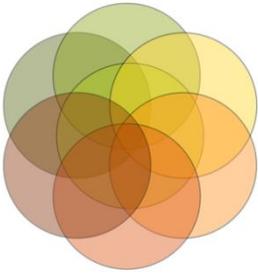


**Oklahoma Academic  
Standards for Mathematics**

**Third DRAFT**

**September, 2015**



# Acknowledgements

The Oklahoma Academic Standards for Mathematics 2015 is the result of the contributions of many mathematics teachers and mathematics educators from across the state. We believe this document reflects a balanced synthesis of the work of all members of the Oklahoma Academic Standards for Mathematics Writing Committee.

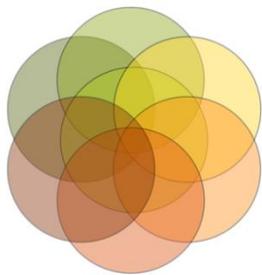
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# Introduction

The Oklahoma Academic Standards for Mathematics 2015 specify what students should know and be able to do as learners of mathematics at the end of each grade level or course. Students are held responsible for learning standards listed at earlier grade levels as well as their current grade level. Following each of the standards are **Sample Problems or Classroom Activities (Forthcoming)** that clarify the standards and provide possibilities for their implementation.

Throughout this document, the standards are written to allow time for study of additional material at every grade level. The order of the standards at any grade level is not meant to imply a sequence of topics and should be considered flexible for the organization of any course. The document provides standards for PK-7, Pre-Algebra, Algebra I, Geometry, Algebra II with Algebra I as the pre-requisite for both Geometry and Algebra II.

## Development of the Oklahoma Academic Standards for Mathematics

The Oklahoma Academic Standards for Mathematics writing team drew on the work of the National Council of Teachers of Mathematics (NCTM) standards documents; the National Research Council's report *Adding It Up*, the Oklahoma Priority Academic Standards (PASS), and other states' standards documents and curriculum framework guides (e.g., Minnesota, Virginia, and Massachusetts). Please see the reference list at the end of this document for a more complete list of all resources consulted.

## Vision and Guiding Principles

These standards envision all students in Oklahoma will become mathematically proficient and literate through a strong mathematics program that emphasizes and engages them in problem solving, communicating, reasoning and proof, making connections, and using representations. Mathematically proficient and literate students can confidently and effectively use mathematics concepts, computation skills, and numbers to problem-solve, reason and analyze information. Developing mathematical proficiency and literacy for Oklahoma students depends in large part on a clear, comprehensive, coherent, and developmentally appropriate set of standards to guide curricular decisions. The understanding and implementation of these standards throughout PK-12 mathematics experience for students is based on the following guiding principles:

**Guiding Principle 1:** Excellence in mathematics education requires equity--high expectations and strong support for all students.

All students must have opportunities to study—and support to learn—mathematics. Equity does not mean that every student should receive identical instruction; instead, it demands that reasonable and appropriate accommodations be made as needed to promote access and attainment for all students.

**Guiding Principle 2:** Mathematical ideas should be explored in ways that stimulate curiosity, create enjoyment of mathematics, and develop depth of understanding.

Students need to understand mathematics deeply and use it effectively. To achieve mathematical understanding, students should be actively engaged in doing meaningful mathematics, discussing mathematical ideas, and applying mathematics in interesting, thought provoking situations. Student understanding is further developed through ongoing reflection about cognitively demanding and worthwhile tasks.

Tasks should challenge and engage students in mathematics in multiple ways. Short- and long-term investigations that connect procedures and skills with conceptual understanding are integral components of an effective mathematics program. Activities should build upon curiosity and prior knowledge, and enable students to solve progressively deeper, broader, and more sophisticated problems. Mathematical tasks reflecting significant mathematics should generate active classroom talk, promote the development of conjectures, and lead to an understanding of the necessity for mathematical reasoning.

**Guiding Principle 3:** An effective mathematics program focuses on problem solving.

Mathematical problem solving is the hallmark of an effective mathematics program. Skill in mathematical problem solving requires practice with a variety of mathematical problems as well as a firm grasp of mathematical techniques and their underlying principles. Students who possess a deeper knowledge of mathematics can then use mathematics in a flexible way to attack various problems and devise different ways of solving any particular problem. Mathematical problem solving calls for reflective thinking, persistence, learning from the ideas of others, and going back over one's own work with a critical eye. Success in solving mathematical problems helps to create an abiding interest in mathematics.

**Guiding Principle 4:** Technology is essential in teaching and learning mathematics.

Technology enhances the mathematics curriculum in many ways. Technology enables students to communicate ideas within the classroom or to search for needed information. It can be especially helpful in assisting students with special needs in regular and special classrooms, at home, and in the community. Technology changes what mathematics is to be learned and when and how it is learned. Tools such as measuring instruments, manipulatives (such as base ten blocks and fraction pieces), scientific and graphing calculators, and computers with appropriate software, if properly used, contribute to a rich learning environment for developing and applying mathematical concepts. Appropriate use of calculators is essential; calculators should not be used as a replacement for basic understanding and skills. Although the use of a graphing calculator can help middle and secondary students to visualize properties of functions and their graphs, graphing calculators should be used to enhance their understanding and skills rather than replace them.

## **Standards Overview**

The Oklahoma Academic Standards for Mathematics are developed around both content and process strands. The four main content strands, Algebraic Reasoning and Algebra, Number and Operations,

Geometry and Measurement, and Data and Probability organize the content standards throughout PK-7 and Pre-Algebra. The standards for Algebra I, Algebra II, and Geometry are fundamentally organized around these strands as well. The process standards are defined as the Mathematical Actions and Processes and are comprised of the skills and abilities students should develop and be engaged in developing throughout their PK-12 mathematics education. Among these are the ability to problem solve and communicate and reason about mathematics which will help students be ready for the mathematics expectations of college and the skills desired by many employers. The process and content standards work in concert to create clear, concise and rigorous mathematics standards and expectations for Oklahoma students with the aim of helping them be college and career ready. Both content and process strands are described below.

**Algebraic Reasoning and Algebra Strand:** All students should be able to reason algebraically and learn algebra. This strand provides focus for the PK-7 and Pre-Algebra standards around the notion that algebra is more than moving symbols around. It is about understanding patterns, relations and functions, representing and analyzing mathematical situations and structures using algebraic symbols, using mathematical models to represent and understanding quantitative relationships, and analyzing change in various contexts. Understanding change is fundamental to algebraic reasoning and understanding the concept of function with depth. It is also fundamental to understanding many real-world problems and ideas presented in the news.

**Number and Operations Strand:** A focus on number and operations is the cornerstone of a strong mathematics program. Developing students' fluency with number and operations throughout their PK-12 mathematics experience requires a balance and connection between conceptual understanding and computational proficiency. This strand provides focus on the importance of students' understanding of numbers, ways of representing numbers, relationships among numbers, relationships among number systems, and meanings of operations and how they relate to one another. Further, it requires that students should be able to compute fluently and make reasonable estimates.

