Escondido Union High School District

Math 4

EUHSD Board Approval Date: 4/19/16

Honors Extensions Added Spring 2018 for Board Approval: 6/19/18
The EUHSD Mathematics curriculum document outlines specific course expectations in a comprehensive integrated math curriculum. The curriculum documents are designed to be updated annually based on student academic achievement data, research and best practices, and input from stakeholders. The EUHSD mathematics curriculum document contains the following:

A. Course Description
B. Course Guidelines - graduation credit information, transcript information, adopted materials, adopted technology, assessment outline
C. Instructional Materials References
D. Scope and Sequence Map with Essential Standards, Unit Topics, and Key Unit Objectives delineated
E. References to key essential design and implementation documents (see items 1-8 below)

The EUHSD Mathematics program is designed so that all students have access to the rigorous curriculum necessary to graduate high school college and career ready. Pathway options and courses of study will provide students with a rich array of courses designed to meet the needs of all learners from acceleration to intervention. Regardless of a student's entry point, the pathway provides all students access to the highest level of courses offered. The contextualized learning inherent in an integrated program provides students with deeper understanding and improved retention of math concepts. Student-Centered learning provides opportunity for collaboration, communication, and a robust learning environment and provides opportunities for all students to meet the goals of the district’s Instructional Focus at the time of this writing: "All students communicate their thinking, ideas and understanding by effectively using oral, written and/or non-verbal expression."

A key design consideration in the transition to the new California State Standards is a focus on changes to pedagogy. The instructional shifts guide classroom teaching and learning and the foundation of curriculum and instructional design.

### Instructional Shifts in Mathematics

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<tr>
<th>Focus:</th>
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<tr>
<td><strong>Focus strongly where the Standards focus</strong></td>
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<tr>
<td>Focus requires that we significantly narrow and deepen the scope of content in each grade so that students experience concepts at a deeper level.</td>
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<tr>
<td>- Instruction engages students through cross-curricular concepts and application. Each unit focuses on implementation of the Math Practices in conjunction with math content.</td>
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<td>- Effective instruction is framed by performance tasks that engage students and promote questions in order to provide a clear and explicit purpose for instruction.</td>
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<tr>
<th>Coherence:</th>
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<tr>
<td><strong>Think across grades; and link to major topics within grades</strong></td>
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<tr>
<td>Coherence in our instruction supports students to make connections within and across grade levels.</td>
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<tr>
<td>- Problems and activities connect clusters and domains through the art of questioning.</td>
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<tr>
<td>- A purposeful sequence of lessons build meaning by moving from concrete to abstract, with new learning built upon prior knowledge and connections made to previous learning.</td>
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<tr>
<td>- Coherence promotes mathematical sense making. It is critical to think across grades and examine the progressions in the standards to ensure the development of major topics over time. The emphasis on problem solving, reasoning and proof, communication, representation, and connections require students to build comprehension of mathematical concepts, procedural fluency, and productive dispositions.</td>
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<tr>
<th>Rigor:</th>
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<tr>
<td><strong>In major topics, pursue conceptual</strong></td>
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<td>Rigor helps students to read various depths of knowledge by balancing conceptual understanding, procedural skills and fluency, and real-world applications with equal intensity.</td>
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<tr>
<td>- Conceptual understanding underpins fluency; fluency is practiced in contextual applications; and applications build conceptual understanding.</td>
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understanding, procedural skills and fluency, and application

- These elements may be explicitly addressed separately or at other times combined. Students demonstrate deep conceptual understanding of core math concepts by applying them in new situations, as well as writing and speaking about their understanding. Students will make meaning of content outside of math by applying math concepts to real-world situations.
- Each unit contains a balance of challenging, multiple-step problems to teach new mathematics, and exercises to practice mathematical skills.

