

### **S.ID.7 – Interpreting Categorical and Quantitative Data**

**Standard:** Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

### **S.ID.8 – Interpreting Categorical and Quantitative Data**

**Standard:** Compute and interpret the correlation coefficient of a linear fit.

### **S.ID.9 – Interpreting Categorical and Quantitative Data**

**Standard:** Distinguish between correlation and causation.

## Learning Objectives and Activities

### **SWBAT answer the following questions:**

- How can linear models be used to make predictions?
- When is a linear model appropriate for representing data?
- How can trends in scatter plots help determine relationships between variables?
- What are the limitations of using a linear model?
- How does correlation help evaluate the strength of a linear relationship?
- Why is extrapolation sometimes unreliable?

### **SWBAT demonstrate understanding of the following:**

- Linear models can describe relationships between two variables and be used to make predictions.
- Scatter plots can reveal patterns, trends, and associations in data.
- Correlation measures the strength and direction of a linear relationship.
- A line of best fit can be used to estimate values within a reasonable domain.
- Interpolation is generally more reliable than extrapolation.
- Not all relationships are linear, and models must be evaluated for reasonableness.
- Context is essential when interpreting slope, intercepts, and predictions.

### **Learning Activities:**

- Analyze scatter plots to determine if a linear model is appropriate
- Use graphing calculators or Desmos to generate lines of best fit
- Compare strong, weak, positive, negative, and no correlation data sets
- Predict values using equations and graphs of linear models
- Discuss interpolation vs. extrapolation using real-world examples
- CBL Activity – “Which Model Fits Best?”
- Interpret slope and y-intercept in context
- Use residuals informally to evaluate model fit
- Group activity evaluating whether predictions are reasonable

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### Assessments

#### **Formative:**

- Classwork
- Teacher Observation
- Entrance/Exit Tickets
- Scatter Plot Analysis
- Small Group Discussions

#### **Summative:**

- Mid-unit Quiz
- Topic Test
- Real-World Modeling Task

#### **Alternative:**

- Desmos Modeling Activity
- Kahoot/Quizizz
- Create and analyze a real-world scatter plot using collected data

### Interdisciplinary Connections

#### **Science:**

**HS-ETS1-3** – Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs.

Students use linear models to analyze scientific data such as temperature trends, speed, or population growth.

#### **ELA:**

**NJSLSA.W2** – Write informative/explanatory texts to examine and convey ideas clearly.

Students explain conclusions drawn from data and justify the appropriateness of linear models.

**SL.11-12.1** – Initiate and participate effectively in collaborative discussions.

Students discuss and critique predictions and interpretations from statistical models.

### Career Readiness, Life Literacies, and Key Skills

#### **9.4.12.CI.2:**

Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

#### **9.4.12.CT.2:**

Develop multiple solutions to a problem and evaluate short- and long-term impacts of each.

### Technology Integration

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All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaboratively and to create and communicate knowledge.

**9.4.8.TL.6:** Collaborate to develop and publish work that provides perspectives on a real-world problem.

Students will use Desmos and graphing technology to create and analyze linear regression models.

**9.4.8.TL.3:** Select appropriate tools to organize and present information digitally.

Students will use Quizizz, Kahoot, and collaborative digital platforms to reflect on understanding of linear modeling.

**9.4.5.CT.3:** Describe how digital tools and technology may be used to solve problems.

Supplemental practice and modeling activities will be completed using IXL and online graphing tools.

**9.4.12.TL.1:** Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task.

Students will use Google Classroom and spreadsheet software to organize and interpret data.

**9.4.12.TL.4:** Collaborate in online learning communities or virtual worlds to analyze and propose a resolution to a real-world problem.

Students will use graphing calculators and Desmos to evaluate the effectiveness of linear models.

**9.4.8.IML.3:** Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping.

### Career Education

**9.4.12.CI.1:** Demonstrate use of technical knowledge and skills.

**9.4.12.CT.2:** Explain the value of academic and technical skills in the workplace.

**9.4.12.TL.3:** Use digital tools to enhance productivity.

**9.4.12.IML.5:** Evaluate and select digital tools for effective communication and collaboration.

Time Frame

1 cycle (3 ~ 56 minute blocks)

Topic

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### Modeling Nonlinear Data with Exponential Functions

#### Alignment to Standards

##### **N.Q.1 – Reason Quantitatively and Use Units to Solve Problems**

Use units as a way to understand problems and guide the solution of multi-step problems.

##### **N.Q.2 – Reason Quantitatively and Use Units to Solve Problems**

Define appropriate quantities for descriptive modeling.

##### **F.IF.4 – Interpret Functions That Arise in Applications in Terms of the Context**

Interpret key features of graphs and tables in terms of the quantities represented.

##### **F.IF.5 – Interpret Functions That Arise in Applications in Terms of the Context**

Relate the domain of a function to its graph and the quantitative relationship it describes.

##### **F.IF.6 – Interpret Functions That Arise in Applications in Terms of the Context**

Calculate and interpret the average rate of change of a function over a specified interval.

##### **F.IF.7e – Analyze Functions Using Different Representations**

Graph exponential functions, showing intercepts and end behavior.

##### **F.IF.8b – Analyze Functions Using Different Representations**

Use the properties of exponents to interpret exponential expressions.

##### **F.IF.9 – Compare Properties of Two Functions Represented in Different Ways**

Compare properties of functions represented algebraically, graphically, numerically, or verbally.

##### **F.BF.1 – Build a Function That Models a Relationship Between Two Quantities**

Write a function that describes a relationship between two quantities.

##### **F.LE.1 – Distinguish Between Situations That Can Be Modeled with Linear and Exponential Functions**

Distinguish between situations modeled with linear functions and exponential functions.

##### **F.LE.2 – Construct Linear and Exponential Functions**

Construct exponential functions given a graph, description, table, or input-output pairs.

##### **F.LE.3 – Observe Using Graphs and Tables That a Quantity Increasing Exponentially Eventually Exceeds a Quantity Increasing Linearly or Quadratically**

##### **A.CED.2 – Create Equations That Describe Numbers or Relationships**

Create equations in two or more variables to represent relationships between quantities.

##### **S.ID.6a – Summarize, Represent, and Interpret Data on Two Quantitative Variables**

Fit functions to data and use functions fitted to data to solve problems in context.

#### Learning Objectives and Activities

##### **SWBAT answer the following questions:**

- How can exponential functions model nonlinear data?

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- What characteristics distinguish exponential models from linear models?
- How can tables, graphs, and equations reveal exponential behavior?
- When is an exponential model more appropriate than a linear model?
- How does the growth or decay factor affect the graph of an exponential function?
- Why do exponential models change more rapidly over time?

### **SWBAT demonstrate understanding of the following:**

- Exponential relationships involve repeated multiplication and constant ratios.
- Exponential growth and decay can model real-world phenomena such as population growth, depreciation, and compound interest.
- Exponential functions can be represented verbally, numerically, graphically, and algebraically.
- Nonlinear data patterns often indicate exponential behavior rather than linear behavior.
- Graphs and tables help determine whether a model is exponential.
- The growth factor determines whether an exponential function represents growth or decay.
- Exponential growth eventually exceeds linear growth.

### **Learning Activities:**

- Analyze tables to identify constant ratios and exponential behavior
- Compare linear and exponential models using graphs and real-world data
- Use graphing calculators or Desmos to generate exponential regression models
- CBL Activity – Modeling population growth or viral trends
- Match graphs, equations, and tables representing exponential relationships
- Interpret parameters in exponential equations in context
- Investigate exponential growth and decay scenarios
- Dry erase board practice identifying nonlinear data patterns
- Use Desmos sliders to explore how changing parameters affects exponential graphs

### **Assessments**

#### **Formative:**

- Classwork
- Teacher Observation
- Entrance/Exit Tickets
- Graph and Table Analysis
- Group Discussions

#### **Summative:**

- Mid-unit Quiz
- Topic Test

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- Real-World Exponential Modeling Task

### **Alternative:**

- Desmos Activity Summary
- Kahoot/Quizizz
- Create and present a real-world example of exponential growth or decay

### Interdisciplinary Connections

#### **Science:**

**HS-LS2-1** – Use mathematical representations to support explanations of factors affecting populations and ecosystems.

Students model population growth, radioactive decay, and spread of disease using exponential functions.

#### **ELA:**

**NJSLSA.W2** – Write informative/explanatory texts to examine and convey ideas clearly.

Students explain why an exponential model best represents a given situation.

**SL.11-12.1** – Initiate and participate effectively in collaborative discussions.

Students discuss and defend reasoning when selecting appropriate mathematical models.

### Career Readiness, Life Literacies, and Key Skills

#### **9.4.12.CI.2:**

Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

#### **9.4.12.CT.2:**

Develop multiple solutions to a problem and evaluate short- and long-term impacts of each.

### Technology Integration

All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaboratively and to create and communicate knowledge.

**9.4.8.TL.6:** Collaborate to develop and publish work that provides perspectives on a real-world problem.

Students will use Desmos and graphing technology to analyze exponential models and nonlinear data.

**9.4.8.TL.3:** Select appropriate tools to organize and present information digitally.

Students will use Quizizz, Kahoot, and collaborative digital tools to reinforce understanding of exponential relationships.





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**9.4.5.CT.3:** Describe how digital tools and technology may be used to solve problems.

Supplemental instruction and online modeling activities will be completed using IXL and Big Ideas Math resources.

**9.4.12.TL.1:** Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task.

Students will use Google Classroom and graphing technology to interpret nonlinear data and exponential models.

**9.4.12.TL.4:** Collaborate in online learning communities or virtual worlds to analyze and propose a resolution to a real-world problem.

Students will use graphing calculators and Desmos to compare exponential and linear models.

**9.4.8.IML.3:** Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping.

### Career Education

**9.4.12.CI.1:** Demonstrate use of technical knowledge and skills.

**9.4.12.CT.2:** Explain the value of academic and technical skills in the workplace.

**9.4.12.TL.3:** Use digital tools to enhance productivity.

**9.4.12.IML.5:** Evaluate and select digital tools for effective communication and collaboration.

|                                                                                                                                                                                        |                                 |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| Time Frame                                                                                                                                                                             | 2 cycles (6 ~ 56 minute blocks) |
| Topic                                                                                                                                                                                  |                                 |
| Modeling Data with Quadratic Functions                                                                                                                                                 |                                 |
| Alignment to Standards                                                                                                                                                                 |                                 |
| <b>N.Q.1 – Reason Quantitatively and Use Units to Solve Problems</b><br>Use units as a way to understand problems and guide the solution of multi-step problems.                       |                                 |
| <b>N.Q.2 – Reason Quantitatively and Use Units to Solve Problems</b><br>Define appropriate quantities for descriptive modeling.                                                        |                                 |
| <b>F.IF.4 – Interpret Functions That Arise in Applications in Terms of the Context</b><br>Interpret key features of graphs and tables in terms of the quantities represented.          |                                 |
| <b>F.IF.5 – Interpret Functions That Arise in Applications in Terms of the Context</b><br>Relate the domain of a function to its graph and the quantitative relationship it describes. |                                 |

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### **F.IF.6 – Interpret Functions That Arise in Applications in Terms of the Context**

Calculate and interpret the average rate of change of a function over a specified interval.