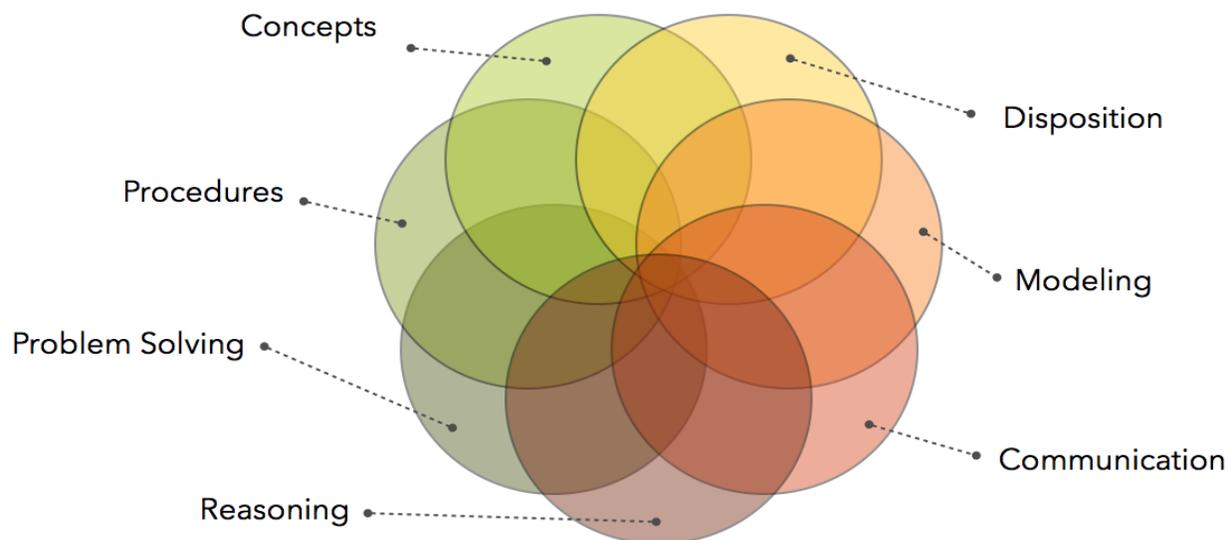
**Geometry and Measurement Strand:** All students should gain experience using a variety of visual and coordinate representations to analyze problems and solve mathematics and learn how to use appropriate units and tools for measuring. This strand provides focus for the PK-7 and Geometry standards around the notion that geometry and measurement help students understand and represent ideas and solve problems they will encounter in their daily lives. A focus on geometry should enable students to analyze characteristics of two- and three-dimensional objects, develop arguments based on geometric relationships, describe spatial relationships using coordinate geometry and other representational systems, apply transformations and symmetry to analyze mathematical situations, and utilize visualization, spatial reasoning and geometric modeling to solve problems. A focus on measurement should enable students to understand measurable attributes of objects and the units, systems, and processes of measurement, and apply appropriate techniques, tools, and formulas to determine measurements.

**Data and Probability Strand:** An increased emphasis on understanding data should span all grade levels. The idea that making sense of data and probability has become a part of our daily lives provides support for the importance of this strand throughout a students' PK-12 mathematics experience. A focus on data and probability should enable all students to formulate questions that can be addressed with data, and collect, organize, and display relevant data to answer them, select and use appropriate statistical methods to analyze data, develop and evaluate inferences and predictions that are based on data, and understand and

apply basic concepts of probability. The study of data is also an opportunity to apply the basic skills of computing with numbers while the study of probability provides application and use of fractions in daily life.

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# Mathematical Actions & Processes



Throughout their Pk-12 education experience, mathematically literate students will:



## **Develop a Deep and Flexible *Conceptual* Understanding**

Demonstrate a deep and flexible conceptual understanding of mathematical concepts, operations, and relations while making mathematical and real-world connections.



## **Develop Accurate and Appropriate *Procedural* Fluency**

Pursue efficient procedures for various computations and repeated processes based on a strong sense of numbers. They will develop a sophisticated understanding of the development and application of algorithms and procedures.



## **Develop Strategies for *Problem Solving***

Analyze the parts of complex mathematical tasks and identify entry points to begin the search for a solution. They will select from a variety of problem solving strategies and use corresponding multiple representations (verbal, physical, symbolic, pictorial, graphical, tabular) when appropriate. They will pursue

solutions to various tasks from real-world situations and applications that are often interdisciplinary in nature. They will find methods to verify their answers in context and will always question the reasonableness of solutions.



### **Develop Mathematical *Reasoning***

Explore and communicate a variety of reasoning strategies to think through problems. They will apply their logic to critique the thinking and strategies of others to develop and evaluate mathematical arguments, including making arguments and counterarguments and making connections to other contexts.



### **Develop a Productive Mathematical *Disposition***

Hold the belief that mathematics is sensible, useful and worthwhile. They will develop the habit of looking for and making use of patterns and mathematical structures. They will persevere and become resilient, effective problem solvers.



### **Develop the Ability to Make Conjectures, *Model*, and Generalize**

Make predictions and conjectures and draw conclusions throughout the problem solving process based on patterns and the repeated structures in mathematics. They will create, identify, and extend patterns as a strategy for solving and making sense of problems.



### **Develop the Ability to *Communicate* Mathematically**

Develop the ability to communicate mathematically. They will discuss, write, read, interpret and translate ideas and concepts mathematically. As they progress, students' ability to communicate mathematically will include their increased use of mathematical language and terms and analysis of mathematical definitions.

# Oklahoma Academic Standards for Mathematics

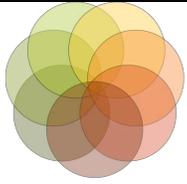
## Algebra I

The Algebra I standards are divided into four strands: Number and Operations, Algebra, Functions, and Data and Probability. The Algebra strand extends the foundation in linear relationships and proportionality from PreAlgebra to allow students to use linear equations and inequalities as well as systems of linear equations and inequalities to represent and solve mathematical and real world problems. Students will not only graph and interpret linear equations but also write linear equations and recognize linear and nonlinear graphs generated from arithmetic and geometric sequences. Work with expressions will be expanded to include absolute value, rational, radical, and polynomials. In the Function strand, students will distinguish between linear and nonlinear functions and evaluate linear and nonlinear functions. The Data and Probability strand's focus is applying counting procedures, using Venn diagrams, analyzing data with regression lines to make predications and interpreting graphs as discrete or continuous. Students will apply probability concepts to real world situations to make informed decisions. The Algebra I course should be taught in such a way as to help students transition from the concrete to the abstract and to make connections with practical applications to attach meaning to the abstract concepts of algebra.