The EUHSD mathematics curriculum document and all supporting documentation are aligned to the California State Standards for Mathematics, the Eight Standards for Mathematical Practice, as well as the new CA ELD Standards. These standards will be integrated and delineated within each Unit Plan. A detailed list of resources around which the EUHSD Mathematics curriculum is designed and implemented are as follows:

1. California State Standards for Mathematics
2. Guide to the CASS-M Conceptual Category Abbreviations
3. Eight Standards for Mathematical Practice
4. California Frameworks for Mathematics
5. Smarter Balanced Assessment System Mathematics Assessment Blueprint
6. California English Language Development Standards
7. University of California Mathematics Pathway FAQ
8. Core Plus Instructional Materials

California State Standards for Mathematics - Content

The California Standards for high school mathematics (CASS-M) are divided into six conceptual categories which portray a coherent view of higher mathematics which cross a number of traditional course boundaries. Each conceptual category is further broken down into domains or clusters of standards that address big ideas - Guide to the CASS-M Conceptual Category Abbreviations. The conceptual categories are Number and Quantity, Algebra, Functions, Modeling, Geometry, and Statistics and Probability. Modeling is best interpreted not as a collection of topics but in relation to other standards, thus Modeling is considered both a conceptual category and a Standard for Mathematical Practice and modeling standards are called within the other conceptual categories, indicated by a (*) symbol.

Common Core Standards for Mathematical Practice

The CASS-M call for mathematical practices and content to be connected as students engage in mathematical tasks. These connections are essential to support the development of students’ broader mathematical understanding - students who lack understanding of a topic may rely too heavily on procedures. The 8 Math Practice standards must be taught as carefully and practiced as intentionally as the Standards for Math Content. Neither should be isolated from the other; effective mathematics instruction occurs when the two halves of the CASS-M come together as a powerful whole (CASS-M, 2013).
Standards for Mathematical Practice

1. **Make sense of problems and persevere in solving them.**

Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems, and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, “Does this make sense?” They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.

2. **Reason abstractly and quantitatively.**

Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.

3. **Construct viable arguments and critique the reasoning of others.**

Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical
situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

5. Use appropriate tools strategically.

Mathematically proficient students consider the available tools when solving a mathematical problem. These tools might include pencil and paper, concrete models, a ruler, a protractor, a calculator, a spreadsheet, a computer algebra system, a statistical package, or dynamic geometry software. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations. For example, mathematically proficient high school students analyze graphs of functions and solutions generated using a graphing calculator. They detect possible errors by strategically using estimation and other mathematical knowledge. When making mathematical models, they know that technology can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data. Mathematically proficient students at various grade levels are able to identify relevant external mathematical resources, such as digital content located on a website, and use them to pose or solve problems. They are able to use technological tools to explore and deepen their understanding of concepts.

6. Attend to precision.

Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the problem context. In the elementary grades, students give carefully formulated explanations to each other. By the time they reach high school they have learned to examine claims and make explicit use of definitions.

7. Look for and make use of structure.

Mathematically proficient students look closely to discern a pattern or structure. Young students, for example, might notice that three and seven more is the same amount as seven and three more, or they may sort a collection of shapes according to how many sides the shapes have. Later, students will see \(7 \times 8\) equals the well-remembered \(7 \times 5 + 7 \times 3\), in preparation for learning about the distributive property. In the expression \(x^2 + 9x + 14\), older students can see the 14 as \(2 \times 7\) and the 9 as \(2 + 7\). They recognize the significance of an existing line in a geometric figure and can use the strategy of drawing an auxiliary line for solving problems. They also can step back for an overview and shift perspective. They can see complicated things, such as some algebraic expressions, as single objects or as being composed of several objects. For example, they can see \(5 - 3(x - y)^2\) as 5 minus a positive number times a square and use that to realize that its value cannot be more than 5 for any real numbers \(x\) and \(y\).