### **F.IF.7a – Analyze Functions Using Different Representations**

Graph quadratic functions and show intercepts, maxima, and minima.

### **F.IF.8a – Analyze Functions Using Different Representations**

Use the process of factoring and completing the square to show zeros, extreme values, and symmetry of the graph.

### **F.IF.9 – Compare Properties of Two Functions Represented in Different Ways**

Compare properties of functions represented algebraically, graphically, numerically, or verbally.

### **F.BF.1 – Build a Function That Models a Relationship Between Two Quantities**

Write a function that describes a relationship between two quantities.

### **F.BF.3 – Build New Functions from Existing Functions**

Identify the effect on the graph of replacing  $f(x)$  with  $f(x)+k$ ,  $kf(x)$ ,  $f(kx)$ , and  $f(x+k)$ .

### **A.CED.2 – Create Equations That Describe Numbers or Relationships**

Create equations in two or more variables to represent relationships between quantities.

### **A.SSE.3a – Write Expressions in Equivalent Forms to Solve Problems**

Factor quadratic expressions to reveal zeros of the function.

### **A.REI.4b – Solve Quadratic Equations in One Variable**

Solve quadratic equations by inspection, factoring, completing the square, and the quadratic formula.

### **S.ID.6a – Summarize, Represent, and Interpret Data on Two Quantitative Variables**

Fit functions to data and use functions fitted to data to solve problems in context.

## Learning Objectives and Activities

### **SWBAT answer the following questions:**

- How can quadratic functions model real-world situations?
- What characteristics distinguish quadratic models from linear and exponential models?
- How do tables, graphs, and equations reveal quadratic behavior?
- What do the vertex, axis of symmetry, and intercepts represent in context?
- How can quadratic models be used to make predictions?
- Why is it important to evaluate whether a quadratic model is appropriate?

### **SWBAT demonstrate understanding of the following:**

- Quadratic relationships produce curved graphs called parabolas.
- Quadratic functions have a constant second difference in tables.
- Key features such as the vertex, maximum/minimum values, intercepts, and axis of symmetry provide important contextual information.

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COURSE Pre AP Algebra II

- Quadratic models can represent projectile motion, revenue optimization, area relationships, and other real-world phenomena.
- Functions can be represented verbally, numerically, graphically, and algebraically.
- Different forms of quadratic equations reveal different characteristics of the graph.
- Modeling involves selecting and evaluating the most appropriate function type for a given data set.

### **Learning Activities:**

- Analyze tables to identify constant second differences
- Use graphing calculators or Desmos to generate quadratic regression models
- Compare linear, exponential, and quadratic models using real-world data
- CBL Activity – Modeling projectile motion or revenue optimization
- Match graphs, equations, and tables representing quadratic relationships
- Investigate the meaning of the vertex and intercepts in context
- Use transformations to explore changes in quadratic graphs
- Dry erase board practice identifying characteristics of quadratic functions
- Use Desmos sliders to explore how parameters affect quadratic graphs
- Solve real-world modeling problems involving maximums and minimums

### Assessments

#### **Formative:**

- Classwork
- Teacher Observation
- Entrance/Exit Tickets
- Graph and Table Analysis
- Group Discussions

#### **Summative:**

- Mid-unit Quiz
- Topic Test
- Quadratic Modeling Performance Task

#### **Alternative:**

- Desmos Activity Summary
- Kahoot/Quizizz
- Create and analyze a real-world scenario modeled by a quadratic function

### Interdisciplinary Connections

#### **Science:**

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**HS-PS2-1** – Analyze data to support the claim that Newton’s Second Law of Motion describes the mathematical relationship among forces, mass, and acceleration.  
Students model projectile motion and other physical phenomena using quadratic functions.

**ELA:**

**NJSLSA.W2** – Write informative/explanatory texts to examine and convey ideas clearly.  
Students explain how quadratic models represent real-world situations and justify conclusions drawn from graphs and equations.

**SL.11-12.1** – Initiate and participate effectively in collaborative discussions.  
Students discuss and defend strategies used to model data with quadratic functions.

### Career Readiness, Life Literacies, and Key Skills

**9.4.12.CI.2:**

Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

**9.4.12.CT.2:**

Develop multiple solutions to a problem and evaluate short- and long-term impacts of each.

### Technology Integration

All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaboratively and to create and communicate knowledge.

**9.4.8.TL.6:** Collaborate to develop and publish work that provides perspectives on a real-world problem.

Students will use Desmos and graphing technology to investigate quadratic models and nonlinear data.

**9.4.8.TL.3:** Select appropriate tools to organize and present information digitally.

Students will use Quizizz, Kahoot, and collaborative digital platforms to reinforce understanding of quadratic functions.

**9.4.5.CT.3:** Describe how digital tools and technology may be used to solve problems.

Supplemental instruction and online modeling activities will be completed using IXL and Big Ideas Math resources.

**9.4.12.TL.1:** Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task.

Students will use Google Classroom and graphing technology to interpret quadratic models and data.

**9.4.12.TL.4:** Collaborate in online learning communities or virtual worlds to analyze and propose a resolution to a real-world problem.

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Students will use graphing calculators and Desmos to compare quadratic, linear, and exponential models.

**9.4.8.IML.3:** Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping.

### Career Education

**9.4.12.CI.1:** Demonstrate use of technical knowledge and skills.

**9.4.12.CT.2:** Explain the value of academic and technical skills in the workplace.

**9.4.12.TL.3:** Use digital tools to enhance productivity.

**9.4.12.IML.5:** Evaluate and select digital tools for effective communication and collaboration.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| Time Frame                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 1 cycle (3 ~ 56 minute blocks) |
| Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                |
| Rate of Change                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                |
| Alignment to Standards                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                |
| <p><b>N.Q.2 – Reason Quantitatively and Use Units to Solve Problems</b><br/>Define appropriate quantities for descriptive modeling.</p> <p><b>F.IF.4 – Interpret Functions That Arise in Applications in Terms of the Context</b><br/>Interpret key features of graphs and tables in terms of the quantities represented.</p> <p><b>F.IF.5 – Interpret Functions That Arise in Applications in Terms of the Context</b><br/>Relate the domain of a function to its graph and the quantitative relationship it describes.</p> <p><b>F.IF.6 – Interpret Functions That Arise in Applications in Terms of the Context</b><br/>Calculate and interpret the average rate of change of a function over a specified interval.</p> <p><b>F.IF.7 – Analyze Functions Using Different Representations</b><br/>Graph functions expressed symbolically and show key features of the graph.</p> <p><b>F.IF.9 – Compare Properties of Two Functions Represented in Different Ways</b><br/>Compare properties of functions represented algebraically, graphically, numerically, or verbally.</p> <p><b>F.BF.1 – Build a Function That Models a Relationship Between Two Quantities</b><br/>Write a function that describes a relationship between two quantities.</p> <p><b>A.CED.2 – Create Equations That Describe Numbers or Relationships</b><br/>Create equations in two or more variables to represent relationships between quantities.</p> |                                |

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COURSE Pre AP Algebra II

### **S.ID.6a – Summarize, Represent, and Interpret Data on Two Quantitative Variables**

Fit functions to data and use functions fitted to data to solve problems in context.

#### Learning Objectives and Activities

##### **SWBAT answer the following questions:**

- What does rate of change represent in a real-world context?
- How can average rate of change be calculated from graphs, tables, and equations?
- How does the rate of change differ among linear, quadratic, and exponential functions?
- Why is the rate of change constant for linear functions but not for nonlinear functions?
- How can rates of change help compare different functions and models?
- How can graphical behavior help interpret increasing and decreasing rates of change?

##### **SWBAT demonstrate understanding of the following:**

- Rate of change measures how one quantity changes relative to another.
- Linear functions have a constant rate of change.
- Quadratic and exponential functions have changing rates of change.
- Average rate of change can be calculated using function values over an interval.
- Tables, graphs, equations, and verbal descriptions can all represent rates of change.
- Rates of change provide insight into patterns, trends, and real-world behavior.
- Interpreting units is essential when analyzing rates of change in context.

##### **Learning Activities:**

- Calculate average rate of change from tables, graphs, and equations
- Compare rates of change for linear, quadratic, and exponential functions
- Use graphing calculators or Desmos to explore changing slopes on graphs
- CBL Activity – Compare motion scenarios using distance-time graphs
- Analyze real-world situations involving speed, population growth, or cost changes
- Match graphs and tables based on rate of change behavior
- Dry erase board practice identifying constant versus changing rates of change
- Use Desmos sliders to investigate how parameters affect rates of change
- Group discussions interpreting rate of change in context

#### Assessments

##### Formative:

- Classwork
- Teacher Observation
- Entrance/Exit Tickets

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- Graph and Table Analysis
- Group Discussions

Summative:

- Mid-unit Quiz
- Topic Test
- Real-World Rate of Change Modeling Task

Alternative:

- Desmos Activity Summary
- Kahoot/Quizizz
- Create and analyze a real-world example involving average rate of change

### Interdisciplinary Connections

**Science:**

**HS-PS2-1** – Analyze data to support claims regarding relationships among force, motion, and acceleration.

Students analyze rates of change in motion, velocity, and acceleration scenarios.

**ELA:**

**NJSLSA.W2** – Write informative/explanatory texts to examine and convey ideas clearly.

Students explain the meaning of rates of change and justify conclusions drawn from mathematical models.

**SL.11-12.1** – Initiate and participate effectively in collaborative discussions.

Students discuss and critique interpretations of graphical and numerical data.

### Career Readiness, Life Literacies, and Key Skills

**9.4.12.CI.2:**

Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

**9.4.12.CT.2:**

Develop multiple solutions to a problem and evaluate short- and long-term impacts of each.

### Technology Integration

All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaboratively and to create and communicate knowledge.

**9.4.8.TL.6:** Collaborate to develop and publish work that provides perspectives on a real-world problem.

Students will use Desmos and graphing technology to investigate rates of change in multiple function families.