Problem solving has been integrated throughout the content strands. The development of problem solving skills should be a major goal of the mathematics program at every grade level. Experience with the process of problem solving will need to be integrated early and continuously into each student's mathematics education. Students must be helped to develop a wide range of skills and strategies for solving a variety of problem types.

While learning mathematics, students should be actively engaged, using concrete materials and appropriate technologies such as calculators and computers. However, facility in the use of technology should not be regarded as a substitute for a student's understanding of quantitative concepts and relationships or for proficiency and fluency with basic computations.

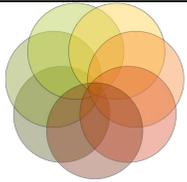
Mathematics has its own language, and the acquisition of specialized vocabulary and language patterns is crucial to a student's understanding, appreciation of, and disposition for the subject. Students should be encouraged to correctly use the concepts, skills, symbols, and vocabulary identified in the following set of standards.



# Number and Operations

**A1.N.1 Apply mathematical actions and processes to extend the understanding of number and operations to include square roots and cubic roots.**

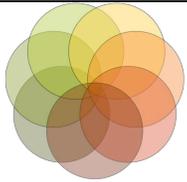
| <b>Mathematical Actions and Processes</b>  | <b>Mathematical Benchmark</b>  |
|--|--|
| <p>Develop a Deep and Flexible Conceptual Understanding</p> <p>Develop Accurate and Appropriate Procedural Fluency</p> <p>Develop Strategies for Problem Solving</p> <p>Develop Mathematical Reasoning</p> <p>Develop a Productive Mathematical Disposition</p> <p>Develop the Ability to Make Conjectures, Model, and Generalize</p> <p>Develop the Ability to Communicate Mathematically</p> | <p><b>A1.N.1.1</b> Write square roots and cube roots of monomial algebraic expressions in simplest radical form.</p> <p><b>A1.N.1.2</b> Add, subtract, multiply, and simplify square roots of monomial algebraic expressions and divide square roots of whole numbers.</p> |
| <p><b>Sample Problems or Classroom Activities</b></p> <p style="text-align: center; color: red; font-weight: bold; font-size: 1.2em;">FORTHCOMING</p>  |  |



# Algebra

**A1.A.1 Apply mathematical actions and processes to represent and solve mathematical and real world problems using linear equations (including absolute value equations) and systems of equations; interpret solutions in the original context.**

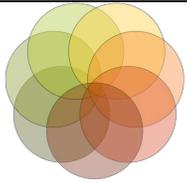
| <b>Mathematical Actions and Processes</b>   | <b>Mathematical Benchmark</b>  |
|---|--|
| Develop a Deep and Flexible Conceptual Understanding<br>Develop Accurate and Appropriate Procedural Fluency<br>Develop Strategies for Problem Solving<br>Develop Mathematical Reasoning<br>Develop a Productive Mathematical Disposition<br>Develop the Ability to Make Conjectures, Model, and Generalize<br>Develop the Ability to Communicate Mathematically | <b>A1.A.1.1</b> Use knowledge of solving multi-step equations to represent and solve mathematical and real-world problems (e.g., angle measures, geometric formulas, science, or statistics) and interpret the solutions in the original context.<br><br><b>A1.A.1.2</b> Solve absolute value equations and interpret the solutions in the original context.<br><br><b>A1.A.1.3</b> Solve systems of linear equations with a maximum of two variables by graphing (graphing calculator optional), substitution, and elimination and interpret the solutions in the original context. |
| <b>Sample Problems or Classroom Activities</b><br><br><p style="text-align: center;"><b>FORTHCOMING</b></p>   |  |



# Algebra

**A1.A.2 Apply mathematical actions and processes to represent and solve real-world and mathematical problems using linear inequalities (including compound inequalities); interpret solutions in the original context.**

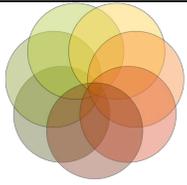
| <b>Mathematical Actions and Processes</b>  | <b>Mathematical Benchmark</b>  |
|--|--|
| <p>Develop a Deep and Flexible Conceptual Understanding</p> <p>Develop Accurate and Appropriate Procedural Fluency</p> <p>Develop Strategies for Problem Solving</p> <p>Develop Mathematical Reasoning</p> <p>Develop a Productive Mathematical Disposition</p> <p>Develop the Ability to Make Conjectures, Model, and Generalize</p> <p>Develop the Ability to Communicate Mathematically</p> | <p><b>A1.A.2.1</b> Represent relationships in various contexts with linear inequalities and solve the resulting inequalities, graph, and interpret the solutions on a coordinate plane.</p> <p><b>A1.A.2.2</b> Represent relationships in various contexts with compound and absolute value inequalities and solve the resulting inequalities, graph, and interpret the solutions on a number line.</p> <p><b>A1.A.2.3</b> Solve systems of linear inequalities with a maximum of two variables, graph, and interpret the solutions on a coordinate plane.</p> |
| <p><b>Sample Problems or Classroom Activities</b></p> <p style="text-align: center; color: red; font-weight: bold; font-size: 1.5em;">FORTHCOMING</p>  |  |



# Algebra

**A1.A.3 Apply mathematical actions and processes to generate equivalent algebraic expressions and use algebraic properties to evaluate expressions and arithmetic and geometric sequences.**

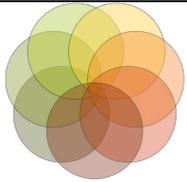
| Mathematical Actions and Processes   | Mathematical Benchmark   |
|--|--|
| <p>Develop a Deep and Flexible Conceptual Understanding</p> <p>Develop Accurate and Appropriate Procedural Fluency</p> <p>Develop Strategies for Problem Solving</p> <p>Develop Mathematical Reasoning</p> <p>Develop a Productive Mathematical Disposition</p> <p>Develop the Ability to Make Conjectures, Model, and Generalize</p> <p>Develop the Ability to Communicate Mathematically</p> | <p><b>A1.A.3.1</b> Solve literal equations involving several variables for one variable in terms of the others.</p> <p><b>A1.A.3.2</b> Simplify polynomial expressions by adding, subtracting, or multiplying.</p> <p><b>A1.A.3.3</b> Factor common monomial factors from polynomial expressions and factor quadratic expressions with a leading coefficient of 1.</p> <p><b>A1.A.3.4</b> Evaluate linear, absolute value, rational, and radical expressions. Include applying a nonstandard operation such as <math>a \odot b = 2a + 5</math>.</p> <p><b>A1.A.3.5</b> Recognize that arithmetic sequences are linear using equations, tables, graphs and verbal descriptions. Using the pattern, find the next term.</p> <p><b>A1.A.3.6</b> Recognize that geometric sequences are exponential using equations, tables, graphs and verbal descriptions. Given the formula <math>f(x) = a(r)^x</math>, find the next term.</p> |
| <p><b>Sample Problems or Classroom Activities</b></p> <p style="text-align: center;"><b>FORTHCOMING</b></p>  |  |