8. Look for and express regularity in repeated reasoning.

Mathematically proficient students notice if calculations are repeated, and look both for general methods and for shortcuts. Upper elementary students might notice when dividing 25 by 11 that they are repeating the same calculations over and over again, and conclude they have a repeating decimal. By paying attention to the calculation of slope as they repeatedly check whether points are on the line through \((1, 2)\) with slope 3, middle school students might abstract the equation \((y - 2)/(x - 1) = 3\). Noticing the regularity in the way terms cancel when expanding \((x - 1) (x + 1), (x - 1) (x^2 + x + 1), \) and \((x - 1) (x^3 + x^2 + x + 1)\) might lead them to the general formula for the sum of a geometric series. As they work to solve a problem, mathematically proficient students maintain oversight of the process, while attending to the details. They continually evaluate the reasonableness of their intermediate results.
Math 4 - Course Description

Math 4 continues the preparation of students for college mathematics. In Course 4, formal and symbolic reasoning strategies, the hallmarks of advanced mathematics, are developed as complements to more intuitive arguments and numerical and graphical approaches to problems developed in Courses 1-3. The mathematical content and 11 units in course 4 allows considerable flexibility in tailoring a course to best prepare students for undergraduate programs. A sequence of units in Course 4 is recommended for students intending to pursue programs in the mathematical, physical, and biological sciences, or engineering. The Math 4 curriculum addresses each of the conceptual categories outlined by the California State Standards for Mathematics: number and quantity; algebra, functions, geometry, statistics and probability, and modeling. The curriculum includes attention to each of the Eight Standards for Mathematical Practice. Instructional materials and classroom experiences provide students with a rich array of resources and technology designed to support student mastery of specific concepts and both procedural and conceptual understanding while building essential 21st Century skills designed for college and career readiness. Assessments are outlined in the Scope and Sequence document. Each unit will culminate in a district-wide common assessment (year 1 implementation will use Core-Plus provided assessments).

Honors Option for Math 4

The primary goals of the EUHSD Mathematics program are as follows: first, ensure students develop a deeper understanding of mathematics; second, prepare students to take on more advanced studies in math; third, personalize the pursuit of honors and advanced coursework; fourth, to focus on the level of rigor evidenced by the work produced by students.

Accordingly, students who elect to participate in and produce honors level work will receive honors credit. Students who earn the honors designation in these courses will produce work that addresses more sophisticated questions, delve more deeply into the mathematics of the course, and satisfy the California State Standards with added rigor. The honors modification applied to some course assignments will broaden the scope or deepen the examination of the course content.

Within the first 20 days of the semester, students who elect to challenge themselves with honors work will complete an Honors Option Registration Contract, signed by Student, Teacher, and Parent/Guardian (see attached). Students who opt-in and later elect not to pursue the honors option for the course must complete a Petition for Release from Honors Option Contract by the 8th week of the semester, to be signed by Student, Teacher and Parent/Guardian (also attached).

Students electing the Honors Option will have differentiated homework, required projects, portfolios due each semester, required participation in a demonstration of learning once per semester, and will be required to demonstrate understanding on assessment extension problems.
# Math 4 Course Requirements

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<tr>
<th>Course Length:</th>
<th>Year-Long</th>
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<tbody>
<tr>
<td>Grade Level:</td>
<td>Grade 9-12</td>
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<tr>
<td>UC/CSU Requirement:</td>
<td>Approved by UC/CSU as a “c” mathematics course</td>
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<tr>
<td>Graduation Requirement:</td>
<td>Students will receive (5) math credits per successfully completed semester for a total of (10) math credits for the year.</td>
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<thead>
<tr>
<th>Course Number Semester A:</th>
<th>Transcript Name Semester A:</th>
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<tbody>
<tr>
<td>(P) 2265</td>
<td>(P): Math 4 A (P)</td>
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<tr>
<td>(H) 2269</td>
<td>(H): Math 4 A (H)</td>
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<tr>
<td>(SE) 2267</td>
<td>(SE): Math 4 A (SE)</td>
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<tr>
<th>Course Number Semester B:</th>
<th>Transcript Name Semester B:</th>
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<tbody>
<tr>
<td>(P) 2266</td>
<td>(P): Math 4 B (P)</td>
</tr>
<tr>
<td>(H) 2270</td>
<td>(H): Math 4 B (H)</td>
</tr>
<tr>
<td>(SE) 2268</td>
<td>(SE): Math 4 B (SE)</td>
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Honors course will be the “Opt-in” model, taught within the same classroom. We will not be registering any students for these courses until after the beginning of the school year. Students will be required to sign a contract, as will their parents.