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COURSE Pre AP Algebra II

**9.4.8.TL.3:** Select appropriate tools to organize and present information digitally.

Students will use Quizizz, Kahoot, and collaborative digital platforms to reinforce understanding of rates of change.

**9.4.5.CT.3:** Describe how digital tools and technology may be used to solve problems.

Supplemental instruction and online activities will be completed using IXL and Big Ideas Math resources.

**9.4.12.TL.1:** Assess digital tools based on accessibility options, capacities, and utility for accomplishing a specified task.

Students will use Google Classroom and graphing technology to analyze and interpret rates of change.

**9.4.12.TL.4:** Collaborate in online learning communities or virtual worlds to analyze and propose a resolution to a real-world problem.

Students will use graphing calculators and Desmos to compare rates of change among different function families.

**9.4.8.IML.3:** Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping.

### Career Education

**9.4.12.CI.1:** Demonstrate use of technical knowledge and skills.

**9.4.12.CT.2:** Explain the value of academic and technical skills in the workplace.

**9.4.12.TL.3:** Use digital tools to enhance productivity.

**9.4.12.IML.5:** Evaluate and select digital tools for effective communication and collaboration.

|                        |                                |
|------------------------|--------------------------------|
| Time Frame             | 1 cycle (3 ~ 56 minute blocks) |
| Topic                  |                                |
| Piecewise Functions    |                                |
| Alignment to Standards |                                |

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### **N.Q.1 – Reason Quantitatively and Use Units to Solve Problems**

Use units as a way to understand problems and guide the solution of multi-step problems.

### **N.Q.2 – Reason Quantitatively and Use Units to Solve Problems**

Define appropriate quantities for descriptive modeling.

### **F.IF.1 – Understand the Concept of a Function and Use Function Notation**

Understand that a function assigns to each element of the domain exactly one element of the range.

### **F.IF.2 – Understand the Concept of a Function and Use Function Notation**

Use function notation, evaluate functions for inputs in their domains, and interpret statements using function notation in context.

### **F.IF.4 – Interpret Functions That Arise in Applications in Terms of the Context**

Interpret key features of graphs and tables in terms of the quantities represented.

### **F.IF.5 – Interpret Functions That Arise in Applications in Terms of the Context**

Relate the domain of a function to its graph and the quantitative relationship it describes.

### **F.IF.6 – Interpret Functions That Arise in Applications in Terms of the Context**

Calculate and interpret the average rate of change of a function over a specified interval.

### **F.IF.7 – Analyze Functions Using Different Representations**

Graph functions expressed symbolically and show key features of the graph.

### **F.IF.9 – Compare Properties of Two Functions Represented in Different Ways**

Compare properties of functions represented algebraically, graphically, numerically, or verbally.

### **F.BF.1 – Build a Function That Models a Relationship Between Two Quantities**

Write a function that describes a relationship between two quantities.

### **A.CED.2 – Create Equations That Describe Numbers or Relationships**

Create equations in two or more variables to represent relationships between quantities.

### **A.REI.11 – Represent and Solve Equations and Inequalities Graphically**

Explain why the x-coordinates of the points where graphs intersect are solutions to equations.

## Learning Objectives and Activities

### **SWBAT answer the following questions:**

- How can piecewise functions model real-world situations with changing conditions?
- How are domains used to determine which rule applies in a piecewise function?
- How can piecewise functions be represented graphically, numerically, verbally, and algebraically?
- What do open and closed circles represent on graphs of piecewise functions?
- How can rates of change vary across different pieces of a function?
- Why are piecewise functions useful for modeling real-world data?

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### **SWBAT demonstrate understanding of the following:**

- Piecewise functions use different rules over different intervals of the domain.
- Domains determine which equation applies for a given input value.
- Piecewise functions can model situations involving changing rates or conditions.
- Graphs of piecewise functions may contain discontinuities or changing behaviors.
- Multiple representations help analyze and interpret piecewise functions.
- Real-world contexts often require more than one equation to accurately model behavior.
- Open and closed endpoints communicate inclusion or exclusion in intervals.

### **Learning Activities:**

- Evaluate piecewise functions for given input values
- Graph piecewise functions by identifying domains and endpoints
- Interpret real-world piecewise models such as taxi fares, shipping costs, or cell phone plans
- CBL Activity – Analyze tiered pricing structures using piecewise equations
- Match graphs, equations, tables, and verbal descriptions of piecewise functions
- Use graphing calculators or Desmos to explore piecewise graphs
- Dry erase board practice graphing and evaluating piecewise functions
- Compare rates of change across different intervals
- Create piecewise models from real-world scenarios

### **Assessments**

#### **Formative:**

- Classwork
- Teacher Observation
- Entrance/Exit Tickets
- Graph and Equation Analysis
- Group Discussions

#### **Summative:**

- Mid-unit Quiz
- Topic Test
- Piecewise Modeling Performance Task

#### **Alternative:**

- Desmos Activity Summary
- Kahoot/Quizizz
- Create and present a real-world piecewise function model

### **Interdisciplinary Connections**

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### **Science:**

**HS-PS3-1** (Energy) – Create computational models to calculate changes in energy.

### **ELA:**

**NJSLSA.W2** – Write informative/explanatory texts to examine and convey ideas clearly.  
Students explain how piecewise functions represent changing conditions in real-world contexts.

**SL.11-12.1** – Initiate and participate effectively in collaborative discussions.  
Students discuss and defend reasoning used to analyze and graph piecewise functions.

### Career Readiness, Life Literacies, and Key Skills

#### **9.4.12.CI.2:**

Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

#### **9.4.12.CT.2:**

Develop multiple solutions to a problem and evaluate short- and long-term impacts of each.

### Technology Integration

All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaboratively and to create and communicate knowledge.

**9.4.8.TL.6:** Collaborate to develop and publish work that provides perspectives on a real-world problem.

Students will use Desmos and graphing technology to investigate and model piecewise functions.

**9.4.8.TL.3:** Select appropriate tools to organize and present information digitally.

Students will use Quizizz, Kahoot, and collaborative digital tools to reinforce understanding of piecewise functions.

**9.4.5.CT.3:** Describe how digital tools and technology may be used to solve problems.

Supplemental instruction and online graphing activities will be completed using IXL and Big Ideas Math resources.

**9.4.12.TL.1:** Assess digital tools based on accessibility options, capacities, and utility for accomplishing a specified task.

Students will use Google Classroom and graphing technology to analyze and interpret piecewise models.

**9.4.12.TL.4:** Collaborate in online learning communities or virtual worlds to analyze and propose a resolution to a real-world problem.

Students will use graphing calculators and Desmos to compare behaviors across intervals in piecewise functions.

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**9.4.8.IML.3:** Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping.

### Career Education

**9.4.12.CI.1:** Demonstrate use of technical knowledge and skills.

**9.4.12.CT.2:** Explain the value of academic and technical skills in the workplace.

**9.4.12.TL.3:** Use digital tools to enhance productivity.

**9.4.12.IML.5:** Evaluate and select digital tools for effective communication and collaboration.

Time Frame

2 cycles ~ 6 ( 56 minute) blocks

### Topic

Function Compositions

### Alignment to Standards

**F.BF.A.1** Build a function that models a relationship between two quantities.

**F.IF.A.2** Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

**F.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.

**F.BF.1c(+)** Compose functions. For example, if  $T(y)$  is the temperature in the atmosphere as a function of height, and  $h(t)$  is the height of a weather balloon as a function of time, then  $T(h(t))$  is the temperature at the location of the weather balloon as a function of time

**F.BF.4b(+)** Verify by composition that one function is the inverse of another

### Learning Objectives and Activities

**SWBAT answer the following questions:**

- What does it mean to compose two functions?
- How does function composition combine multiple processes into a single mathematical model?
- Why are  $(f \circ g)(x)$  and  $(g \circ f)(x)$  not always equivalent?
- How can composite functions be represented graphically, numerically, verbally, and algebraically?

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- How does composing a function with the absolute value function affect its behavior and graph?
- How can composite functions be used to model real-world situations involving sequential changes?
- How do inputs and outputs help determine the structure of a composite function?

### **SWBAT demonstrate understanding of the following:**

- Function composition occurs when the output of one function becomes the input of another function.
- The notation  $(f \circ g)(x)$  represents applying  $g(x)$  first and then  $f(x)$ .
- The order of composition affects the resulting function and may produce different outputs.
- Composite functions can be represented and analyzed using graphs, tables, equations, and verbal descriptions.
- Compositions involving the absolute value function can alter a function's graph and behavior.
- Real-world processes often involve multiple stages that can be modeled using composite functions.
- Multiple representations help reveal patterns and relationships within composite functions.
- Function composition can be used to build more complex models from simpler functions.

### **Learning Activities:**

- Evaluate composite functions for given input values.
- Compose functions algebraically and simplify resulting expressions.
- Determine and compare  $(f \circ g)(x)$  and  $(g \circ f)(x)$ .
- Use function machines and input-output diagrams to model composition.
- Match graphs, equations, tables, and verbal descriptions of composite functions.
- Investigate compositions involving the absolute value function and describe resulting transformations.
- Predict the graph of a composite function before verifying with technology.
- Use graphing calculators or Desmos to explore and analyze composite functions.
- Dry erase board practice evaluating and composing functions.
- Interpret real-world situations involving sequential processes such as discounts, taxes, conversions, or production costs.
- CBL Activity – Analyze a multi-step real-world scenario and represent it using composite functions.
- Justify conclusions through mathematical discussion and written explanations using multiple representations.

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### Assessments

#### **Formative:**

- Warm-up and exit ticket problems
- Turn-and-talk discussions
- Teacher observation during collaborative activities
- Whiteboard checks
- Graphing technology investigations
- Reflection prompts requiring written justification

#### **Summative:**

- Assessment requiring students to:
- Evaluate composite functions.
- Compose functions algebraically.
- Interpret composite functions in context.
- Analyze compositions involving absolute value functions.
- Justify conclusions using graphs, tables, and equations.
- Explain differences between  $(f \circ g)(x)$  and  $(g \circ f)(x)$

#### **Alternative:**

- Student-created presentation explaining a composite function model.
- Performance task involving a real-world application of function composition.
- Mathematical poster or digital infographic demonstrating composition through multiple representations.

### Interdisciplinary Connections

#### **Computer Science (NJSL 8.2.12.ITH.1):**

Students examine how complex computational procedures are created by combining simpler operations, mirroring the structure of composite functions.

#### **Science (NJSL-SCI HS-ETS1-4):**

Students model systems in which one process produces outputs that become inputs for subsequent processes, reinforcing the concept of composition.

