FORMAT GUIDE

Clarifying notes about the unit

Concept generalizations

Topic

- Facts/Procedures
- Facts/Procedures
- Facts/Procedures

Topic goals and generalizations

Topic

- Facts/Procedures
- Facts/Procedures
- Facts/Procedures

Topic goals and generalizations

Unit: CONCEPT

Topic

- Facts/Procedures
- Facts/Procedures
- Facts/Procedures

Topic goals and generalizations

Essential Understandings

- Concept and topic goals and generalizations based on the compelling questions

WHERE and **HOW** this material relates to the bigger picture

Compelling Questions

- The Questions that lead us to the essential understandings - *Why does this matter*, and *What are we trying to find out*?

WHY are we focusing on this material, and **WHAT** will we learn?

Critical Content

- What students will know

WHAT are the most important things to know

Key Skills

- What students will be able to do

HOW this material can be applied

Algebra 2 Concept-Based Map DRAFT

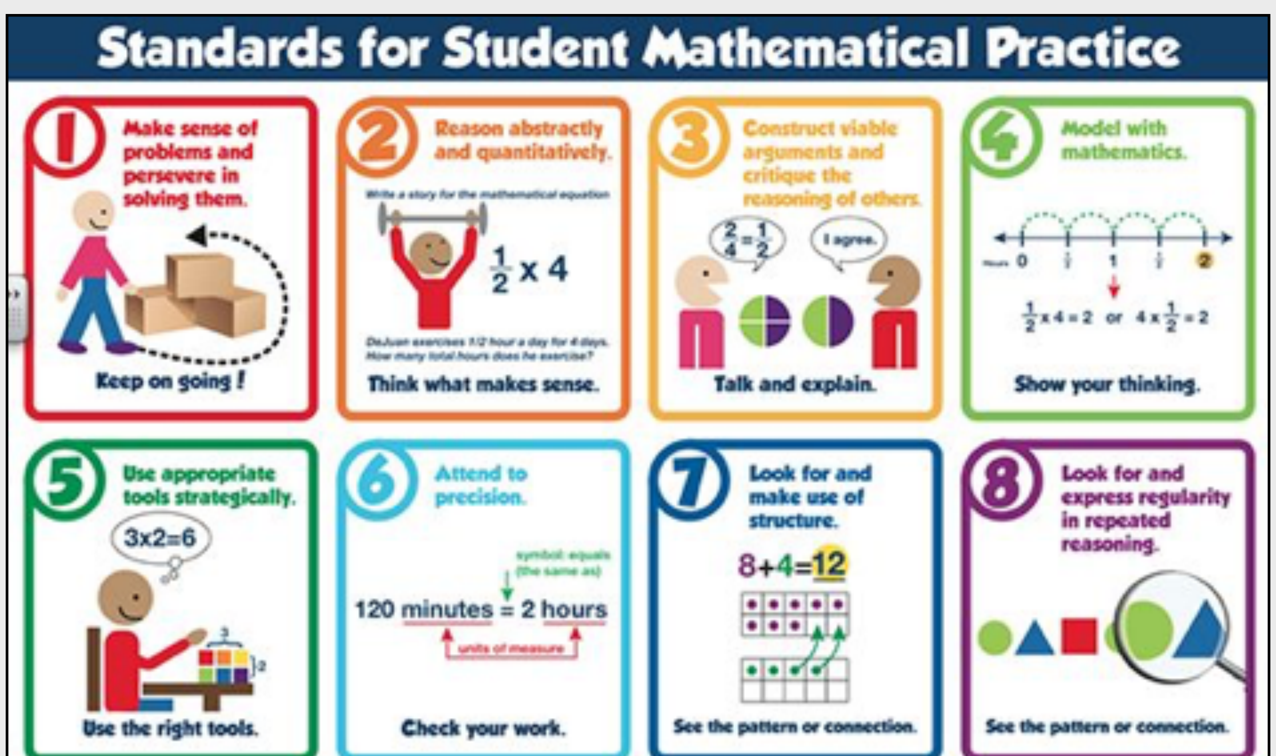
Algebra 2 is a language that can express relationships and reveal patterns between two related variables. It gives us the tools to apply and relate functions to equations and to create mathematical models, which we can use to make inferences, predictions and to draw conclusions.