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<thead>
<tr>
<th>Number of Credits Semester A:</th>
<th>five (5) <strong>Honors Weighted</strong></th>
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<tbody>
<tr>
<td>Number of Credits Semester B:</td>
<td>five (5) <strong>Honors Weighted</strong></td>
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<tr>
<th>Required Prerequisites:</th>
<th>N/A</th>
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<tbody>
<tr>
<td>Recommended Prerequisites:</td>
<td>Math 1, Math 2, Math 3 or Algebra 1, Geometry, and Algebra 2</td>
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<tr>
<th>Board Approval Date/Curriculum:</th>
<th>4/19/16</th>
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<tr>
<td>Board Approval Date for Honors Extensions:</td>
<td>6/19/18</td>
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<tr>
<th>Board Approval Date/Textbooks:</th>
<th>4/19/16</th>
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<tr>
<th>Supplemental Resource/s:</th>
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<tbody>
<tr>
<td>All adopted ancillary materials within the Core-Plus instructional program</td>
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<tr>
<th>Supplemental Technology Resource/s:</th>
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<tbody>
<tr>
<td>Graphing Calculator</td>
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<tr>
<td>CPMP Tools (online resource)</td>
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<th>Assessment/s:</th>
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<tr>
<td>Year 4 - All EUHSD Math 4 teachers will give common assessments which accompany the Core-Plus Mathematics Program (lesson quizzes, unit tests, common district final exams).</td>
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### Math 4 Scope and Sequence