# Algebra

**A1.A.4 Apply mathematical actions and processes to analyze mathematical change involving linear equations in in real world and mathematical problems.**

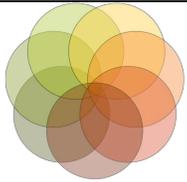
| <b>Mathematical Actions and Processes</b>  | <b>Mathematical Benchmark</b>  |
|--|--|
| <p>Develop a Deep and Flexible Conceptual Understanding</p> <p>Develop Accurate and Appropriate Procedural Fluency</p> <p>Develop Strategies for Problem Solving</p> <p>Develop Mathematical Reasoning</p> <p>Develop a Productive Mathematical Disposition</p> <p>Develop the Ability to Make Conjectures, Model, and Generalize</p> <p>Develop the Ability to Communicate Mathematically</p> | <p><b>A1.A.4.1</b> Calculate the slope of a line using a graph, an equation, two points, or a set of data points and interpret the slope and x- and y- intercepts in real world and mathematical problems.</p> <p><b>A1.A.4.2</b> Use the slope to differentiate between lines that are parallel, perpendicular, horizontal, or vertical.</p> <p><b>A1.A.4.3</b> Express linear equations in slope-intercept, point-slope, and standard forms and convert between these forms. Given sufficient information (slope and y-intercept, slope and one-point on the line, two points on the line, x-intercept and y-intercept, or a set of data points), write the equation of a line.</p> <p><b>A1.A.4.4</b> Relate a graph to a situation described qualitatively (e.g., faster change, slower change).</p> |
| <p><b>Sample Problems or Classroom Activities</b></p> <p style="text-align: center;"><b>FORTHCOMING</b></p>  |  |



# Function

**A1.F.1 Apply mathematical actions and processes to understand functions as descriptions of covariation (how related quantities vary together) in real world and mathematical problems.**

| <b>Mathematical Actions and Processes</b>  | <b>Mathematical Benchmark</b>  |
|--|--|
| <p>Develop a Deep and Flexible Conceptual Understanding</p> <p>Develop Accurate and Appropriate Procedural Fluency</p> <p>Develop Strategies for Problem Solving</p> <p>Develop Mathematical Reasoning</p> <p>Develop a Productive Mathematical Disposition</p> <p>Develop the Ability to Make Conjectures, Model, and Generalize</p> <p>Develop the Ability to Communicate Mathematically</p> | <p><b>A1.F.1.1</b> Distinguish between relations and functions using the vertical line test and the definition of a function.</p> <p><b>A1.F.1.2</b> Identify the dependent and independent variables as well as the domain and range given a function, equation, or graph. Identify restrictions on the domain and range in real world contexts.</p> <p><b>A1.F.1.3</b> Write linear functions in terms of real world context using function notation.</p> <p><b>A1.F.1.4</b> Given a graph modeling a real world situation, read and interpret the linear piecewise function (excluding step functions).</p> |
| <p><b>Sample Problems or Classroom Activities</b></p> <p style="text-align: center;"><b>FORTHCOMING</b></p>  |  |



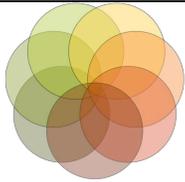
# Function

**A1.F.2 Apply mathematical actions and processes to understand that families of functions are characterized by the rate of change.**

| <b>Mathematical Actions and Processes</b>  | <b>Mathematical Benchmark</b>  |
|--|--|
| <p>Develop a Deep and Flexible Conceptual Understanding</p> <p>Develop Accurate and Appropriate Procedural Fluency</p> <p>Develop Strategies for Problem Solving</p> <p>Develop Mathematical Reasoning</p> <p>Develop a Productive Mathematical Disposition</p> <p>Develop the Ability to Make Conjectures, Model, and Generalize</p> <p>Develop the Ability to Communicate Mathematically</p> | <p><b>A1.F.2.1</b> Distinguish between linear and nonlinear data (including exponential) through tables, graphs, equations, and real-world contexts.</p> <p><b>A1.F.2.2</b> Recognize the graph of the functions <math>f(x) = x</math> and <math>f(x) =  x </math> and predict the effects of transformations algebraically and graphically on the graph using various methods and tools which may include graphing calculators.</p> |

**Sample Problems or Classroom Activities**

**FORTHCOMING**



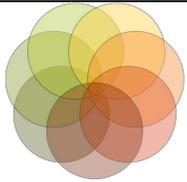
# Function

**A1.F.3 Apply mathematical actions and processes to represent functions can in multiple ways and use to interpret real world and mathematical problems.**

| <b>Mathematical Actions and Processes</b>  | <b>Mathematical Benchmark</b>   |
|--|---|
| <p>Develop a Deep and Flexible Conceptual Understanding</p> <p>Develop Accurate and Appropriate Procedural Fluency</p> <p>Develop Strategies for Problem Solving</p> <p>Develop Mathematical Reasoning</p> <p>Develop a Productive Mathematical Disposition</p> <p>Develop the Ability to Make Conjectures, Model, and Generalize</p> <p>Develop the Ability to Communicate Mathematically</p> | <p><b>A1.F.3.1</b> Identify matching linear equations, graphs, tables, and real-world situations.</p> <p><b>A1.F.3.2</b> Use function notation and evaluate a function (including nonlinear) at a given point in its domain algebraically and graphically and interpret the results in terms of real world and mathematical problems.</p> <p><b>A1.F.3.3</b> Add, subtract, and multiply functions using function notation.</p> |

**Sample Problems or Classroom Activities**

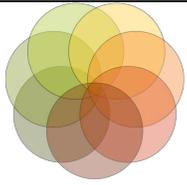
**FORTHCOMING**



# Data and Probability

## A1.D.1 Apply mathematical actions and processes to display and analyze data.

| Mathematical Actions and Processes   | Mathematical Benchmark  |
|--|---|
| <p>Develop a Deep and Flexible Conceptual Understanding</p> <p>Develop Accurate and Appropriate Procedural Fluency</p> <p>Develop Strategies for Problem Solving</p> <p>Develop Mathematical Reasoning</p> <p>Develop a Productive Mathematical Disposition</p> <p>Develop the Ability to Make Conjectures, Model, and Generalize</p> <p>Develop the Ability to Communicate Mathematically</p> | <p><b>A1.D.1.1</b> Describe a data set using data displays, describe and compare data sets using summary statistics, including measures of central tendency, location, and spread. Measures of central tendency and location include mean, median, mode, and percentile. Measures of spread include standard deviation and range. Know how to use calculators, spreadsheets, or other appropriate technology to display data and calculate summary statistics.</p> <p><b>A1.D.1.2</b> Collect data and use scatterplots to analyze patterns and describe linear relationships between two variables. Using graphing technology, determine regression lines and correlation coefficients; use regression lines to make predictions and correlation coefficients to assess the reliability of those predictions.</p> <p><b>A1.D.1.3</b> Interpret graphs as being discrete or continuous.</p> |
| <p><b>Sample Problems or Classroom Activities</b></p> <p style="text-align: center; color: red; font-weight: bold; font-size: 1.2em;">FORTHCOMING</p>  |   |