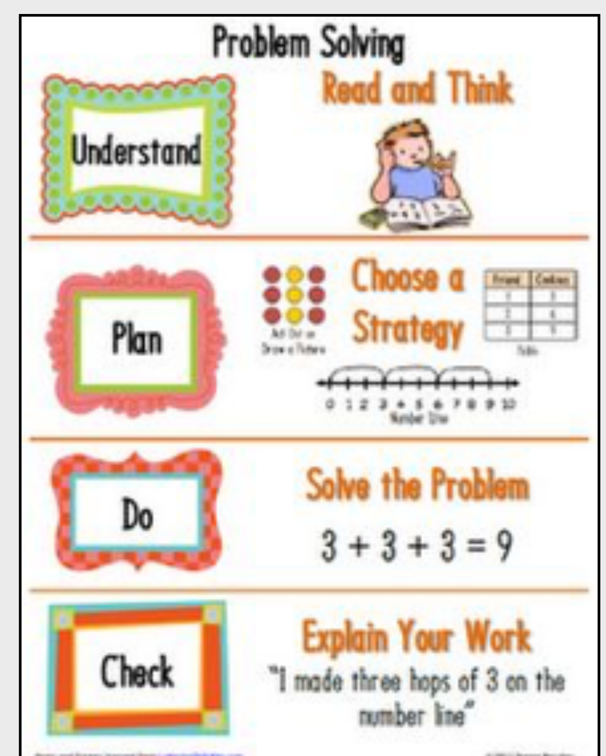
The course starts by providing a general overview of different families of functions so students can identify key features that distinguish families, and recognize that some families work well to model particular situations.

Subsequent units give students opportunities to deepen knowledge of each function family including transformations, inverses, understanding the effects of restricting domain and range, solving for key features including maxima and minima, roots, intercepts, symmetry, and end behavior and how to apply these tools to real life and abstract situations.

This course culminates with applications of functions. Students analyze and interpret statistics and use probability to make predictions and inferences from data.

In conjunction with the above, this course is intended to deepen students' relationships with the mathematical practices and help them to become confident and independent problem-solvers.





Algebra 2 Unit Map

Unit 0: Intro to Algebra 2

Unit 1: Families of Functions

Unit 2: Linear Functions

Unit 3: Exponential Functions

Unit 4: Trigonometric Functions

Unit 5: Quadratic Functions

Unit 6: Logarithmic Functions

Unit 7: Statistics

Algebra 2 Timeline

Week 1	Unit 0: Intro to Algebra 2
Weeks 2-4	Unit 1: Families of Functions
Weeks 5-14	Unit 2: Linear Functions
Weeks 15-18	Unit 3: Exponential Functions
Weeks 16-18	Unit 4: Trigonometric Functions
Weeks 19-20	Review and Exams
Weeks 21-29	Unit 5: Quadratic Functions
Weeks 30-32	Unit 6: Logarithmic Functions
Weeks 33-36	Unit 7: Statistics
Weeks 37-39	Review and Exams

This unit is intended to set the culture and expectations of class for the school year.

Students will understand the importance of listening to how others make sense of their work to arrive at common understandings, and will contextualize themselves as valuable and valued parts of a thinking mathematical community. They will understand that mathematics is a study of patterns and relationships.

Unit 0: Intro to Algebra 2

Growth Mindset

- Potential impact of a growth mindset (e.g. that math is not about talent or natural ability, but about thoughtful practice) and what it means to talk and listen.
- Students will understand that math class is where students practice thinking and doing math.

Students will understand the importance of a growth mindset, and the value of mistakes and risk-taking.

Community

- Co-creation of our learning community
- Student input into how our classroom will run, and therefore responsibility.

Students will understand the importance of creating a safe environment for risk taking and experimentation

Math Practices

- Familiarity with the 8 math practices.

Students will begin to prioritize the use of precise work and language, sharing their ideas, and will understand that successful mathematicians (and math students!) identify, practice, and cultivate specific habits

Patterns and Relationships

- What comes next? Examining patterns.

Students will define Mathematics as a study of patterns and relationships

Problem Solving

- Problem solving steps and methods
- 4-step problem solving cycle
- Focus on processes in addition to solutions

Students will understand that mathematics consists of thinking in addition to procedures and will begin to identify specific steps and systems that they can apply as problem solvers

This unit is primarily about the descriptive, not the quantitative. Students will make connections to and build on their prior understandings of functions and develop a deeper understanding of how two quantities relate to each other.

Students will understand that functions articulate how two quantities are related. They will understand how functions are notated and described, and ways in which we compare functions. Students will understand how and why we represent different functions and function families in different ways - **graphically**, **algebraically**, through **verbal descriptions**, and through **tables**.

Unit 1: Families of Functions

Function Families

- Functions are mappings of inputs to exactly one output
- Families of functions have distinct shapes and characteristics
- Identify and articulate differences between function families
- Key features can help distinguish function families.
- Analyze key features of graphs.

Students will understand that function families share similar graphs, behaviors, and properties

Mathematical Models

- Students will understand that graphs can describe situations from the world
- Students will create graphs to model situations
- Modeling often requires moving among different representations.
- Models are imperfect but often useful.