#### Unit 1- Families of Functions

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<tr>
<th><strong>Unit 1 Families of Functions:</strong></th>
<th><strong>Unit 1 Focus Standards:</strong></th>
<th><strong>Unit 1 Learning Objectives</strong></th>
<th><strong>Unit 1 Sample Investigations and Assignments</strong></th>
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</table>
| ● This unit extends student understanding of linear, exponential, quadratic, power, and circular functions to model data patterns whose graphs are transformations of basic patterns; and develops understanding of operations on functions useful in representing and reasoning about quantitative relationships. | **Algebra**
   A-SSE.1*, 3*: Interpret expressions that represent a quantity in terms of its context. Interpret parts of an expression, such as terms, factors, and coefficients. Interpret complicated expressions by viewing one or more of their parts as a single entity. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. Factor a quadratic expression to reveal the zeroes of the function it defines. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines. Use the properties of exponents to transform expressions for exponential functions.
   A-APR.1, 6: Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials. Rewrite simple rational expressions in different forms; write \( a(x)/b(x) \) in the form \( q(x) + r(x)/b(x) \), where \( a(x) \), \( b(x) \), \( q(x) \), and \( r(x) \) are polynomials with the degree of \( r(x) \) less than the degree of \( b(x) \), using inspection, long division, or, for the more complicated examples, a computer algebra system. | ● Review properties and applications of linear, exponential, power, sine, cosine, and inverse variation functions.
   ● Develop a taxonomy of function rule, graph, and numerical patterns.
   ● Discover the connections between rules of functions whose graphs are related by vertical translation, reflection across the x-axis, and horizontal translation.
   ● Discover ways that maximum and minimum points, zeroes, and y-intercepts of two functions are related if their graphs are related by vertical translation, reflection across the x-axis, and horizontal translation.
   ● Develop strategies for using the connections between graph transformations and function rules to develop models for relationships that are based on the core function families.
   ● Discover the connections between rules for functions that are related by horizontal and/or vertical translation. | ● Sample Investigations and Assignments
   ● Honors Extensions |
| **Unit 1 Learning Goals:** | **Functions**
   F-BF.1*, 2*, 3: Write a function that describes a relationship between two quantities. Determine an explicit expression, a recursive process, or steps for calculation from a context. Combine standard function types using arithmetic operations. (+) Compose functions. Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms. Identify the effect on the graph of replacing \( f(x) \) by \( f(x) + k \), \( k \ f(x) \), \( f(kx) \), and \( f(x + k) \) for specific values of \( k \) (both positive and negative); find the value of \( k \) given the \( (x,y) \) values. | **Modeling Atmospheric Change**
   The goal of this investigation is to review patterns that suggest each of the familiar function types as promising models for variation. Students will see that even small changes that seem trivial in weather data can have dramatic consequences. | **It’s All in the Family**
   The goal of this investigation is to build on the in-context explorations of the previous investigation to assemble a comprehensive survey of the basic families of functions and the ways that parameters in their rules affect the shape of graphs and the pattern of change in tables of sample \( (x,y) \) values. |
| ● Review and extend properties of basic function families and their uses in mathematical modeling. | **Modeling Atmospheric Change**
   - Develop strategies for finding rules of functions whose graphs are related by translation, reflection, stretching, and compressing to those of basic family members. | **Vertical Translation**
   In this investigation, we look at some out-of-context mathematical questions that will produce ideas with merit for dealing with a drink-cooling modeling problem. | **Horizontal Stretching and Compressing**
   In this investigation, students |
| ● Develop strategies for finding rules of functions whose graphs are related by translation, reflection, stretching, and compressing to those of basic family members. | **Modeling Atmospheric Change**
   - Develop the definitions and important properties of arithmetic operations on functions. | | |
| ● Review and extend properties of basic function families and their uses in mathematical modeling. | **Functions**
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<td><strong>Learning Objectives</strong></td>
<td><strong>Sample Investigations and Assignments</strong></td>
</tr>
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<td><strong>Related Standards</strong></td>
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<td><strong>Honors Extensions</strong></td>
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<td><strong>Key Assessments</strong></td>
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- **Writing to Learn** - Students will keep a mathematics journal to write about their thinking during investigations and projects. They will be required to justify their reasoning during any investigation and be able to summarize their conclusions. Writing about the mathematics will encourage students to construct viable arguments and critique the reasoning of others.

- **Performance Assessments** - There will be smaller projects and key assignments during the year in which students will show their mastery of the content through a project that allows students to display their learning using questioning, and observations. Informal observations are important for teachers to conduct daily to get the pulse of the classroom and see how students are internalizing the content and procedures.

- **Assessment of Learning** - Small quizzes, larger unit tests, and benchmark exams will assess what students have learned. Small quizzes and unit tests will be made up of both highly contextualized problems and more procedural problems. The contextualized problems will assess students’ ability to make sense of problems, reason abstractly, and construct viable arguments as well as modeling with mathematics. Procedural problems will focus on assessing students’ use of tools, attending to precision, making use of structure, and expressing regularity in repeated reasoning. The benchmark exams will be common assessments that will provide data to further drive changes in teaching strategies in order to enhance student success.

- **Arithmetic with Functions** - The operations of addition, subtraction, multiplication, and division of functions are defined and used just about the way one would intuitively expect. In this investigation, students will analyze problem situations to figure out which arithmetic operations make sense in various problems and to see how one can construct, or at least predict, the shape of graphs for arithmetic combinations of functions from knowledge about the component functions.

Unit 1 Related Standards:

- **F-IF.1, 3, 4*, 5*, 7*, 8, 9**: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. Recognize that sequences are functions, sometimes-defined recursively, whose domain is a subset of the integers. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).