# Data and Probability

**A1.D.2 Apply mathematical actions and processes to calculate probabilities and apply probability concepts.**

| Mathematical Actions and Processes   | Mathematical Benchmark   |
|--|--|
| <p>Develop a Deep and Flexible Conceptual Understanding</p> <p>Develop Accurate and Appropriate Procedural Fluency</p> <p>Develop Strategies for Problem Solving</p> <p>Develop Mathematical Reasoning</p> <p>Develop a Productive Mathematical Disposition</p> <p>Develop the Ability to Make Conjectures, Model, and Generalize</p> <p>Develop the Ability to Communicate Mathematically</p> | <p><b>A1.D.2.1</b> Select and apply counting procedures, such as the multiplication and addition principles and tree diagrams, to determine the size of a sample space (the number of possible outcomes) and to calculate probabilities.</p> <p><b>A1.D.2.2</b> Describe the concepts of intersections, unions, and complements using Venn diagrams to evaluate probabilities. Understand the relationships between these concepts and the words AND, OR, NOT.</p> <p><b>A1.D.2.3</b> Calculate experimental probabilities by performing simulations or experiments involving a probability model and using relative frequencies of outcomes.</p> <p><b>A1.D.2.4</b> Apply probability concepts to real-world situations to make informed decisions.</p> |

## Sample Problems or Classroom Activities

### Example for A1.D.2.2

*Braums is testing out two new ice cream flavors, Pumpkin and Cotton Candy. A poll conducted by Braums showed that 32 customers liked Pumpkin, 58 customers liked Cotton Candy, 12 liked both flavors, and 22 liked neither flavor. What is the **probability** that one of those customers selected at random would like Cotton Candy?*

**MORE FORTHCOMING**

# Oklahoma Academic Standards for Mathematics

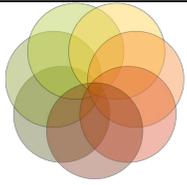
## Geometry

The Geometry course following Algebra I allows students to extend their knowledge of geometry through investigations of properties, lines, congruent and similar polygons, circles, three-dimensional objects, transformations, and right triangle trigonometry. This course emphasizes the use of logical reasoning skills in order to develop and justify mathematical arguments. Students apply the algebraic skills from Algebra I and spatial reasoning in order to solve real world and mathematical problems. Learning appropriate vocabulary is important to develop and apply the geometric concepts. In addition, the course emphasizes the use of appropriate units with problems involving measurements. Calculators, computers, graphing utilities, dynamic geometry software, and other appropriate technology tools can be used to assist in teaching and learning.

Problem solving has been integrated throughout the content strands. The development of problem solving skills should be a major goal of the mathematics program at every grade level. Experience with the process of problem solving will need to be integrated early and continuously into each student's mathematics education. Students must be helped to develop a wide range of skills and strategies for solving a variety of problem types.

While learning mathematics, students should be actively engaged, using concrete materials and appropriate technologies such as calculators and computers. However, facility in the use of technology should not be regarded as a substitute for a student's understanding of quantitative concepts and relationships or for proficiency and fluency with basic computations.

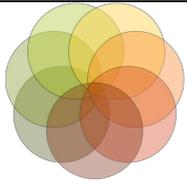
Mathematics has its own language, and the acquisition of specialized vocabulary and language patterns is crucial to a student's understanding, appreciation of, disposition for the subject. Students should be encouraged to correctly use the concepts, skills, symbols, and vocabulary identified in the following set of standards.



## Geometry (Reasoning and Logic)

**G.RL.1 Apply mathematical actions and processes to use appropriate tools and logic to evaluate mathematical arguments.**

| <b>Mathematical Actions and Processes</b>  | <b>Mathematical Benchmark</b>  |
|--|--|
| <p>Develop a Deep and Flexible Conceptual Understanding</p> <p>Develop Accurate and Appropriate Procedural Fluency</p> <p>Develop Strategies for Problem Solving</p> <p>Develop Mathematical Reasoning</p> <p>Develop a Productive Mathematical Disposition</p> <p>Develop the Ability to Make Conjectures, Model, and Generalize</p> <p>Develop the Ability to Communicate Mathematically</p> | <p><b>G.RL.1.1</b> Understand the roles of axioms, postulates, definitions, undefined terms and theorems in logical arguments.</p> <p><b>G.RL.1.2</b> Analyze and draw conclusions based on a set of conditions. Recognize the logical relationships between an "if...then" statement and its inverse, converse and contrapositive.</p> <p><b>G.RL.1.3</b> Assess the validity of a logical argument and give counterexamples to disprove a statement.</p> |
| <p><b>Sample Problems or Classroom Activities</b></p> <p style="text-align: center;"><b>FORTHCOMING</b></p>  |  |



## Geometry (Line, Angle and Polygon Relationships)

**G.2D.1 Apply mathematical actions and processes to discover, evaluate and analyze the relationships between lines, angles and polygons to solve real world and mathematical problems; express proofs in a form that clearly justifies the reasoning, such as two-column proofs, paragraph proofs, flow charts or illustrations.**

| Mathematical Actions and Processes   | Mathematical Benchmark   |
|--|--|
| <p>Develop a Deep and Flexible Conceptual Understanding</p> <p>Develop Accurate and Appropriate Procedural Fluency</p> <p>Develop Strategies for Problem Solving</p> <p>Develop Mathematical Reasoning</p> <p>Develop a Productive Mathematical Disposition</p> <p>Develop the Ability to Make Conjectures, Model, and Generalize</p> <p>Develop the Ability to Communicate Mathematically</p> | <p><b>G.2D.1.1</b> Know and apply properties of parallel and perpendicular lines, including properties of angles formed by a transversal, to solve problems and determine if two lines are parallel, and logically justify results using algebraic and deductive proofs.</p> <p><b>G.2D.1.2</b> Know and apply properties of angles, including corresponding, exterior, interior, vertical, complementary and supplementary angles, to solve algebraic and geometric problems, discover unknowns, and logically justify results.</p> <p><b>G.2D.1.3</b> Apply theorems involving the interior and exterior angle sums of polygons and use them to solve real world and mathematical problems using algebraic reasoning and proofs.</p> <p><b>G.2D.1.4</b> Apply the properties of special quadrilaterals (square, rectangle, trapezoid, isosceles trapezoid, rhombus, kite, parallelogram) and use them to solve real world and mathematical problems involving angle measures and segment lengths using algebraic reasoning and proofs.</p> <p><b>G.2D.1.5</b> Use coordinate geometry to represent and analyze line segments and polygons, including determining lengths, midpoints, and slopes of line segments.</p> <p><b>G.2D.1.6</b> Apply the properties of polygons to solve real world and mathematical problems involving perimeter and area (e.g., triangles, special quadrilaterals, regular polygons – up to 12 sided</p> |

figures, composite figures) and identify types of symmetry.