Students will understand that mathematical models can illustrate and reveal aspects of real situations, and will create and analyze graphs to demonstrate this understanding.

Parent Functions

- Linear
- Exponential
- Logarithmic
- Polynomial
- Square Root
- Absolute Value
- Trig/Periodic
- Quadratic

Students will understand that functions within a family share specific characteristics.

Transformations

- Students will sort functions into families, and will identify their distinct characteristics
- Students will relate transformed functions to parent functions
- Function notation f(x), g(x), etc.

Students will understand that functions within a family are transformations of the parent function. Students will practice with the precise grammar and vocabulary in math by using function notation.

Representation

- Students will connect Graphic, Algebraic, Tabular, and Verbal Representations
- Students will interpret graphs and use them to describe situations
- Students will interpret equations and use them to describe situations

Students will understand that functions can be represented in multiple, equivalent ways

In Unit 1 much of the work is descriptive and general. From Unit 2 forward, students are asked to calculate, quantify and formalize their analysis.

Students will understand that constant rate of change is the key feature that defines linear functions, and that given one location and a rate of change, they can predict any other location**.** Students will understand how graphs, equations, verbal descriptions, and tables can describe different aspects linear functions. Students understand that absolute value functions, linear systems, and linear inequalities are related to and extensions of linear functions.

Unit 2: Linear Functions

Linear Equations

- Slope
- Slope-Intercept form
- Standard form
- Point-slope Form
- A solution is a value that makes a function rule true.
- Writing equations

Students will write equations to represent situations. They will manipulate equations from one form to another, and understand that different but equivalent forms reveal different aspects of a function.

Function Rules

- n^{th} term
- linear/arithmetic sequence
- Input/Output
- Continuous/Discreet
- Arithmetic Sequences and Series including summation
- Sigma Notation
- Common Differences

Students will understand that function rules describe the quantitative relationships between variables.

Constant Rate of Change

- Linear functions are characterized by a constant rate of change.
- A function's rate of change and initial value determine its other properties and behaviors.
- y-intercept and transformations
- Use a function's rate of change to predict future states/generate next steps

Students will know that linear functions are characterized by a constant rate of change. They will understand that the initial value and rate of change can be used to make predictions.

Representation

- Graphic, Algebraic, Verbal, Numeric
- Move with facility between G>A>V>N

Students will understand that functions can be represented in multiple, equivalent ways, and that each way can be helpful for different situations, and can reveal and illuminate different characteristics.

Absolute Value

- Graphs and transformations
- Writing and solving equations/inequalities
- Vertex

Students will recognize the characteristic shape of an absolute value graph, and will recognize transformations from the absolute value parent function y=|x|.

Linear Inequalities

- Graphing
- Notation
- Linear Programming

Students will understand that inequalities in 2 variables divide the plane into two regions, and will create and analyze graphs of 2 variable inequalities.

Linear Systems

- Elimination, Substitution, Graphing

Students will recognize that systems of equations (or Inequalities) contain functions that share the same set of variables. They will understand that a solution simultaneously makes each function rule in a system of equations (or inequalities) true. They will understand that the solution to a system of equations (or inequalities) can be represented in multiple, equivalent ways.

Students investigate exponential growth and decay as key features that define exponential functions, and write equations that describe the relationship between quantities for exponential functions including geometric sequences.

Students recognize and identify key features of exponential growth and decay. They understand how to manipulate exponential equations by using the laws of exponents and roots. Students understand how to communicate using precise mathematical language and forms, and how to compare exponential to linear models. Students understand how to differentiate between geometric and arithmetic sequences.

Unit 3: Exponential Functions

Manipulating Expressions

- Mechanics and properties of exponential expressions
- Rational exponents
- Multiplication/division of exponents
- Similar Bases/ changing to similar base

Students will understand how to do arithmetic with exponential expressions.

Sequences and Series

- Geometric vs. Arithmetic
- nth term rules
- Sigma Notation
- Summation using formulas

Students will understand that geometric sequences relate to and behave like exponential functions, and can be used to model real situations. They will differentiate Geometric and Arithmetic sequences.

Graphing: Growth and Decay

- Modeling
- Graphing
- Describing
- Compound interest

Students will understand the characteristic shape and behavior of exponential growth and decay. Students will understand how to compare exponential to linear models.

Root Functions

- Rational exponents
- Simplify Square roots
- Rationalize the denominator
- Graphing

Students will understand that changing the form of expressions is a way to communicate with specific mathematical grammar. Students understand that roots can be rewritten with rational exponents, and that this is convenient for manipulations and perspective.