- **F-LE.5**: Interpret the parameters in a linear or exponential function in terms of a context.

- **F-TF.5**: Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline. **Modeling**

*all standards marked with asterisks are modeling standards.

- **Stretching and compressing**.
- **Develop strategies for adjusting basic sine and cosine functions to vary amplitude and period.**
- **Discover relationships among maximum and minimum points, zeroes, and y-intercepts of functions whose graphs are related by vertical and/or horizontal stretching and compressing.**
- **Use ideas of transformations of graphs to construct models of periodic variation.**
- **Develop the definitions and important properties of arithmetic operations on functions.**
- **Discover meaningful ways to combine functions by arithmetic operations.**
- **Develop understanding of function composition and skill in constructing rules for composite functions from rules of the component functions.**
Unit 1  | Description | Unit 1  | Focus Standards | Unit 1  | Learning Objectives | Unit 1  | Sample Investigations and Assignments | Honors Extensions
---|---|---|---|---|---|---|---|
- **Common Assessments** - Each unit will culminate in a district-wide common unit assessment (year 1 implementation will use Core-Plus provided assessments). | solve problems. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. **A-REI.3, 10:** Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. Solve one-variable equations and inequalities involving absolute value, graphing the solutions and interpreting them in context. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line). | **F-BF.4:** Find inverse functions. Solve an equation of the form \( f(x) = c \) for a simple function \( f \) that has an inverse and write an expression for the inverse. Verify by composition that one function is the inverse of another. Read values of an inverse function from a graph or a table, given that the function has an inverse. Produce an invertible function from a non-invertible function by restricting the domain. | **F-IF.2:** Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context. | **F-LE.4:** For exponential models, express as a logarithm the solution to \( ab^x = d \) where \( a, c, \) and \( d \) are numbers and the base \( b \) is 2, 10, or \( e \); evaluate the logarithm using technology. Prove simple laws of logarithms. Use the definition of logarithms to translate between logarithms in any base. Understand and use the properties of logarithms to simplify logarithmic numeric expressions and to identify their approximate values. | **G-CO.2:** Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch). | **G-GMD.3:** Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems. | **G-GPE.1:** Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square |

Honors Extensions -
Lesson 1: OYO #E25 and E27, p. 22-23
Lesson 2: OYO #E31, p. 50
Lesson 3: #E23, p. 72
Lesson 4: #E21, p. 90

Project: Compositions of All Types
<table>
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<th>Unit 1</th>
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</table>
| ● Description  
● Learning Goals  
● Key Assessments | ● Focus Standards  
● Related Standards | ● Learning Objectives | ● Sample Investigations and Assignments  
● Honors Extensions |

- to find the center and radius of a circle given by an equation.
  - G-MG.2*: Apply concepts of density based on area and volume in modeling situations.
  - S-ID.2*, 6*: Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models. Informally assess the fit of a function by plotting and analyzing residuals. Fit a linear function for a scatter plot that suggests a linear association.
Unit 2 - Vectors and Motion

Unit 2 Vectors and Motion:
- This unit develops student understanding of two-dimensional vectors and their use in modeling linear, circular, and other nonlinear motion.

Unit 2 Learning Goals:
- Apply geometric concepts in modeling situations.
- Describe and use the concept of vector in mathematical, scientific, and everyday situations.
- Represent vectors geometrically and operate on geometric vectors.
- Describe, represent, and use vector components and operations synthetically and analytically.
- Investigate and justify general properties of vectors and vector operations.
- Provide vector proofs of properties of triangles and parallelograms.
- Use vector concepts to parametrically represent linear, projectile, circular, and elliptical motions in a place.
- Analyze motions using parametric models.

Unit 2 Assessments:
- Assessment for Learning: Feedback given in many forms such as direct teacher conversations and revision suggestions, mini-quizzes, peer grading rubrics, and self-grading will help students to improve their quality of work and deepen their understanding. Informal daily assessments will be used daily by teachers through warm ups, journaling, questioning, and observations. Informal observations are important for teachers to conduct daily to get the pulse of the classroom and see how students are internalizing the content and procedures.