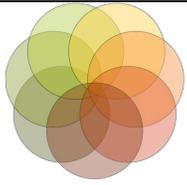
**G.2D.1.7** Apply the properties of congruent or similar polygons to solve real world and mathematical problems using algebraic and logical reasoning.

**G.2D.1.8** Construct logical arguments to prove triangle congruence (SSS, SAS, ASA, AAS and HL) and triangle similarity ( $AA\sim$ ,  $SSS\sim$ ,  $SAS\sim$ ).

**G.2D.1.9** Use numeric, graphic and algebraic representations of transformations in two dimensions, such as reflections, translations, dilations, and rotations about the origin by multiples of  $90^\circ$ , to solve problems involving figures on a coordinate plane.

### Sample Problems or Classroom Activities

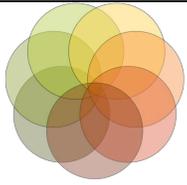
**FORTHCOMING**



## Geometry (3-Dimensional Shapes)

**G.3D.1 Apply mathematical actions and processes to solve real world and mathematical problems involving 3-dimensional figures.**

| Mathematical Actions and Processes   | Mathematical Benchmark   |
|--|--|
| <p>Develop a Deep and Flexible Conceptual Understanding</p> <p>Develop Accurate and Appropriate Procedural Fluency</p> <p>Develop Strategies for Problem Solving</p> <p>Develop Mathematical Reasoning</p> <p>Develop a Productive Mathematical Disposition</p> <p>Develop the Ability to Make Conjectures, Model, and Generalize</p> <p>Develop the Ability to Communicate Mathematically</p> | <p><b>G.3D.1.1</b> Solve real world and mathematical problems using the surface area and volume of prisms, cylinders, pyramids, cones, spheres, and composites of these figures. Use nets, measuring devices, or formulas as appropriate</p> <p><b>G.3D.1.2</b> Use ratios of similar 3-dimensional figures to solve for unknown values such as angles, side lengths, perimeter or circumference of a face, area of a face, and volume.</p> <p><b>G.3D.1.3</b> Apply the fact that dilations can be conveyed by the effect of a scale factor <math>k</math> on length, area and volume, multiplied by <math>k</math>, <math>k^2</math> and <math>k^3</math>, respectively.</p> |
| <p><b>Sample Problems or Classroom Activities</b></p> <p style="text-align: center; color: red; font-weight: bold; font-size: 1.5em;">FORTHCOMING</p>  |  |



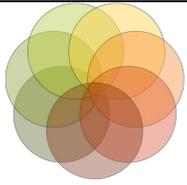
## Geometry (Circles)

**G.C.1 Apply mathematical actions and processes to solve real world and mathematical problems using the properties of circles.**

| <b>Mathematical Actions and Processes</b>   | <b>Mathematical Benchmark</b>   |
|---|---|
| Develop a Deep and Flexible Conceptual Understanding<br>Develop Accurate and Appropriate Procedural Fluency<br>Develop Strategies for Problem Solving<br>Develop Mathematical Reasoning<br>Develop a Productive Mathematical Disposition<br>Develop the Ability to Make Conjectures, Model, and Generalize<br>Develop the Ability to Communicate Mathematically | <p><b>G.C.1.1</b> Apply the properties of circles to solve problems involving circumference and area, as approximate values and in terms of <math>\pi</math>, using algebraic and logical reasoning.</p> <p><b>G.C.1.2</b> Apply the properties of circles and relationships among angles, arcs, and distances in a circle to solve problems using algebraic and logical reasoning.</p> <p><b>G.C.1.3</b> Recognize and write the radius <math>r</math>, center <math>(h,k)</math>, and standard form of the equation of a circle <math>(x - h)^2 + (y - k)^2 = r^2</math> with and without graphs.</p> <p><b>G.C.1.4</b> Apply the distance and midpoint formula, where appropriate, to develop the equation of a circle in standard form.</p> |

### Sample Problems or Classroom Activities

**FORTHCOMING**



## Geometry (Right Triangle Geometry)

**G.RT.1 Apply mathematical actions and processes to develop and verify mathematical relationships of right triangles and trigonometric ratios to solve real world and mathematical problems.**

| <b>Mathematical Actions and Processes</b>  | <b>Mathematical Benchmark</b>   |
|--|---|
| <p>Develop a Deep and Flexible Conceptual Understanding</p> <p>Develop Accurate and Appropriate Procedural Fluency</p> <p>Develop Strategies for Problem Solving</p> <p>Develop Mathematical Reasoning</p> <p>Develop a Productive Mathematical Disposition</p> <p>Develop the Ability to Make Conjectures, Model, and Generalize</p> <p>Develop the Ability to Communicate Mathematically</p> | <p><b>G.RT.1.1</b> Apply the distance formula, the Pythagorean Theorem, and its converse to solve real world and mathematical problems, as approximate and exact values, using algebraic and logical reasoning (include Pythagorean Triples).</p> <p><b>G.RT.1.2</b> Verify and apply properties of right triangles, including properties of 45-45-90 and 30-60-90 triangles, to solve problems using algebraic and logical reasoning.</p> <p><b>G.RT.1.3</b> Use the definition of the trigonometric functions to determine the sine, cosine and tangent ratio of an acute angle in a right triangle.</p> <p><b>G.RT.1.4</b> Apply the trigonometric functions as ratios (sine, cosine and tangent) to find side lengths in right triangles in real world and mathematical problems.</p> <p><b>G.RT.1.5</b> Apply inverse trigonometric functions to solve problems to find acute angle measures in right triangles in real world and mathematical problems.</p> |

**Sample Problems or Classroom Activities**

**FORTHCOMING**

# Oklahoma Academic Standards for Mathematics

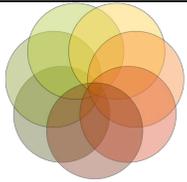
## Algebra II

The standards for Algebra II are divided into four strands: Number and Operations, Algebra, Functions, and Data and Probability. The Number and Operation strand extends the understanding of number and operations to include expressions with rational exponents, complex numbers, and matrices. The Algebra strand emphasizes the representation and solving of real world and mathematical situations using linear, quadratic, and exponential equations as well as systems of equations. The Function strand explores various functions including quadratic, exponential, logarithmic, rational, polynomial, and radical and introduces the role of inverses. The Data and Probability strand's focus is the displaying and analysis of data including the application of the normal curve and linear and non-linear regression models. Graphing calculators, dynamic software, and other appropriate technology tools can be used to assist in teaching and learning.