This unit is intended as an overview of right angle trigonometry and vector addition. The work in this unit will scaffold students so they gain the skills they will need for the work they will be doing in Grade 10 Physics.

Students will understand how to find all measurements in right triangles given either one side and one angle or two side lengths, and will recognize relationships between circles and triangles. Students will understand that vector addition can be modeled with right-angled triangles, and they will understand how to create graphs and models using the sine function.

Vectors

- Definition of Vectors vs. Scalars
- Vector addition
- Force and direction problems

Students will understand that a vector quantity has both direction and magnitude. They will be able to model forces in the world with vectors, and to solve problems using their models.

Modeling

- Modeling with the sine function
- Graphing Trig Sine, Cosine, Tangent functions
- Real World examples (eg. Day length, Tidal Flow)

Students will recognize and graph sine functions. They model situations using sine and solve problems using their models.

Unit 4: Trigonometric Functions

Right Angle Trigonometry

- Unit Circle - connection to Pythagorean Theorem
- Sine, Tangent, Cosine
- Ratio and Proportion

Students will know how to find all measurements in right triangles given either one side and one angle, or two side lengths. Students will understand that equations for circles can be formed by using the Pythagorean Theorem and the relationships in right-angled triangles, and that Trig functions can be derived in this way.

Students will understand key features that define quadratic functions, and how to write equations that describe the relationship between quantities for quadratics. Students will understand how to identify key features of quadratic models through analysis of graphs. They will understand that they can solve quadratic equations through multiple methods and will identify the advantages of each method. They will understand how to manipulate the graphs of quadratic equations by transforming the parent function $y=x^2$ and will understand that they can transfer this understanding to analyze characteristics of higher degree polynomials.

Unit 5: Quadratic Functions

Representation

- Vertex form
- Standard form
- Factored form
- Graphing
- Tables > common 2nd differences

Students will understand that equivalent representations of a function highlight different properties. They will demonstrate facility in using the tools of algebra to move between different forms.

Quadratic Equations

- Multiple ways to solve quadratic equations
- Complete the Square
- Quadratic Formula
- Factoring
- 1,2, or no real roots
- Powers of *i,* imaginary and complex solutions

Students will understand that there are many ways to solve a quadratic equation, and that there will be one, two, or no real solutions. Students will understand that if there are no real solutions, there are solutions, using *i* on the set of complex numbers.

Transformations

- Vertical and Horizontal shifts
- Vertical and Horizontal stretches/flips
- Symmetry of quadratics

Students will understand that all graphs of functions within a family (including quadratics) are transformations of the parent function.

Characteristics

- Quadratic equations are distinguished by x^2, and will relate this concept to the area of a quadrilateral.
- Characteristic shape of a Parabola
- Roots (Solutions), Vertex,
- Line of Symmetry, Minimum/Maximum
- Graphs

Students will understand that quadratic functions are distinguished by x^2, and that quadratic graphs make a distinct shape called a parabola

Polynomials

- Local Minima and Maxima
- End Behavior
- Graphing
- Factoring
- Quadratic and Cubic sequences and common differences - nth term rules

Students will understand that concepts of quadratics, and algebraic techniques can be used to help understand high degree polynomials.

Students understand key features that define Logarithmic functions, the inverse relationship between logs and exponentials, and the implications of that relationship to the rate of change of logs.

Unit 6: Logarithmic Functions

Graphing

- Inverse > Log vs. Exponential
- Transformations
- intercepts
- asymptotes

Students will recognize that Log functions are the inverse of exponential functions, and that they have symmetry over the line *y*=*x*.

Manipulating Expressions

- Properties of logs
- Mechanics and properties of logs
- Bases, *e,* Natural Log and Base 10
- Moving between exponential and log
- Solving log equations

Students will understand how to do arithmetic with logarithmic expressions.

Modeling

- Logarithmic Scale
- Domain and Range

Students will understand the characteristic behavior of logarithmic functions and how excruciatingly slowly log functions grow.

Students apply their knowledge of functions to analyze and interpret statistical information and to make predictions and inferences from data.

Students understand how to choose appropriate visual models to illustrate connections between variables and how to use statistics to support and critique arguments and make predictions

Unit 7: Statistics

Interpreting Data and making predictions

- Collect and analyze data
- Line/ Curve of best fit
- Normal Distribution (Bell Curve)
- Spread and mean
- Sample space and probability of an event
- Correlation/ causation
- describe the relationship between variables for the graph of a scatter plot
- shape, center, spread, and extreme values

Students will summarize and interpret data using statistical measures and visual representations.