#### **Business and Economics (NJSL 9.2.12.CAP.5):**

Students analyze situations involving multiple financial operations, such as discounts, taxes, commissions, or fees, represented through composite functions.

### Career Readiness, Life Literacies, and Key Skills

**9.4.A.4** Demonstrate creativity and innovation in solving problems.

**9.4.DC.5** Analyze the characteristics of and potential risks associated with the use of digital tools and resources.

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**9.4.M.1** Identify and use appropriate tools and resources to support decision-making and problem solving.

**9.4.TL.2** Generate ideas to solve problems individually and collaboratively.

**9.4.TL.3** Analyze the effectiveness of communication and collaboration in digital and face-to-face interactions.

### Technology Integration

**9.4.F.1** Utilize critical thinking and problem-solving skills to analyze information and mathematical relationships.

### Career Education

**CRP1:** Act as a responsible and contributing citizen and employee.

**CRP2:** Apply appropriate academic and technical skills.

**CRP4:** Communicate clearly and effectively and with reason.

**CRP5:** Consider the environmental, social, and economic impacts of decisions.

**CRP8:** Utilize critical thinking to make sense of problems and persevere in solving them.

**CRP11:** Use technology to enhance productivity.

**CRP12:** Work productively in teams while using cultural global competence.

|                                                                                                                                                                                                                                                                                                                            |                                   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| Time Frame                                                                                                                                                                                                                                                                                                                 | 2 cycles ~ (6 - 56 minute blocks) |
| Topic                                                                                                                                                                                                                                                                                                                      |                                   |
| Transformations on parent functions                                                                                                                                                                                                                                                                                        |                                   |
| Alignment to Standards                                                                                                                                                                                                                                                                                                     |                                   |
| <b>F.BF.3 – Build New Functions from Existing Functions</b><br>Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$ , $kf(x)$ , $f(kx)$ , and $f(x + k)$ for specific values of $k$ ; find the value of $k$ given the graphs.                                                                                |                                   |
| Learning Objectives and Activities                                                                                                                                                                                                                                                                                         |                                   |
| <b>SWBAT answer the following questions:</b> <ul style="list-style-type: none"> <li>How does an equation change when there is a vertical shift?</li> <li>How does an equation change when there is a horizontal shift?</li> <li>How does an equation change when there is a vertical stretch/compression shift?</li> </ul> |                                   |

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- How does an equation change when there is a horizontal stretch/compression shift?

### **SWBAT demonstrate understanding of the following:**

- Recognize and describe transformations of parent functions: vertical shifts, horizontal shifts, reflections, and stretches/compressions.
- Analyze the impact of constants on the function rules:
  - $f(x)+k$ : vertical shift
  - $f(x+k)$ : horizontal shift
  - $kf(x)$ : vertical stretch/compression or reflection over the x-axis
  - $f(kx)$ : horizontal stretch/compression or reflection over the y-axis.
- Match equations to transformed graphs and vice versa.
- Apply knowledge of transformations to model and interpret real-world situations.

### **Learning Activities:**

- Use Desmos or GeoGebra to dynamically explore transformations on graphs.
- Card sort matching equations to graphs and transformation descriptions.
- Collaborative group work with transformation stations (each station representing a type of transformation).

## Assessments

### **Formative:**

- Exit tickets identifying transformation types from graphs.
- Quick check-in quizzes using transformed and parent functions.  
Think-Pair-Share discussions interpreting transformations.

### **Summative:**

- Unit test featuring graph identification, equation transformations, and real-world applications.
- Performance task: students design and explain a real-world scenario that involves multiple transformations.

### **Alternative:**

- Students create a digital presentation or infographic explaining each transformation type with examples.
- Oral assessment or recorded explanation of how changing a function's rule affects its graph.

## Interdisciplinary Connections

### **Science**

HS-PS2-1: Analyze data to support the claim that the gravitational force exerted by Earth on objects is directed down.

HS-PS3-1: Create a computational model to calculate the change in the energy of one component in a system when the components of the system interact.





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DEPARTMENT Mathematics

COURSE Pre AP Algebra II

In physics, transformations of functions can represent energy changes, motion patterns, or wave behavior. For example, changing amplitude and frequency in sine functions can model sound waves.

### **Visual Arts**

**1.1.12prof.Cn10a: Synthesizing and relating knowledge and personal experiences to create products.**

Students apply transformations creatively to design patterns and visual compositions, linking math to symmetry and design in visual media.

### Career Readiness, Life Literacies, and Key Skills

#### **9.4.12.CI.2:**

Collaborate with individuals of diverse backgrounds to brainstorm and solve problems related to interpreting function transformations.

#### **9.4.12.IML.7:**

Evaluate the accuracy and reliability of visual data, such as graphs depicting economic or population growth trends using transformed functions.

#### **9.4.12.CT.2:**

Develop solutions to solve complex real-world problems using critical thinking, such as adjusting formulas in spreadsheets for business forecasts.

### Technology Integration

**9.4.12.TL.3** – Use a variety of digital tools to design and develop a solution or product.

**9.4.12.DC.1** – Evaluate the social and economic implications of digital decisions.

### Career Education

**9.4.12.CI.1:** Demonstrate use of technical knowledge and skills.

**9.4.12.CT.2:** Explain the value of academic and technical skills in the workplace.

**9.4.12.CI.3** – Collaborate with individuals of diverse backgrounds to produce quality work.

**9.4.12.CI.4** – Demonstrate effective communication and collaboration in a digital environment.

**9.4.12.IML.4** – Explain how a message and its delivery can impact how it is understood.

Time Frame

2 cycles ~ 6 ( 56 minute ) blocks

Topic

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### Inverting Functions

#### Alignment to Standards

**F.BF.B.4a** 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.

**F.BF.B.4b(+)** Verify by composition that one function is the inverse of another.

**F.IF.A.2** Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

**F.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.

#### **F.BF.4c(+)** – Read Values of an Inverse Function from a Graph or a Table

Read values of an inverse function from a graph or a table, given that the function has an inverse.

#### **F.BF.4d(+)** – Produce an Invertible Function from a Non-Invertible Function by Restricting the Domain

Produce an invertible function from a non-invertible function by restricting the domain.

#### Learning Objectives and Activities

##### **SWBAT answer the following questions:**

- What does it mean to "undo" a mathematical process?
- How are inverse operations related to inverse functions?
- How can inverse functions be represented graphically, numerically, verbally, and algebraically?
- Why must a function be one-to-one in order to have an inverse that is also a function?
- How can composition be used to verify inverse functions?
- What is the relationship between the graphs of a function and its inverse?
- How can inverse functions be used to model and solve real-world problems?

##### **SWBAT demonstrate understanding of the following:**

- Inverse operations reverse the effect of a given operation.
- An inverse function reverses the relationship represented by the original function.
- The domain and range of a function switch roles in its inverse.
- A function and its inverse are reflections across the line  $(y=x)$ .
- Composition can be used to verify whether two functions are inverses.
- Not all functions have inverses that are functions without restricting the domain.
- Multiple representations help analyze and interpret inverse relationships.
- Inverse functions can model situations where an original input must be recovered from an output.

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### **Learning Activities:**

- Identify and apply inverse operations to solve equations.
- Evaluate functions and their inverses using tables and function notation.
- Find inverses of linear and simple nonlinear functions algebraically.
- Verify inverse functions using composition.
- Match graphs, equations, tables, and verbal descriptions of functions and their inverses.
- Graph functions and inverses and analyze symmetry across the line ( $y=x$ ).
- Use graphing calculators or Desmos to explore inverse relationships.
- Dry erase board practice finding and verifying inverses.
- Investigate one-to-one functions using the Horizontal Line Test.
- Interpret inverse functions in real-world contexts such as unit conversions, pricing models, and temperature scales.
- CBL Activity – Analyze a real-world process and determine how an inverse function can recover the original input.
- Engage in mathematical discourse to justify whether functions are inverses using multiple representations.

### **Assessments**

#### **Formative:**

- Warm-up and exit ticket problems
- Turn-and-talk discussions
- Teacher observation during collaborative activities
- Whiteboard checks
- Technology-based explorations
- Reflection prompts requiring written justification

#### **Summative:**

- Assessment requiring students to:
  - Find inverse functions algebraically.
  - Verify inverses through composition.
  - Analyze graphs of functions and inverses.
  - Interpret inverse functions in context.
  - Explain the relationship between domains and ranges of inverse functions.
  - Justify conclusions using multiple representations.

#### **Alternative:**

- Student-created presentation explaining inverse relationships using multiple representations.
- Performance task involving a real-world inverse function model.
- Mathematical poster or digital infographic illustrating inverse functions and their

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properties.

### Interdisciplinary Connections

#### **Computer Science (NJSLS 8.2.12.ITH.1):**

Students examine how algorithms can reverse processes or decode information, connecting to the concept of inverse functions.

#### **Science (NJSLS-SCI HS-ETS1-4):**

Students analyze scientific relationships where original measurements must be recovered from transformed data.

#### **Business and Economics (NJSLS 9.2.12.CAP.5):**

Students investigate situations involving reversing financial calculations, conversions, and pricing structures.