Problem solving has been integrated throughout the content strands. The development of problem solving skills should be a major goal of the mathematics program at every grade level. Experience with the process of problem solving will need to be integrated early and continuously into each student's mathematics education. Students must be helped to develop a wide range of skills and strategies for solving a variety of problem types.

While learning mathematics, students should be actively engaged, using concrete materials and appropriate technologies such as calculators and computers. However, facility in the use of technology should not be regarded as a substitute for a student's understanding of quantitative concepts and relationships or for proficiency and fluency with basic computations.

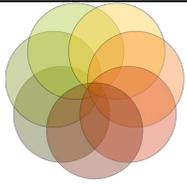
Mathematics has its own language, and the acquisition of specialized vocabulary and language patterns is crucial to a student's understanding, appreciation of, and disposition for the subject. Students should be encouraged to correctly use the concepts, skills, symbols, and vocabulary identified in the following set of standards.



# Number and Operations

**A2.N.1 Apply mathematical actions and processes to extend the understanding of number and operations to include complex numbers, matrices and expressions written with rational exponents.**

| <b>Mathematical Actions and Processes</b>  | <b>Mathematical Benchmark</b>   |
|--|---|
| <p>Develop a Deep and Flexible Conceptual Understanding</p> <p>Develop Accurate and Appropriate Procedural Fluency</p> <p>Develop Strategies for Problem Solving</p> <p>Develop Mathematical Reasoning</p> <p>Develop a Productive Mathematical Disposition</p> <p>Develop the Ability to Make Conjectures, Model, and Generalize</p> <p>Develop the Ability to Communicate Mathematically</p> | <p><b>A2.N.1.1</b> Find the value of <math>i^n</math> for any whole number <math>n</math>.</p> <p><b>A2.N.1.2</b> Simply, add, subtract, multiply, and divide complex numbers.</p> <p><b>A2.N.1.3</b> Identify the order (dimension) of a matrix, add and subtract matrices of appropriate dimensions, and multiply a matrix by a scalar to create new matrices.</p> <p><b>A2.N.1.4</b> Add, subtract, multiply, divide and simplify radical expressions and expressions containing rational exponents.</p> |
| <p><b>Sample Problems or Classroom Activities</b></p> <p style="text-align: center; color: red; font-size: 2em; font-weight: bold;">DRAFT</p> <p style="text-align: center; color: red; font-size: 2em; font-weight: bold;">FORTHCOMING</p>  |   |



# Algebra

**A2.A.1 Apply mathematical actions and processes to represent, model and solve mathematical and real-world problems using nonlinear equations and systems of linear equations; interpret the solutions in the original context.**

| Mathematical Actions and Processes   | Mathematical Benchmark  |
|--|---|
| <p>Develop a Deep and Flexible Conceptual Understanding</p> <p>Develop Accurate and Appropriate Procedural Fluency</p> <p>Develop Strategies for Problem Solving</p> <p>Develop Mathematical Reasoning</p> <p>Develop a Productive Mathematical Disposition</p> <p>Develop the Ability to Make Conjectures, Model, and Generalize</p> <p>Develop the Ability to Communicate Mathematically</p> | <p><b>A2.A.1.1</b> Represent and model real world or mathematical problems using quadratic equations and solve using various methods including graphing (including graphing calculator or other appropriate technology), factoring, completing the square, and the quadratic formula. Find complex roots when they exist.</p> <p><b>A2.A.1.2</b> Represent and model real world or mathematical problems using exponential equations, such as compound interest, depreciation, and population growth, and solve these equations graphically (including graphing calculator or other appropriate technology) or algebraically.</p> <p><b>A2.A.1.3</b> Solve rational equations with only one variable and limited to three or less denominators. Check for extraneous solutions.</p> <p><b>A2.A.1.4</b> Find and interpret the meaning of zeros of polynomials from a graphical perspective.</p> <p><b>A2.A.1.5</b> Solve radical equations (square root only) with one variable and only one radical on either one or both sides of the equal sign. Check for extraneous solutions.</p> <p><b>A2.A.1.6</b> Solve common and natural logarithmic equations using the properties of logs.</p> <p><b>A2.A.1.7</b> Use graphing calculators or other appropriate technology to explore and solve real world and mathematical problems that can be</p> |

modeled using arithmetic or finite geometric sequences or series given the  $n$ th terms and sum formulas.

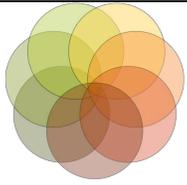
**A2.A.1.8** Represent and model real world or mathematical problems using systems of linear equations with a maximum of three variables and solve using various methods which may include substitution, elimination, and graphing (may include graphing calculators or other appropriate technology).

**A2.A.1.9** Solve systems of equations containing one linear equation and one quadratic equation using tools which may include graphing calculators or other appropriate technology.

**A2.A.1.10** Assess the reasonableness of a solution in its given context and compare the solution to appropriate graphical or numerical estimates; interpret a solution in the context of the domain.

### Sample Problems or Classroom Activities

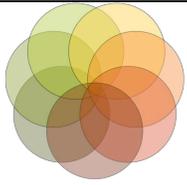
**FORTHCOMING**



# Algebra

**A2.A.2 Apply mathematical actions and processes to represent and analyze mathematical situations and structures using algebraic symbols using various strategies to write equivalent forms of expressions.**

| <b>Mathematical Actions and Processes</b>  | <b>Mathematical Benchmark</b>   |
|--|---|
| <p>Develop a Deep and Flexible Conceptual Understanding</p> <p>Develop Accurate and Appropriate Procedural Fluency</p> <p>Develop Strategies for Problem Solving</p> <p>Develop Mathematical Reasoning</p> <p>Develop a Productive Mathematical Disposition</p> <p>Develop the Ability to Make Conjectures, Model, and Generalize</p> <p>Develop the Ability to Communicate Mathematically</p> | <p><b>A2.A.2.1</b> Factor polynomial expressions including but not limited to trinomials, differences of squares, sum and difference of cubes, and factoring by grouping using a variety of tools and strategies.</p> <p><b>A2.A.2.2</b> Add, subtract, multiply, divide, and simplify polynomial and rational expressions.</p> <p><b>A2.A.2.3</b> Recognize that a quadratic equation has different equivalent representations (<math>f(x) = ax^2 + bx + c</math>, <math>f(x) = a(x - h)^2 + k</math>, or in factored form) and identify the representation that is most appropriate for the situation (solving or graphing) .</p> <p><b>A2.A.2.4</b> Rewrite expressions involving radicals and rational exponents using the properties of exponents.</p> |
| <p><b>Sample Problems or Classroom Activities</b></p> <p style="text-align: center; color: red; font-weight: bold; font-size: 1.2em;">FORTHCOMING</p>  |   |