Visualizing data

- Creating graphs and charts reveals insights into data
- Graphs illustrate correlation of bivariate data
- Measures of center are used to interpret univariate data.
- Regression
- Multiple representations (graphs, charts, tables, formulas) can be used to communicate and potentially miscommunicate different meaning about statistics.
- Choose representations for communicating statistics based on the appropriateness of these representations.

Students will summarize and interpret data using statistical measures and visual representations, and will choose effective representations to communicate about data.

Modeling

- Comparing and recognizing models from all of the function families
- Making predictions based on data (use a fitted function to predict and justify other possible data points)
- Line of best fit
- Correlation
- inverse variation, joint variation, direct variation
- Comparisons between collected data and simulations

Students will create mathematical models to analyze real situations, and will use their models to support and critique arguments.

Permutations and Combinations

- Distinguish between permutations and combinations
- Factorial, multiplication principle, counting principle
- Probability of an event

Students will distinguish between permutations and combinations, and will determine probabilities related to each.

Problem solving is integrated through the entire course, but it is important to place emphasis on supporting students through this process. The materials and ideas connected to this unit are intended to support students in becoming confident and independent problem-solvers. Some of the learning experiences are connected to specific course content, and some are targeted to discreet problem-solving skills. This work should be included wherever possible throughout the course.

Strategies

- 4-Step Problem-solving cycle based on Polya's process
- Problem solving steps and methods
- Focus on processes in addition to solutions

Students will identify specific steps and systems that they can apply as problem solvers

Unit X: Problem Solving

Habits of Mind

- Perseverance
- Flexibility and multiple paths to a solution
- Forming and critiquing arguments
- Showing and articulating steps
- Choosing appropriate tools strategically
- Seeing and making use of structure
- Importance of precision
- Looking for and finding patterns

Students will understand that successful mathematicians (and math students!) identify, practice, and cultivate specific habits

Unit 0: Intro to Algebra 2

Essential Understandings

- A learning community has to be a safe environment for risk taking and experimentation
- A growth mindset, and willingness to take risks and make mistakes are essential to learning and doing mathematic? Successful mathematicians (and math students!) identify, practice, and cultivate specific habits
- Mathematics consists of thinking in addition to procedures, and there are specific steps and systems that we can apply as problem solvers
- Social learning and collaboration are important to gaining understanding, especially in math. Working independently is a way to make sure that you have learned and can apply concepts.
- Precise work and language are important in communicating and sharing ideas in math.
- Mathematics is a study of patterns and relationships. These patterns provide insights into potential relationships.
- Patterns and relationships can be represented numerically, graphically, symbolically, and verbally. Each representation can help us to understand these relationships in different ways.

Compelling Questions

- What is important in a learning community?
- What makes a strong math thinker? What makes a strong math student?
- What makes a strong problem solver, and how can we learn to be strong problem solvers?
- How can collaboration help us to learn (math)? When and why is it important to work independently?
- What are the different ways of communicating mathematics with clarity?
- How can patterns be used to make predictions?
- What are the different ways that we can illustrate relationships, and how do we choose between them?

Vocabulary

1. Growth Mindset
2. Fixed Mindset
3. Math Practices
4. Habits of Mind
5. Pattern
6. Relationship
7. Precise
8. Persevere
9. Reason

Critical Content

- Mathematics as the study of patterns
- Understanding of growth and fixed mindsets and the impact that each has on learning
- Understanding that every member contributes to the culture of a learning community
- There are specific strategies and habits for problem-solving that can be cultivated and learned

Key Skills

- Collaborative work
- Independent work
- Perseverance
- Arguing and Critiquing
- Finding patterns
- Finding and using structure
- Precision in arithmetic and language

Unit 1: Families of Functions

Essential Understandings

- A function is a correspondence between two sets, X and Y, in which each element of X is matched to one and only one element of Y. The set X is called the domain of the function.
- Function families share similar graphs, behaviors, and properties; functions within a family are transformations of the parent function
- Functions can be represented in multiple, equivalent ways. Each representation has its own advantages
- Mathematical models can illustrate and reveal aspects of real situations; graphing assists in our analysis and understanding.
- The grammar and vocabulary of math, including function notation, allow us to communicate precisely. We can make explicit use of this precision to make strong arguments

Compelling Questions

- What is a function?
- What features do functions within the same family share? What makes a particular function family unique from other types of functions?
- What are the different ways that we can illustrate functions, and how do we choose between them?
- Why do we create mathematical models and what do the key features of the graph of a function reveal?
- Why are there different methods of notation for functions? Why is it important to use precise notation?