### Career Readiness, Life Literacies, and Key Skills

**9.4.A.4** Demonstrate creativity and innovation in solving problems.

**9.4.DC.5** Analyze the characteristics of and potential risks associated with the use of digital tools and resources.

**9.4.M.1** Identify and use appropriate tools and resources to support decision-making and problem solving.

**9.4.TL.2** Generate ideas to solve problems individually and collaboratively.

**9.4.TL.3** Analyze the effectiveness of communication and collaboration in digital and face-to-face interactions.

### Technology Integration

**9.4.F.1** Utilize critical thinking and problem-solving skills to analyze information and mathematical relationships.

### Career Education

**CRP1:** Act as a responsible and contributing citizen and employee.

**CRP2:** Apply appropriate academic and technical skills.

**CRP4:** Communicate clearly and effectively and with reason.

**CRP8:** Utilize critical thinking to make sense of problems and persevere in solving them.

**CRP11:** Use technology to enhance productivity.

**CRP12:** Work productively in teams while using cultural global competence.

Time Frame

8 cycles (24 ~ 56 minute blocks)

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| Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Exponential and Logarithmic Functions and Relations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Alignment to Standards                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <p><b>N.Q.2 – Reason Quantitatively and Use Units to Solve Problems</b><br/>Define appropriate quantities for the purpose of descriptive modeling</p> <p><b>F.BF.1.b – Build a Function That Models a Relationship Between Two Quantities</b><br/>Combine standard function types using arithmetic operations.</p> <p><b>F.BF.5(+)</b> – Understand the Inverse Relationship Between Exponents and Logarithms<br/>Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.</p> <p><b>F.IF.7.f (t)</b> – Analyze Functions Using Different Representations<br/>Graph trigonometric functions, showing period, midline, and amplitude.</p> <p><b>F.IF.8.b – Write a Function Defined by an Expression in Different but Equivalent Forms</b><br/>Use the properties of exponents to interpret expressions for exponential functions.</p> <p><b>F.LE.2 – Construct and Compare Linear, Quadratic, and Exponential Models and Solve Problems</b><br/>Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs</p> <p><b>F.LE.4 – Construct and Compare Linear, Quadratic, and Exponential Models and Solve Problems</b><br/><b>Standard:</b> For exponential models, express as a logarithm the solution to <math>ab^{ct} = d</math> where <math>a</math>, <math>c</math>, and <math>d</math> are numbers and the base <math>b</math> is 2, 10, or <math>e</math>; evaluate the logarithm using technology.</p> <p><b>F.LE.5 – Interpret Expressions for Functions in Terms of the Situation They Model</b><br/>Interpret the parameters in a linear or exponential function in terms of a context.</p> <p><b>A.SSE.3.c – Choose and Produce an Equivalent Form of an Expression to Reveal and Explain Properties of the Quantity Represented by the Expression</b><br/>Use the properties of exponents to transform expressions for exponential functions.</p> |
| Learning Objectives and Activities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <p><b>SWBAT answer the following questions:</b></p> <ul style="list-style-type: none"><li>• How can you make good decisions?</li><li>• What factors can affect good decision making?</li><li>• What is the difference between exponential growth and decay?</li><li>• Why do we need “e”?</li><li>• How are logs and exponents related?</li><li>• When graphing <math>y=ab^x+c</math>, what does <math>a</math>, <math>b</math>, and <math>c</math> do to the graph?</li><li>• How do you solve a log problem with a base other than 10?</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

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### **SWBAT demonstrate understanding of the following:**

- Nth roots are inverses of power functions.
- Understanding the properties of power functions and how inverses behave explains the properties of nth roots.
- Computing with rational exponents is no different from computing with integral exponents.
- Exponential and logarithmic functions behave the same as other functions with respect to graphical transformations.
- Two special logarithmic functions are the common log and natural log. These special functions occur often in nature.

### **Learning Activities:**

- M & M Lab- exponential decay
- Compound Interest Activity
- Population Growth Activity

### Assessments

#### **Formative:**

- Daily Practice Problems
- IXL Practice
- Class Debate of Approaches/Mathematical Methods
- Entrance/Exit Cards

#### **Summative:**

- Mid-unit Quizzes
- Topic Tests
- Problem-based Quiz/Test on Exponential growth/decay

#### **Alternative:**

- Kahoot/Quizizz
- Individual or group productive struggle assessment during introductory lessons

### Interdisciplinary Connections

Science:

**HS-PS1-4** – Develop a model to describe the macroscopic properties of a substance based on particle-level interactions.

**HS-LS2-4** – Use mathematical representations to describe and predict the effects of interactions.

**HS-ESS3-6** – Evaluate or model solutions to reduce human impact on the environment.

### Career Readiness, Life Literacies, and Key Skills

9.1.12.CDM.8: In the logarithmic unit students will compare and compute interest and compound interest and develop an amortization table using business tools.

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9.1.12.CDM.6: When learning exponential equations students will compute and assess the accumulating effect of interest paid over time when using a variety of sources of credit (e.g., student loans, credit cards, auto loans, mortgages, etc.)

### Technology Integration

All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaboratively and to create and communicate knowledge.

- 9.4.8.TL.6: Collaborate to develop and publish work that provides perspectives on a real-world problem.

Students will access the Big Ideas online ebook to further investigate lesson concepts and demonstrate understanding of standards.

- 9.4.8.TL.3: Select appropriate tools to organize and present information digitally.

Students will use internet based game sites such as Quizizz, Kahoot, and Quizlet live to reflect on their learning progress.

- 9.4.5.CT.3: Describe how digital tools and technology may be used to solve problems.

Supplemental instruction and math games will be presented using IXL Math and Video Tutor bigideasmath.com.

- 9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task

Students will use Google Classroom to collaborate, work towards solving authentic problems, or participate in an online classroom discussion utilizing pre-learned etiquette about blended learning platforms.

- 9.4.12.TL.4: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem.

Students will use graphing calculators to use math tools strategically and attend to precision and will use Desmos in order to discover new concepts involving graphing and functions.

- 9.4.8.IML.3: Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping

### Career Education

**9.4.12.CI.1** – Demonstrate the ability to reflect, analyze, and refine creative ideas to improve a product or solution.

**9.4.12.CI.2** – Evaluate diverse perspectives and incorporate them to develop creative solutions.

**9.4.12.CI.3** – Work collaboratively to produce innovative solutions in real-world contexts.

**9.4.12.CT.1** – Identify problem-solving strategies used in the development of a product or solution.

**9.4.12.CT.2** – Analyze a complex problem and determine steps to reach a viable solution.

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**9.4.12.CT.3** – Evaluate solutions for their effectiveness and refine them as needed.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| Time Frame                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 6 cycles ~ 18 (56 minute ) blocks |
| Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                   |
| Polynomials and Polynomial Functions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                   |
| Alignment to Standards                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                   |
| <p><b>A.APR.1 - Perform arithmetic operations on polynomials</b><br/>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</p> <p><b>A.APR.2 – Understand the Relationship Between Zeros and Factors of Polynomials</b><br/>Know and apply the Remainder Theorem: For a polynomial <math>p(x)</math> and a number <math>a</math>, the remainder on division by <math>x - a</math> is <math>p(a)</math>, so <math>p(a) = 0</math> if and only if <math>(x - a)</math> is a factor of <math>p(x)</math>.</p> <p><b>A.APR.3 – Identify Zeros of Polynomials When Suitable Factoring is Available</b><br/><b>Standard:</b> 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</p> <p><b>A.APR.4 (+) – Use Polynomial Identities to Solve Problems</b><br/>Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity <math>(x^2 + y^2)^2 = (x^2 - y^2)^2 + (2xy)^2</math> can be used to generate Pythagorean triples.</p> <p><b>F.IF.7.c – Analyze Functions Using Different Representations</b><br/>Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.</p> <p><b>N.CN.9(+)- Use Complex Numbers in Polynomial Identities and Equations</b><br/>Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.</p> |                                   |
| Learning Objectives and Activities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                   |
| <p><b>SWBAT answer the following questions:</b></p> <ul style="list-style-type: none"> <li>• Why is math used to model real-world situations?</li> <li>• How do we use polynomial patterns to make real-world predictions?</li> <li>• How can I use the remainder and factor theorems to solve polynomials?</li> </ul> <p><b>SWBAT demonstrate understanding of the following:</b></p> <ul style="list-style-type: none"> <li>• The arithmetic of rational expressions is governed by the same rules as the arithmetic of rational numbers.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                   |

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- Defining and solving the problem begins by selecting the appropriate procedural tool.
- The characteristics of polynomial functions and their representations are useful in solving real-world problems.
- The domain and range of polynomial functions can be extended to include the set of complex numbers.

### **Learning Activities:**

- Algebra Tile Activity to divide polynomials
- Dividing Polynomials Lab

### Assessments

#### **Formative:**

- Classwork and Homework
- IXL Practice
- Teacher Observation
- Class Debate of Approaches/Mathematical Methods
- Math Scavenger Hunt/Trail
- Entrance/Exit Cards

#### **Summative:**

- Mid-unit Quizzes
- Topic Tests

#### **Alternative:**

- Kahoot/Quizizz
- Individual or group productive struggle assessment during introductory lessons

### Interdisciplinary Connections

ELA:

**SL.11-12.4** – Present information, findings, and supporting evidence clearly and logically. *Students present polynomial modeling problems and explain how polynomial degrees and roots relate to real-world applications (e.g., profit, motion, engineering design).*

Science:

**HS-LS4-2** – Construct explanations based on evidence for how evolution results from various factors.

*Polynomial models can be used to represent biological growth, rates of change, or population fluctuations under varying conditions.*

### Career Readiness, Life Literacies, and Key Skills

9.3.ST.2: When determining a regression model that fits data students will use technology to acquire, manipulate, analyze and report data.

### Technology Integration

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Students will access the Big Ideas online ebook to further investigate lesson concepts and demonstrate understanding of standards.

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Students will use Google Classroom to collaborate, work towards solving authentic problems, or participate in an online classroom discussion utilizing pre-learned etiquette about blended learning platforms.

- 9.4.12.TL.4: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem.

Students will use graphing calculators to use math tools strategically and attend to precision and will use Desmos in order to discover new concepts involving graphing and functions.

- 9.4.8.IML.3: Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping

## Career Education

**9.4.12.CI.1** – Demonstrate the ability to reflect, analyze, and creatively adapt to complex situations.

**9.4.12.CI.2** – Collaborate with others to expand thinking about a topic or problem.

**9.4.12.CT.1** – Identify a problem and use critical thinking and logic to solve it.

**9.4.12.CT.2** – Evaluate alternate solutions based on their effectiveness.

**9.4.12.CT.3** – Use critical thinking to improve academic and technical performance.

**9.4.12.TL.3** – Analyze the effectiveness of current and emerging technologies and how they can support or hinder productivity.

**9.4.12.IML.5** – Evaluate and responsibly use digital tools to enhance research and productivity.

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|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| Time Frame                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 5 cycles ~ 15 (56 minute) blocks |
| Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                  |
| Rational Functions and Relations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                  |
| Alignment to Standards                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                  |
| <p><b>A.APR.6 – Rational Expressions</b><br/><b>Standard:</b> Rewrite simple rational expressions in different forms; write <math>a(x)/b(x)</math> in the form <math>q(x) + r(x)/b(x)</math>, where <math>a(x)</math>, <math>b(x)</math>, <math>q(x)</math>, and <math>r(x)</math> are polynomials with the degree of <math>r(x)</math> less than the degree of <math>b(x)</math>, using inspection, long division, or, for the more complicated examples, a computer algebra system.</p> <p><b>A.APR.7(+) – Rational Expressions</b><br/><b>Standard:</b> 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.</p> <p><b>A.CED.1 – Creating Equations</b><br/><b>Standard:</b> 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.</p> <p><b>A.CED.2 – Creating Equations</b><br/><b>Standard:</b> Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.</p> <p><b>A.REI.2 – Reasoning with Equations and Inequalities</b><br/><b>Standard:</b> Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.</p> <p><b>F.IF.7.d(+) – Interpreting Functions</b><br/><b>Standard:</b> Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.</p> <p><b>F.IF.9 – Interpreting Functions</b><br/><b>Standard:</b> Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).</p> |                                  |
| Learning Objectives and Activities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                  |
| <p><b>SWBAT answer the following questions:</b></p> <ul style="list-style-type: none"><li>• How do rational functions model situations involving rates, ratios, and inverse variation?</li><li>• How do the numerator and denominator influence the behavior of a rational function?</li><li>• Why do rational functions sometimes have restrictions in their domains?</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                  |

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- What do vertical and horizontal asymptotes tell us about a function's behavior?
- How can rational functions be represented graphically, numerically, verbally, and algebraically?
- How do transformations affect the graphs of rational functions?
- How can end behavior help us understand and interpret rational functions?
- How can rational functions be used to model real-world situations?
- How do rational functions compare to other function families studied in Algebra 2?