# Function

**A2.F.1 Apply mathematical actions and processes to understand functions as descriptions of covariation (how related quantities vary together).**

| Mathematical Actions and Processes   | Mathematical Benchmark   |
|--|--|
| <p>Develop a Deep and Flexible Conceptual Understanding</p> <p>Develop Accurate and Appropriate Procedural Fluency</p> <p>Develop Strategies for Problem Solving</p> <p>Develop Mathematical Reasoning</p> <p>Develop a Productive Mathematical Disposition</p> <p>Develop the Ability to Make Conjectures, Model, and Generalize</p> <p>Develop the Ability to Communicate Mathematically</p> | <p><b>A2.F.1.1</b> Use algebraic, interval, and set notations to specify the domain and range of functions of various types and evaluate a function at a given point in its domain.</p> <p><b>A2.F.1.2</b> Recognize the graphs of exponential, radical (square root and cube root only), quadratic, and logarithmic functions. Predict the effects of transformations algebraically and graphically on the graphs, using various methods and tools which may include graphing calculators or other appropriate technology [e.g., <math>f(x)+c</math>, <math>f(x+c)</math>, <math>f(cx)</math>, and <math>cf(x)</math>, where <math>c</math> is a positive or negative constant].</p> <p><b>A2.F.1.3</b> Graph a quadratic function. Identify the <math>x</math>- and <math>y</math>- intercepts, maximum or minimum value, axis of symmetry, and vertex using various methods and tools which may include a graphing calculator or appropriate technology.</p> <p><b>A2.F.1.4</b> Graph exponential and logarithmic functions. Identify asymptotes and <math>x</math>- and <math>y</math>- intercepts using various methods and tools which may include graphing calculators or other appropriate technology. Recognize exponential decay and growth graphically and algebraically.</p> <p><b>A2.F.1.5</b> Identify the domain, range, intercepts, zeros, relative maxima, relative minima, and intervals of increase and decrease given the graph of a polynomial functions.</p> <p><b>A2.F.1.6</b> Graph a rational function and identify the <math>x</math>- and <math>y</math>- intercepts, vertical and horizontal asymptotes, using various methods and tools which</p> |

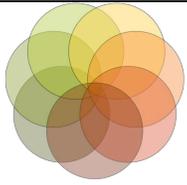
may include a graphing calculator or other appropriate technology. (Excluding slant asymptotes and holes.)

**A2.F.1.7** Graph a radical function (square root and cube root only) and identify the x- and y- intercepts using various methods and tools which may include a graphing calculator or other appropriate technology.

**A2.F.1.8** Graph piecewise functions with no more than three branches. Given a graph, analyze piecewise functions.

**Sample Problems or Classroom Activities**

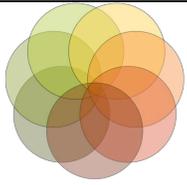
FORTHCOMING



# Function

**A2.F.2 Apply mathematical actions and processes to understand functions can be combined algebraically and by composition and in some cases will have an inverse.**

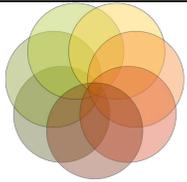
| <b>Mathematical Actions and Processes</b>  | <b>Mathematical Benchmark</b>   |
|--|---|
| <p>Develop a Deep and Flexible Conceptual Understanding</p> <p>Develop Accurate and Appropriate Procedural Fluency</p> <p>Develop Strategies for Problem Solving</p> <p>Develop Mathematical Reasoning</p> <p>Develop a Productive Mathematical Disposition</p> <p>Develop the Ability to Make Conjectures, Model, and Generalize</p> <p>Develop the Ability to Communicate Mathematically</p> | <p><b>A2.F.2.1</b> Add, subtract, multiply, and divide functions using function notation and recognize domain restrictions.</p> <p><b>A2.F.2.2</b> Combine functions by composition and recognize that <math>f(x)</math> and <math>g(x)</math> are inverse functions if <math>f(g(x))=g(f(x))=x</math>.</p> <p><b>A2.F.2.3</b> Find and graph the inverse of a function, if it exists, and know the graphs are reflected in the line <math>y=x</math>.</p> <p><b>A2.F.2.4</b> Apply the inverse relationship between exponential and logarithmic functions to convert from one form to another.</p> |
| <p><b>Sample Problems or Classroom Activities</b></p> <p style="text-align: center; color: red; font-weight: bold; font-size: 1.5em;">FORTHCOMING</p>  |   |



# Data and Probability

## A2.D.1 Apply mathematical actions and processes to display and analyze data.

| Mathematical Actions and Processes   | Mathematical Benchmark  |
|--|---|
| <p>Develop a Deep and Flexible Conceptual Understanding</p> <p>Develop Accurate and Appropriate Procedural Fluency</p> <p>Develop Strategies for Problem Solving</p> <p>Develop Mathematical Reasoning</p> <p>Develop a Productive Mathematical Disposition</p> <p>Develop the Ability to Make Conjectures, Model, and Generalize</p> <p>Develop the Ability to Communicate Mathematically</p> | <p><b>A2.D.1.1</b> Use the mean and standard deviation of a data set to fit it to a normal distribution (bell-shaped curve) and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate.</p> <p><b>A2.D.1.2</b> Collect data and use scatterplots to analyze patterns and describe linear, exponential or quadratic relationships between two variables. Using graphing calculators or other appropriate technology, determine regression equation and correlation coefficients; use regression equations to make predictions and correlation coefficients to assess the reliability of those predictions.</p> <p><b>A2.D.1.3</b> Based upon the real world context, recognize whether a discrete or continuous graphical representation is appropriate and then create the graph.</p> |
| <p><b>Sample Problems or Classroom Activities</b></p> <p style="text-align: center; color: red; font-weight: bold; font-size: 1.2em;">FORTHCOMING</p>  |   |



# Data and Probability

**A2.D.2 Apply mathematical actions and processes to analyze statistical thinking to draw inferences, make predictions, and justify conclusions.**

| <b>Mathematical Actions and Processes</b>  | <b>Mathematical Benchmark</b>  |
|--|--|
| <p>Develop a Deep and Flexible Conceptual Understanding</p> <p>Develop Accurate and Appropriate Procedural Fluency</p> <p>Develop Strategies for Problem Solving</p> <p>Develop Mathematical Reasoning</p> <p>Develop a Productive Mathematical Disposition</p> <p>Develop the Ability to Make Conjectures, Model, and Generalize</p> <p>Develop the Ability to Communicate Mathematically</p> | <p><b>A2.D.2.1</b> Evaluate reports based on data published in the media by identifying the source of the data, the design of the study, and the way the data are analyzed and displayed. Given spreadsheets, tables, or graphs, recognize and analyze distortions in data displays. Show how graphs and data can be distorted to support different points of view.</p> <p><b>A2.D.2.2</b> Identify and explain misleading uses of data. Recognize when arguments based on data confuse correlation and causation.</p> |
| <p><b>Sample Problems or Classroom Activities</b></p> <p style="text-align: center;"><b>FORTHCOMING</b></p>  |  |