Critical Content

- Analyze key features of graphs, including: Increasing interval, decreasing interval, intercepts, periodicity, minimum/maximum, domain and range, end behavior
- Recognize the differences between average rate of change vs. Constant Rate of Change
- Relate graphs and tables to situations; tell the "story" of a graph
- Creation of scatterplots, Time-Distance Graphs
- Distinguish between function families
- Recognize transformations from a parent function
- Make connections between multiple representations
- Understanding that mathematical models can illustrate and reveal aspects of real situations

Key Skills

- Describe key features using appropriate vocabulary
- Identify the general shape and behavior of different function families
- Use minimums, maximums and intercepts to describe a function and represent it in multiple ways
- Determine a function's family using its key points, and shape
- Interpret a situation, graph, table of values, or equation using the rate of change
- Identify an appropriate function family for a situation and defend that choice; model a situation with an appropriate representation.
- Justify and compare representations of different function families and describe similarities and differences. Given one representation, create another.
- Compare functions within a family and describe the transformations from the parent function
- Create and analyze graphs to illustrate and reveal aspects of real situations

Vocabulary

1. Linear
2. Exponential
3. Quadratic
4. Logarithmic
5. Trigonometric
6. Piecewise
7. Absolute Value
8. Step Function
9. Zero
10. Infinity
11. Independent/ Dependent variable
12. Domain
13. Range
14. Function notation

Unit 2: Linear Functions

Essential Understandings

- Linear equations represent real and abstract situations characterized by a constant rate of change. Their graphs always make straight lines
- Equations can be manipulated from one form to another, and different but equivalent forms reveal different aspects of a function
- Function rules describe the quantitative relationships between variables. Tables are useful for beginning a pattern, and nth term expressions are useful for making more distant predictions
- The initial value and rate of change of a linear function can be used to make predictions.
- An absolute value graph has a characteristic "V" shape, and transformations from the absolute value parent function $y=|x|$ share this characteristic. Absolute value represents distance from zero.
- Systems of equations represent situations with more than one constraint, and contain functions that share the same set of variables. A solution simultaneously makes each function rule in a system of equations true, and the solution to a system of equations can be represented in multiple, equivalent ways.
- Linear inequalities in 2 variables divide the plane into two regions. They are related to linear equations, but can be used to model situations with a maximum or minimum

Compelling Questions

- What types of relationships can be modeled by linear functions, and what do math models of these relationships look like?
- Why are there different forms for notating equations of lines, and how can we decide in which format to write a linear equation?
- How can we write recursive or explicit rules for linear situations, and why do we write function rules?
- How can we use linear equations to make predictions?
- What are the key features of absolute value relationships and graphs?
- What can we do with a system of equations/inequalities that we cannot do with a single equation/inequality? How do we find solutions to systems?
- How are linear inequalities similar or different from linear equations, and when are they useful?

Vocabulary

1. Linear Equation
2. n^{th} term
3. Arithmetic Sequence
4. Arithmetic Series
5. Slope
6. x- and y-intercepts
7. Parallel
8. Perpendicular
9. Common Difference
10. System of Equations
11. Inequality

Critical Content

- Linear functions are characterized by a constant rate of change
- Recognize and solve linear combinations
- Solving linear equations
- Fitting lines to data on a graph (how to find a line of best fit), through sketching and through technology.
- Constant rate of change problems
- Solving absolute value problems
- Geometrically, the absolute value of a number is its distance on a number line from 0; Algebraically, the absolute value of a number equals the nonnegative square root of its square.

Key Skills

- Determine the slope and intercepts of a line given its equation.
- Find an equation of a line given two points on it or given a point on it and its slope.
- Recognize properties of linear functions.
- Model constant-increase or constant-decrease situations, linear combination situations, mixture problems, and situations leading to piecewise linear functions or to linear step functions.
- Create and analyze graphs of linear functions, piecewise linear functions, step functions, and sequences.
- Solve absolute value equations and inequalities algebraically and graphically.
- Write and analyze equations and inequalities that describe the relationship between quantities for linear functions.
- Write nth term expressions.

Unit 3: Exponential Functions

Essential Understandings

- There are rules and procedures for arithmetic with exponential expressions which can save us from doing repeated or redundant calculations
- Geometric sequences relate to and behave like exponential functions, and can be used to model real situations. Geometric and Arithmetic sequences have specific similarities and differences.
- Exponential growth and decay have characteristic shape and behavior, and are substantially different from linear growth. Exponential graphs have a characteristic shape, and all exponential graphs are transformations from the parent function $y=b^x$.
- Roots can be expressed as rational exponents.
- Changing the form of expressions and equations is a way to communicate with specific mathematical grammar. Equations can be manipulated from one form to another, and different but equivalent forms reveal different aspects of a function

Compelling Questions

- Why is it helpful to learn about the mechanics of exponents, and how do exponents work?
- How are geometric sequences related to exponential functions, and where do they show up in the world? How are they similar or different from arithmetic sequences?
- What does exponential growth or decay look like, and how does it compare to linear growth? How can graphs help us to visualize these differences?
- How are expressions involving radicals and exponents related?
- Why are there different forms for notating expressions and equations, and how can we decide in which format to write an exponential equation?