### **SWBAT demonstrate understanding of the following:**

- Rational functions are ratios of polynomial functions.
- Values that make the denominator equal to zero are excluded from the domain.
- Vertical asymptotes indicate values that the function approaches but does not attain.
- Horizontal and other end-behavior patterns describe long-term function behavior.
- Tables, graphs, equations, and contexts provide different perspectives on rational functions.
- Transformations can be used to generate and analyze families of rational functions.
- Rational functions can model inverse variation and situations involving rates and efficiency.
- The structure of a rational function helps predict its graphical behavior.
- Mathematical reasoning can be used to connect algebraic features to graphical features.

### **Learning Activities:**

- Explore the parent function and describe its key characteristics.
- Investigate how changes to the numerator and denominator affect the graph.
- Use graphing technology to explore transformations of rational functions.
- Analyze domain restrictions and explain their significance.
- Match graphs, equations, tables, and verbal descriptions of rational functions.
- Complete card sorts identifying asymptotes, domains, ranges, and equations.
- Compare rational functions represented in different forms.
- Identify and interpret vertical and horizontal asymptotes.
- Sketch graphs using key features and verify with technology.
- Compare end behavior of rational, polynomial, exponential, and logarithmic functions.
- Analyze how transformations affect asymptotes and intercepts.
- Use Desmos or graphing calculators to investigate parameter changes.
- Explore real-time graph transformations.
- Verify predictions about asymptotes and end behavior.
- Model average cost as production increases.
- Analyze speed, density, or efficiency relationships.
- Interpret rational functions in business, science, and engineering applications.
- Create rational-function models from contextual data.
- Justify the location of asymptotes using algebraic reasoning.
- Explain how the structure of a rational function determines its graph.
- Write and critique mathematical arguments about function behavior.

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### Assessments

#### **Formative:**

- Daily Practice Problems
- Teacher Observation
- Math Scavenger Hunt/Trail
- Entrance/Exit Cards

#### **Summative:**

- Mid-unit Quizzes
- Topic Tests

#### **Alternative:**

- Kahoot/Quizizz
- Individual or group productive struggle assessment during introductory lessons

### Interdisciplinary Connections

ELA:

**NJSLSA.R1** – Read closely to determine what the text says explicitly and make logical inferences from it; cite specific textual evidence.

*Students read and interpret word problems and real-world contexts involving rational functions, identifying key relationships between variables and reasoning through their solutions.*

Science:

**HS-PS2-4** – Use mathematical representations to describe a physical system.

*Rational functions can be used to model systems with inverse relationships, such as velocity and time, or electrical resistance and current in circuits.*

### Career Readiness, Life Literacies, and Key Skills

#### **9.4.12.CT.2:**

*Develop multiple solutions to a problem and evaluate short- and long-term impacts of each solution.*

Students analyze and compare multiple algebraic strategies when solving inverse or radical equations.

### Technology Integration

All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaboratively and to create and communicate knowledge.

- 9.4.8.TL.6: Collaborate to develop and publish work that provides perspectives on a real-world problem.

Students will access the Big Ideas online ebook to further investigate lesson concepts and

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demonstrate understanding of standards.

- 9.4.8.TL.3: Select appropriate tools to organize and present information digitally. Students will use internet based game sites such as Quizizz, Kahoot, and Quizlet live to reflect on their learning progress.
- 9.4.5.CT.3: Describe how digital tools and technology may be used to solve problems. Supplemental instruction and math games will be presented using IXL Math and Video Tutor bigideasmath.com.
- 9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task  
Students will use Google Classroom to collaborate, work towards solving authentic problems, or participate in an online classroom discussion utilizing pre-learned etiquette about blended learning platforms.
- 9.4.12.TL.4: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem.  
Students will use graphing calculators to use math tools strategically and attend to precision and will use Desmos in order to discover new concepts involving graphing and functions.
- 9.4.8.IML.3: Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping

### Career Education

- **9.4.12.TL.3** – Use digital tools to enhance productivity in a variety of contexts.
- **9.4.12.TL.1** – Analyze the impact of technology on personal and professional productivity.
- **9.4.12.IML.5** – Evaluate digital tools for effectiveness and reliability in gathering and using information.

|                                                                                                                                                    |                                 |
|----------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| Time Frame                                                                                                                                         | 2 cycles ~ 6 (56 minute) blocks |
| Topic                                                                                                                                              |                                 |
| Square & Cube Root Functions                                                                                                                       |                                 |
| Alignment to Standards                                                                                                                             |                                 |
| <b>N.RN.1 – Explain the Properties of Rational and Irrational Numbers</b><br>Explain how the properties of exponents extend to rational exponents. |                                 |
| <b>N.RN.2 – Rewrite Expressions Involving Radicals and Rational Exponents</b>                                                                      |                                 |

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Rewrite expressions involving radicals and rational exponents using the properties of exponents.

### **F.IF.4 – Interpret Functions That Arise in Applications in Terms of the Context**

For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities

### **F.IF.7b – Graph Functions Expressed Symbolically and Show Key Features of the Graph**

Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.

### **A.REI.2 – Solve Simple Rational and Radical Equations in One Variable**

Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise

## Learning Objectives and Activities

### **SWBAT answer the following questions:**

- How are square root and cube root functions related to quadratic and cubic functions?
- How do inverse relationships help us understand square root and cube root functions?
- How can square root and cube root functions be represented graphically, numerically, verbally, and algebraically?
- How do domain and range differ between square root and cube root functions?
- How do transformations affect the graphs of square root and cube root functions?
- Why does a square root function have domain restrictions while a cube root function does not?
- How can square root and cube root functions be used to model real-world situations?
- How do the characteristics of square root and cube root functions compare to other function families?

### **SWBAT demonstrate understanding of the following:**

- Square root functions are inverses of quadratic functions when the domain is appropriately restricted.
- Cube root functions are inverses of cubic functions.
- The domain of a square root function is restricted by the radicand, while cube root functions are defined for all real numbers.
- Transformations affect the position, orientation, and shape of square root and cube root graphs.
- Graphs, tables, equations, and contexts reveal different aspects of function behavior.
- Multiple representations can be used to analyze and interpret root functions.

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- Root functions can model relationships involving area, volume, distance, and other real-world quantities.
- Understanding inverse relationships helps explain the structure and behavior of root functions.

### **Learning Activities**

- Explore the relationship between quadratic functions and square root functions through inverse relationships.
- Explore the relationship between cubic functions and cube root functions.
- Generate tables of values and identify patterns in square root and cube root functions.
- Investigate domain and range through graphical and numerical analysis.
- Match graphs, equations, tables, and verbal descriptions of root functions.
- Compare representations of quadratic functions and their square root inverses.
- Analyze how function behavior is reflected across different representations.
- Graph parent square root and cube root functions.
- Predict and verify transformations using graphing technology.
- Compare the effects of translations, reflections, and stretches on root functions.
- Use graphing calculators or Desmos to explore families of root functions.
- Small-group discussions analyzing similarities and differences between square root and cube root functions.
- Create mathematical models from contextual data involving square or cubic relationships.
- Use Desmos to investigate inverse relationships between functions.
- Compare graphs of quadratic functions and square root functions.
- Explore transformations dynamically and justify observations.
- Use technology to test conjectures and communicate findings.
- Justify domain and range restrictions.
- Explain why square root and cube root functions behave differently.
- Compare root functions with linear, quadratic, exponential, and rational functions.
- Analyze how inverse relationships influence graph behavior.
- Construct written arguments using graphical, numerical, and algebraic evidence.

### **Assessments**

#### **Formative:**

- Classwork and Homework
- IXL Practice
- Teacher Observation
- Math Scavenger Hunt/Trail

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- Entrance/Exit Cards

### **Summative:**

- Mid-unit Quizzes
- Topic Tests

### **Alternative:**

- Kahoot
- Quizizz

## Interdisciplinary Connections

ELA:

**SL.11-12.1** – Initiate and participate effectively in a range of collaborative discussions.  
*Students discuss how to identify, solve, and verify inverse and radical functions in real-world applications (e.g., reverse engineering, architecture, physics).*

## Career Readiness, Life Literacies, and Key Skills

**9.4.12.CT.2** – Identify opportunities for innovation through recognizing patterns in radical or inverse functions.

## Technology Integration

All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaboratively and to create and communicate knowledge.

- 9.4.8.TL.6: Collaborate to develop and publish work that provides perspectives on a real-world problem.

Students will access the Big Ideas online ebook to further investigate lesson concepts and demonstrate understanding of standards.

- 9.4.8.TL.3: Select appropriate tools to organize and present information digitally.

Students will use internet based game sites such as Quizizz, Kahoot, and Quizlet live to reflect on their learning progress.

- 9.4.5.CT.3: Describe how digital tools and technology may be used to solve problems.

Supplemental instruction and math games will be presented using IXL Math and Video Tutor bigideasmath.com.

- 9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task

Students will use Google Classroom to collaborate, work towards solving authentic problems, or participate in an online classroom discussion utilizing pre-learned etiquette about blended learning platforms.

- 9.4.12.TL.4: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem.

Students will use graphing calculators to use math tools strategically and attend to precision

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and will use Desmos in order to discover new concepts involving graphing and functions.

- 9.4.8.IML.3: Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping

### Career Education

**9.4.12.CI.3** – Collaborate with individuals of diverse backgrounds to produce quality work.

**9.4.12.CI.4** – Demonstrate effective communication and collaboration in a digital environment.

**9.4.12.IML.4** – Explain how a message and its delivery can impact how it is understood.

**9.4.12.TL.3** – Analyze the effectiveness of current and emerging technologies and how they can support or hinder productivity.

**9.4.12.IML.5** – Evaluate and responsibly use digital tools and resources to enhance productivity.

|                                                                                                                                                                                        |                                  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| Time Frame                                                                                                                                                                             | 4 cycles (12 ~ 56 minute blocks) |
| Topic                                                                                                                                                                                  |                                  |
| Radian Measure and Sinusoidal Functions                                                                                                                                                |                                  |
| Alignment to Standards                                                                                                                                                                 |                                  |
| <b>N.Q.1 – Reason Quantitatively and Use Units to Solve Problems</b><br>Use units as a way to understand problems and guide the solution of multi-step problems.                       |                                  |
| <b>F.IF.4 – Interpret Functions That Arise in Applications in Terms of the Context</b><br>Interpret key features of graphs and tables in terms of the quantities represented.          |                                  |
| <b>F.IF.5 – Interpret Functions That Arise in Applications in Terms of the Context</b><br>Relate the domain of a function to its graph and the quantitative relationship it describes. |                                  |
| <b>F.IF.7e – Analyze Functions Using Different Representations</b><br>Graph trigonometric functions, showing period, midline, amplitude, and intercepts.                               |                                  |
| <b>F.IF.9 – Compare Properties of Two Functions Represented in Different Ways</b><br>Compare properties of functions represented algebraically, graphically, numerically, or verbally. |                                  |

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### **F.TF.A1(+)** – **Extend the Domain of Trigonometric Functions Using the Unit Circle**

Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.

### **F.TF.A.2 (+)** - **Extend the Domain of Trigonometric Functions Using the Unit Circle**

Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measure of angles traversed counterclockwise around the unit circle

### **F.TF.A.3(+)** - **Extend the Domain of Trigonometric Functions Using the Unit Circle**

Use special right triangles to determine geometrically the values of sine, cosine, tangent for  $\theta$  and use the unit circle to express the values of sine, cosines, and tangent for  $\theta$  in terms of their values for  $x$ , where  $x$  is any real number.

### **F.TF.5** – **Model Periodic Phenomena with Trigonometric Functions**

Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.

### **F.BF.3** – **Build New Functions from Existing Functions**

Identify the effect on the graph of replacing  $f(x)$  with  $f(x)+k$ ,  $kf(x)$ ,  $f(kx)$ , and  $f(x+k)$ .

### **A.CED.2** – **Create Equations That Describe Numbers or Relationships**

Create equations in two or more variables to represent relationships between quantities.

## Learning Objectives and Activities

### **SWBAT answer the following questions:**

- What is radian measure and how is it related to the unit circle?
- How can sinusoidal functions model periodic behavior?
- How do amplitude, period, phase shift, and midline affect sinusoidal graphs?
- Why are radians useful in trigonometry and higher mathematics?
- How can sine and cosine functions represent real-world cyclical phenomena?
- How do transformations change the graph of a sinusoidal function?

### **SWBAT demonstrate understanding of the following:**

- Radian measure relates arc length to radius on the unit circle.
- Trigonometric functions can model repeating or periodic phenomena.
- The sine and cosine functions have repeating wave-like patterns.
- Amplitude measures the vertical stretch of a sinusoidal graph.
- Period represents the length of one complete cycle.
- Midline and phase shift affect the position of the graph.
- Sinusoidal functions can be represented verbally, numerically, graphically, and algebraically.
- Real-world periodic behavior can be modeled using trigonometric functions.

### **Learning Activities:**

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- Convert between degree and radian measure
- Use the unit circle to determine sine and cosine values
- Graph sine and cosine functions by hand and using technology
- Investigate amplitude, period, phase shift, and vertical shifts using Desmos sliders
- CBL Activity – Model Ferris wheel motion or seasonal temperature patterns
- Compare sinusoidal graphs with different transformations
- Match equations, graphs, tables, and verbal descriptions of trigonometric functions
- Use graphing calculators or Desmos to analyze periodic data
- Explore real-world applications such as tides, sound waves, daylight hours, and circular motion
- Dry erase board practice identifying key characteristics of sinusoidal graphs

### Assessments

#### **Formative:**

- Classwork
- Teacher Observation
- Entrance/Exit Tickets
- Unit Circle Practice
- Graph Interpretation Activities
- Group Discussions

#### **Summative:**

- Mid-unit Quiz
- Topic Test
- Sinusoidal Modeling Performance Task

#### **Alternative:**

- Desmos Activity Summary
- Kahoot/Quizizz
- Create and present a real-world sinusoidal model

### Interdisciplinary Connections

#### **Science:**

**HS-PS4-1** – Use mathematical representations to support claims regarding wave behavior. Students model sound waves, light waves, and harmonic motion using sinusoidal functions.

#### **ELA:**

**NJSLSA.W2** – Write informative/explanatory texts to examine and convey ideas clearly. Students explain how sinusoidal functions model periodic phenomena and interpret graph characteristics in context.

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**SL.11-12.1** – Initiate and participate effectively in collaborative discussions.  
Students discuss and critique strategies for graphing and modeling trigonometric functions.

### Career Readiness, Life Literacies, and Key Skills

#### **9.4.12.CI.2:**

Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

#### **9.4.12.CT.2:**

Develop multiple solutions to a problem and evaluate short- and long-term impacts of each.

### Technology Integration

All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaboratively and to create and communicate knowledge.

**9.4.8.TL.6:** Collaborate to develop and publish work that provides perspectives on a real-world problem.

Students will use Desmos and graphing technology to investigate transformations of sinusoidal functions and analyze periodic data.

**9.4.8.TL.3:** Select appropriate tools to organize and present information digitally.

Students will use Quizizz, Kahoot, and collaborative digital tools to reinforce understanding of radian measure and trigonometric functions.

**9.4.5.CT.3:** Describe how digital tools and technology may be used to solve problems.

Supplemental instruction and online graphing activities will be completed using IXL and Big Ideas Math resources.

**9.4.12.TL.1:** Assess digital tools based on accessibility options, capacities, and utility for accomplishing a specified task.

Students will use Google Classroom and graphing technology to interpret and model sinusoidal functions.

**9.4.12.TL.4:** Collaborate in online learning communities or virtual worlds to analyze and propose a resolution to a real-world problem.

Students will use graphing calculators and Desmos to compare sinusoidal models and analyze periodic phenomena.

**9.4.8.IML.3:** Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping.

### Career Education

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- 9.4.12.CI.1:** Demonstrate use of technical knowledge and skills.  
**9.4.12.CT.2:** Explain the value of academic and technical skills in the workplace.  
**9.4.12.TL.3:** Use digital tools to enhance productivity.  
**9.4.12.IML.5:** Evaluate and select digital tools for effective communication and collaboration.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| Time Frame                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 2 cycles (6 ~ 56 minute blocks) |
| Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                 |
| Tangent Function and Other Trigonometric Functions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                 |
| Alignment to Standards                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                 |
| <p><b>N.Q.1 – Reason Quantitatively and Use Units to Solve Problems</b><br/>           Use units as a way to understand problems and guide the solution of multi-step problems.</p> <p><b>F.IF.4 – Interpret Functions That Arise in Applications in Terms of the Context</b><br/>           Interpret key features of graphs and tables in terms of the quantities represented.</p> <p><b>F.IF.5 – Interpret Functions That Arise in Applications in Terms of the Context</b><br/>           Relate the domain of a function to its graph and the quantitative relationship it describes.</p> <p><b>F.IF.7e – Analyze Functions Using Different Representations</b><br/>           Graph trigonometric functions, showing key features including asymptotes, intercepts, period, and behavior.</p> <p><b>F.IF.9 – Compare Properties of Two Functions Represented in Different Ways</b><br/>           Compare properties of functions represented algebraically, graphically, numerically, or verbally.</p> <p><b>F.TF.A.2 (+) - Extend the Domain of Trigonometric Functions Using the Unit Circle</b><br/>           Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measure of angles traversed counterclockwise around the unit circle</p> <p><b>F.TF.A.3(+)- Extend the Domain of Trigonometric Functions Using the Unit Circle</b><br/>           Use special right triangles to determine geometrically the values of sine, cosine, tangent for <math>\theta</math> and use the unit circle to express the values of sine, cosines, and tangent for <math>\theta</math> in terms of their values for <math>x</math>, where <math>x</math> is any real number.</p> <p><b>F.TF.B.5(+)- Model Periodic Phenomena with Trigonometric Functions</b><br/>           Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.</p> |                                 |

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### F.BF.3 – Build New Functions from Existing Functions

Identify the effect on graphs of replacing  $f(x)$  with transformed functions.

### A.CED.2 – Create Equations That Describe Numbers or Relationships

Create equations in two or more variables to represent relationships between quantities.

#### Learning Objectives and Activities

#### SWBAT answer the following questions:

- How is the tangent function related to sine and cosine?
- What characteristics distinguish the tangent function from sine and cosine functions?
- How do asymptotes affect the graph of the tangent function?
- How can reciprocal trigonometric functions be represented and interpreted?
- How do transformations affect tangent and other trigonometric graphs?
- How can trigonometric functions model real-world periodic phenomena?

#### SWBAT demonstrate understanding of the following:

- The tangent function is defined as the ratio of sine to cosine.
- The tangent graph contains vertical asymptotes where cosine equals zero.
- Tangent functions are periodic and repeat at regular intervals.
- Reciprocal trigonometric functions include cosecant, secant, and cotangent.
- Trigonometric functions can be represented verbally, numerically, graphically, and algebraically.
- Transformations affect amplitude, period, phase shift, and vertical translation where applicable.
- Trigonometric functions model cyclical and repeating real-world phenomena.

#### Learning Activities:

- Use the unit circle to determine tangent values for key angles
- Graph tangent, secant, cosecant, and cotangent functions
- Investigate asymptotes and domain restrictions of trigonometric functions
- Compare sine, cosine, and tangent graphs
- Use Desmos sliders to explore transformations of tangent functions
- CBL Activity – Model angles of elevation and periodic motion
- Match equations, graphs, and tables of trigonometric functions
- Explore real-world applications involving slopes, waves, and oscillations
- Dry erase board practice graphing tangent and reciprocal trig functions
- Use graphing calculators or Desmos to analyze trigonometric behavior

#### Assessments

#### Formative:

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DEPARTMENT Mathematics

COURSE Pre AP Algebra II

- Classwork
- Teacher Observation
- Entrance/Exit Tickets
- Unit Circle Practice
- Graph Analysis Activities
- Group Discussions

### **Summative:**

- Mid-unit Quiz
- Topic Test
- Trigonometric Modeling Performance Task

### **Alternative:**

- Desmos Activity Summary
- Kahoot/Quizizz
- Create and present a real-world application involving trigonometric functions

## Interdisciplinary Connections

### **Science:**

**HS-PS4-1** – Use mathematical representations to support claims regarding wave behavior. Students analyze oscillations, wave motion, and periodic behavior using trigonometric functions.