Vocabulary

1. Exponent
2. Exponential Growth
3. Exponential Decay
4. Base
5. Rational Exponent
6. Square Root
7. Power
8. nth root
9. Geometric sequence
10. Compound interest

Critical Content

- Product of powers postulate
- Quotient of powers theorem
- Negative exponent theorem
- Rational exponent theorem
- Manipulate radical expressions
- Understand graphs of exponential equations
- Calculate compound interest
- n^{th} term expressions for geometric sequences

Key Skills

- Manipulate exponential equations by using the laws of exponents and roots
- Write a radical function or expression as an equivalent power function or expression.
- Represent exponential functions numerically, algebraically, and graphically.
- Solve radical equations graphically and algebraically, and check for extraneous roots.
- Write equivalent expressions involving radicals and exponents, including negative exponents.
- Evaluate expressions involving radicals and exponents.
- Sketch graphs of exponential functions and create graphs using technology

Unit 4: Trigonometric Functions

Essential Understandings

- A scalar quantity has magnitude, and a vector quantity has both direction and magnitude.
- Vector addition can be used to solve problems from the world involving force and direction. There are several ways to solve these problems using trig or graphing.
- We can find all measurements in right triangles given either one side and one angle, or two side lengths.
- Equations for circles can be formed by using the Pythagorean Theorem and the relationships in right-angled triangles, and that Trig functions can be derived in this way.
- The graph of a sine functions has a characteristic shape and behavior, which is an excellent model for certain situations. (eg. hours of daylight over time, height of tides, etc.)

Compelling Questions

- What is the difference between a scalar and a vector?
- How and why do we use vectors?
- If we know the lengths & measures of SOME sides & angles of a triangle, when & how can we find all the others?
- How are equations for circles related to right triangles?
- What do the graphs of Trig functions look like and how do they behave?

Vocabulary

1. Ratio
2. Sine
3. Cosine
4. Trigonometry
5. Tangent
6. Vector
7. Magnitude
8. Direction
9. Scale
10. Modulation
11. Period
12. Amplitude

Critical Content

- Model forces in the world with vectors, and solve problems using this model
- Vector addition
- Graphing sine functions, and analysis of these graphs.
- Solving for missing sides/angles of triangles.

Key Skills

- Recognize a situation that modulates and can be represented well with a sine function.
- Create and transform a sine function to match a situation. (eg. height of a ferris wheel over time.)
- Use right angle trig to solve vector problems
- Use graphing method (protractor and ruler) to solve vector problems

Unit 5: Quadratic Functions

Essential Understandings

- Quadratic functions are distinguished by x^2 ;their graphs make a distinct shape called a parabola and quadratic equations are used to model situations in which one variable varies as the square of another.
- There are many ways to solve a quadratic equation; the method chosen in a specific case depends on the information that is given and the preference of the mathematician. There will be one, two, or no real solutions/roots, which are the x-intercepts of the graph.
- Equivalent representations of a function highlight different properties. We can use the tools of algebra to move between different forms. All graphs of quadratic functions are transformations of the parent function: $y=x^2$.
- Finding zeros of a polynomial allows us to use factoring to separate the components of the equation into simpler pieces.
- Quadratic equations arise from problems involving areas of rectangles.
- The square roots of negative numbers are pure imaginary numbers and all are multiples of $\sqrt{-1}$; i^2 *is* defined as -1. If there are no real solutions to a quadratic, there are solutions, using i on the set of complex numbers.

Compelling Questions

- What is a quadratic function?
- How can we find solutions to quadratics and how does the graph of a quadratic function relate to its algebraic equation?
- How can we represent quadratic functions, and why do we use different representations?
- Why is it important to use factoring and other algebraic tools to re-arrange polynomials?
- Where does the word quadratic come from, and why do we use it to describe functions involving x^2?
- What can we do when we have no real solutions to a quadratic; what is *i*?