### **ELA:**

**NJSLSA.W2** – Write informative/explanatory texts to examine and convey ideas clearly. Students explain the characteristics and applications of trigonometric functions in real-world contexts.

**SL.11-12.1** – Initiate and participate effectively in collaborative discussions.

Students discuss and defend strategies used to graph and analyze trigonometric functions.

## Career Readiness, Life Literacies, and Key Skills

### **9.4.12.CI.2:**

Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

### **9.4.12.CT.2:**

Develop multiple solutions to a problem and evaluate short- and long-term impacts of each.

## Technology Integration

All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaboratively and to create and communicate knowledge.

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**9.4.8.TL.6:** Collaborate to develop and publish work that provides perspectives on a real-world problem.

Students will use Desmos and graphing technology to investigate tangent and reciprocal trigonometric functions.

**9.4.8.TL.3:** Select appropriate tools to organize and present information digitally.

Students will use Quizizz, Kahoot, and collaborative digital tools to reinforce understanding of trigonometric functions.

**9.4.5.CT.3:** Describe how digital tools and technology may be used to solve problems.

Supplemental instruction and online graphing activities will be completed using IXL and Big Ideas Math resources.

**9.4.12.TL.1:** Assess digital tools based on accessibility options, capacities, and utility for accomplishing a specified task.

Students will use Google Classroom and graphing technology to interpret and analyze trigonometric models.

**9.4.12.TL.4:** Collaborate in online learning communities or virtual worlds to analyze and propose a resolution to a real-world problem.

Students will use graphing calculators and Desmos to compare and analyze trigonometric functions and transformations.

**9.4.8.IML.3:** Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping.

### Career Education

**9.4.12.CI.1:** Demonstrate use of technical knowledge and skills.

**9.4.12.CT.2:** Explain the value of academic and technical skills in the workplace.

**9.4.12.TL.3:** Use digital tools to enhance productivity.

**9.4.12.IML.5:** Evaluate and select digital tools for effective communication and collaboration.

|                                   |                                |
|-----------------------------------|--------------------------------|
| Time Frame                        | 1 cycle ~ 3 (56 minute) blocks |
| Topic                             |                                |
| Inverting Trigonometric Functions |                                |
| Alignment to Standards            |                                |
| F.BF.4a – Building Functions      |                                |

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**Standard:** Find inverse functions.

### **F.BF.4b (+) – Building Functions**

**Standard:** Verify by composition that one function is the inverse of another.

### **F.IF.4 – Interpreting Functions**

**Standard:** For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities.

### **F.IF.5 – Interpreting Functions**

**Standard:** Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.

### **F.IF.7e (+) – Interpreting Functions**

**Standard:** Graph trigonometric functions, showing period, midline, and amplitude.

### **F.IF.9 – Interpreting Functions**

**Standard:** Compare properties of two functions represented in different ways (algebraically, graphically, numerically in tables, or by verbal descriptions).

### **F.TF.6 – Trigonometric Functions**

**Standard:** Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.

### **F.TF.7 – Trigonometric Functions**

**Standard:** Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate solutions using technology and interpret them in terms of the context.

## Learning Objectives and Activities

### **SWBAT answer the following questions:**

- Why do trigonometric functions need domain restrictions before they can have inverses?
- What makes a function invertible?
- How do inverse trigonometric functions relate to the original trigonometric functions?
- What are the domains and ranges of the inverse sine, cosine, and tangent functions?
- How can inverse trigonometric functions be represented graphically, numerically, verbally, and algebraically?
- How does the graph of an inverse trigonometric function relate to the graph of its corresponding trigonometric function?
- How can inverse trigonometric functions be used to determine unknown angles?
- How do inverse trigonometric functions help solve real-world problems involving indirect measurement?
- How can technology be used to evaluate and interpret inverse trigonometric functions?

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- What limitations exist when using inverse trigonometric functions in modeling situations?

### **SWBAT demonstrate understanding of the following:**

- A function must be one-to-one in order to have an inverse.
- Trigonometric functions require domain restrictions to become one-to-one.
- The inverse sine, cosine, and tangent functions return angle measures.
- Each inverse trigonometric function has a restricted range that ensures a unique output.
- The graphs of inverse functions are reflections across the line  $y = x$ .
- Composition can be used to verify inverse relationships.
- Inverse trigonometric functions can be used to solve equations involving unknown angles.
- Technology can be used to evaluate inverse trigonometric expressions and verify solutions.
- The structure of a trigonometric function determines the behavior of its inverse.
- Inverse trigonometric functions have practical applications in navigation, engineering, physics, and surveying.

### **Learning Activities:**

- Explore whether sine, cosine, and tangent pass the Horizontal Line Test.
- Identify why inverse relations of unrestricted trigonometric functions fail to be functions.
- Restrict domains of trigonometric functions and analyze resulting graphs.
- Use graphing technology to investigate one-to-one intervals.
- Graph inverse sine, inverse cosine, and inverse tangent functions.
- Compare graphs of trigonometric functions and their inverses.
- Reflect graphs across the line  $y = x$ .
- Match inverse trig equations, tables, graphs, and verbal descriptions.
- Create graphic organizers comparing domains and ranges.
- Evaluate inverse trigonometric expressions.
- Use inverse trig functions to determine unknown angles in right triangles.
- Solve contextual problems involving indirect measurement.
- Use technology to verify angle solutions.
- Analyze and interpret calculator outputs in radians and degrees.
- Determine heights of buildings using angle-of-elevation data.
- Model navigation and direction problems.
- Analyze engineering situations involving angles and measurements.
- Explore applications in physics involving vectors and forces.
- Interpret inverse trig functions within contextual models.

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### Assessments

#### **Formative**

- Daily Practice Problems
- Teacher Observation
- Think-Pair-Share Activities
- Entrance/Exit Cards
- Desmos Explorations
- Whiteboard Checks
- Small Group Discussions

#### **Summative**

- Mid-unit Quiz
- Topic Test
- Performance-Based Task involving indirect measurement

#### **Alternative**

- Kahoot/Quizizz
- Individual or Group Productive Struggle Assessment
- Technology-Based Investigation Project
- Student-Created Tutorial Explaining an Inverse Trigonometric Function

### Interdisciplinary Connections

#### **ELA**

**NJSLSA.R1 – Read closely to determine what the text says explicitly and make logical inferences from it; cite specific textual evidence.**

Students interpret real-world scenarios involving angles and measurements, extracting relevant information and justifying mathematical conclusions using evidence from the context.

#### **Science**

**HS-PS2-1 – Analyze data to support claims regarding motion and forces.**

Students use inverse trigonometric functions to determine unknown angles in vector and force applications.

**HS-ETS1-4 – Use mathematical models to analyze and evaluate solutions.**

Students apply inverse trigonometric functions to engineering and design scenarios involving measurement and navigation.

### Career Readiness, Life Literacies, and Key Skills

#### **9.4.12.CT.2**

Develop multiple solutions to a problem and evaluate short- and long-term impacts of each solution.

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Students compare graphical, algebraic, and technological methods for determining unknown angles.

### **9.4.12.IML.1**

Critically curate multiple sources of information.

Students evaluate technological outputs and determine whether calculated angle measures are reasonable within a given context.

### **9.4.12.TL.3**

Use digital tools to enhance productivity in a variety of contexts.

Students use graphing technology and calculators to model and solve trigonometric problems.

## Technology Integration

All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaboratively and to create and communicate knowledge.

### **9.4.8.TL.6**

Collaborate to develop and publish work that provides perspectives on a real-world problem. Students will access the Big Ideas online ebook and digital resources to investigate inverse trigonometric functions and their applications.

### **9.4.8.TL.3**

Select appropriate tools to organize and present information digitally.

Students will use Quizizz, Kahoot, Quizlet Live, and Google Classroom to monitor and communicate learning.

### **9.4.5.CT.3**

Describe how digital tools and technology may be used to solve problems.

Students will use graphing calculators and Desmos to investigate domain restrictions and inverse relationships.

### **9.4.12.TL.1**

Assess digital tools based on accessibility, capacity, and utility.

Students will evaluate the effectiveness of graphing technology and calculator tools when solving inverse trigonometric problems.

### **9.4.12.TL.4**

Collaborate in online learning communities or virtual environments to analyze and propose solutions.

Students will participate in online discussions and collaborative investigations involving inverse trigonometric applications.

### **9.4.8.IML.3**

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Create a digital visualization that effectively communicates a data set.  
Students will create graphical representations comparing trigonometric functions and their inverses using Desmos and other digital platforms.

### Career Education

#### **9.4.12.TL.3**

Use digital tools to enhance productivity in a variety of contexts.

#### **9.4.12.TL.1**

Analyze the impact of technology on personal and professional productivity.

#### **9.4.12.IML.5**

Evaluate digital tools for effectiveness and reliability in gathering and using information.

### Modifications (ELL, Special Education, At-Risk Students, Gifted & Talented, & 504 Plans)

#### **ELL:**

- Work toward longer passages as skills in English increase
- Use visuals
- Introduce key vocabulary before lesson
- Teacher models reading aloud daily
- Provide peer tutoring
- Use of Bilingual Dictionary
- Guided notes and/or scaffold outline for written assignments
- Provide students with English Learner leveled readers.

#### **Supports for Students With IEPs:**

- [Curriculum Companion](#)
- Allow extra time to complete assignments or tests
- Guided notes and/or scaffold outline for written assignments
- Work in a small group
- Allow answers to be given orally or dictated
- Use large print books, Braille, or books on CD (digital text)
- Follow all IEP modifications

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### **At-Risk Students:**

- Guided notes and/or scaffold outline for written assignments
- Introduce key vocabulary before lesson
- Work in a small group
- Lesson taught again using a differentiated approach
- Allow answers to be given orally or dictated
- Use visuals / Anchor Charts
- Leveled texts according to ability

### **Gifted and Talented:**

- Create an enhanced set of introductory activities (e.g. advance organizers, concept maps, concept puzzles)
- Provide options, alternatives and choices to differentiate and broaden the curriculum
- Organize and offer flexible small group learning activities
- Provide whole group enrichment explorations
- Teach cognitive and methodological skills
- Use center, stations, or contracts
- Organize integrated problem-solving simulations
- Propose interest-based extension activities
- Expose students to beyond level texts.

### **Supports for Students With 504 Plans:**

- Follow all the 504 plan modifications
- Text to speech/audio recorded selections
- Amplification system as needed
- Leveled texts according to ability
- Fine motor skill stations embedded in rotation as needed
- Modified or constrained spelling word lists
- Provide anchor charts with high frequency words and phonemic patterns

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