Vocabulary

1. Quadratic
2. Binomial
3. Polynomial
4. Quadratic Formula
5. Complete the square
6. Factor
7. Square root
8. Parabola
9. Root
10. Parent Function
11. Reflection
12. Line of Symmetry
13. Vertex

Critical Content

- The graph of $y = ax^2 + bx + c$, when a does not equal 0, is a parabola that opens upward if $a > 0$ and downward if $a < 0$.
- The Quadratic Formula gives the solutions to any quadratic equation in standard form whose coefficients are known.
- Factoring and completing the square also are ways to solve quadratics
- You can determine whether the solutions to a quadratic equation with real coefficients are real or not real by calculating a value called the discriminant of the quadratic
- End behavior of polynomials

Key Skills

- Solve quadratics through factoring, completing the square, and the quadratic formula
- Graph quadratics, and write equations given a quadratic graph
- Perfect squares are useful in solving quadratics because they allow us to factor the polynomial.
- Describe end behavior of polynomials
- Create a quadratic math model and solve problems given a situation

Unit 6: Logarithmic Functions

Essential Understandings

- Log functions are inverses of exponential functions; an inverse function is a function that “undoes” another function; if f(x) maps x to y, then f-1(x) maps y back to x.
- We can rewrite the laws of exponents to work with logarithms and solve logarithmic equations.
- The graph of a log functions has a characteristic shape and behavior, which is an excellent model for certain situations.

Compelling Questions

- How do logarithms relate to exponents?
- How can we solve logarithmic equations?
- What do the graphs of log functions look like and how do they behave?

Critical Content

- Laws of logs
- Change of base formula
- Graphs of logs

Key Skills

- Manipulate log expressions by using the laws of logs
- Solve log equations
- Graph log functions and write equations given a log graph
- Create a logarithmic math model and solve problems given a situation

Vocabulary

1. Logarithm
2. Inverse
3. Translation
4. Change of Base
5. Common log
6. Natural log
7. Asymptote

Unit 7: Statistics

Essential Understandings

- The way that data is collected, organized and displayed influences interpretation.
- Visual models illustrate the correlation of bivariate data. Different kinds of visual models and graphs can reveal different aspects of a situation; we can choose which model to use depending on what we are trying to communicate, what we are trying to predict, or what question we are trying to answer.
- The probability of an event's occurrence can be predicted with varying degrees of confidence. The accuracy of a prediction increases with the number of events considered; probability calculations can be applied to solve problems and make decisions
- Measures of center are used to interpret univariate data. Mean, median, mode, and range can be used to describe the shape of data; the shape gives us insight into the story told by the data.
- We can use statistical data to support an argument about real and abstract situations, and we can compare our model to actual experimental results.

Compelling Questions

- How can you collect, organize, and display data? How do you interpret the data you have collected? How do charts, tables, and graphs help you interpret data?
- What kinds of questions can be answered using different data displays, and what data display is appropriate for a given set of data?
- How is the likelihood of an event determined and communicated? How can we use or test our predictions? Are they valid? Are they significant?
- What mathematical tools can we use to describe data?
- How do we use evidence to support arguments? How do we interpret evidence in order to support arguments? How do we create, test and validate a model?

Vocabulary

1. Distribution
2. Variance
3. Measure of central tendency
4. Bivariate
5. Correlation
6. Causation
7. Standard Deviation
8. Quartile
9. Mean
10. Median
11. Mode
12. Range

Critical Content

- Measures of central tendency
- Analysis of visual models of data
- Normal (and binomial?) distribution
- Correlation/ causation

Key Skills

- Interpret data using measures of center and spread; calculate and interpret mean, median, mode, range
- Create, analyze, and interpret visual models of data and graphs.
- Use technology to find regression functions
- Model data using familiar functions, and make connections between probability and statistics

Unit X: Problem-Solving

Essential Understandings

- A problem solver can develop specific strategies for how to understand and begin a task.
- There can be different strategies to solve a problem, but some are more effective and efficient than others are.
- The context of a problem determines the reasonableness of a solution.
- The ability to solve problems is the heart of mathematics.
- A problem solver understands what has been done, knows why the process was appropriate, and can support it with reasons and evidence.
- Working independently is essential to develop personal problem solving skills; working collaboratively can yield deeper and more complex perspectives than working alone. Each is important and related skills can be cultivated and practiced
- Precision in language and computation is essential to arriving at clear and reliable answers

Compelling Questions

- How do I know where to begin when solving a problem and what do I do when I get stuck??
- How do I decide what strategy will work best in a given problem situation?
- How do I know when a result is reasonable?
- What is mathematics really about?
- How does explaining my process help me to understand a problem's solution better?
- When should I work independently, and when should I collaborate?
- What is the relationship between solving problems and computation?

Vocabulary

1. Perseverance
2. Growth/Fixed Mindset
3. Process
4. Solution
5. Strategy
6. Polya's 4 step process

Critical Content

- The content for this unit lies in understanding how to approach novel problems and situations, how and when to use resources, when to be independent. and when to collaborate.

Key Skills

- Metacognition
- Perseverance
- Independent work when appropriate
- Collaboration when appropriate
- Develop strategies for what to do when presented with novel situations
- Cultivate mathematical habits of mind