Unit 2 Focus Standards:

Number and Quantity:
N-VM.1,2,3,4,5: (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes. Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point. Solve problems involving velocity and other quantities that can be represented by vectors. Add and subtract vectors. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum. Understand vector subtraction geometrically with the magnitude and direction of their sum. Subtract vectors geometrically and by using horizontal and vertical components, as well as vector subtraction component-wise. Multiply a vector by a scalar; Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise. Compute the magnitude of a scalar multiple cv using ||cv|| = |c|v. Compute the direction of cv knowing that when c > 0, the direction of cv is either along v (for c > 0) or against v (for c < 0).

Algebra
A-CED.2*: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

Students will:
- Represent vectors as directed line segments with both direction and magnitude.
- Describe and illustrate the scalar multiple and the opposite of a vector.
- Describe and illustrate the components of a vector.
- Add two vectors geometrically and by using components.
- Model linear motions and forces with vectors.
- Review and apply the Law of Sines and Law of Cosines to general triangles.
- Describe and illustrate the relationship between the coordinates of the terminal point of a position vector and its components.
- Explore and prove properties of scalar products and addition of vectors.
- Describe and illustrate the dot product of two vectors, use it to compute the cosine of the angle formed by the vectors and to test whether or not those vectors are perpendicular.
- Use vectors to prove properties of triangles and quadrilaterals.

Navigation: What Direction and How Far?-
In this investigation, students will use vectors and vector operations to look for answers to questions such as, How can vectors be represented geometrically with directed line segments? and How can vectors and scalar multiples of vectors be used to model navigation routes?

Changing Course-
In this investigation, students will learn how to find the sum of two vectors geometrically and how to compute vector sums using horizontal and vertical components, as well as investigating properties of vector addition.

Go with the Flow-
This investigation extends the application of vectors to plotting navigational routes for which there are additional forces that affect the path of the boat or plane. One of the ideas under consideration is that the combined force acting on an object is the sum of the individual force vectors, regardless of the number of forces.
### Assessment of Learning
Small quizzes, larger unit tests, and benchmark exams will assess what students have learned. Small quizzes and unit tests will be made up of both highly contextualized problems and more procedural problems. The contextualized problems will assess students’ ability to make sense of problems, reason abstractly, and construct viable arguments as well as modeling with mathematics. Procedural problems will focus on assessing students’ use of tools, attending to precision, making use of structure, and expressing regularity in repeated reasoning. The benchmark exams will be common assessments that will provide data to further drive changes in teaching strategies in order to enhance student success.

### Writing to Learn
Students will keep a mathematics journal to write about their thinking during investigations and projects. Students will be required to justify their reasoning during any investigation and be able to summarize their conclusions. Writing about the mathematics will encourage students to construct viable arguments and critique the reasoning of others.

### Performance Assessments
There will be smaller projects and key assignments during the year in which students will show their mastery of the content through a project that allows students to display their learning using multiple representations.

### Common Assessments
Each unit will culminate in a district-wide common unit assessment (year 1 implementation will use Core-Plus provided assessments).

### Related Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-SSE.1*</td>
<td>Interpret expressions that represent a quantity in terms of its context. Interpret parts of an expression, such as terms, factors, and coefficients. Interpret complicated expressions by viewing one or more of their parts as a single entity.</td>
</tr>
<tr>
<td>F-TF.1</td>
<td>Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.</td>
</tr>
<tr>
<td>G-MG.1*, 3*</td>
<td>Use geometric shapes, their measures, and their properties to describe objects. Apply geometric methods to solve design problems.</td>
</tr>
<tr>
<td>G-SRT.10, 11</td>
<td>(+) Prove the Laws of Sines and Cosines and use them to solve problems. (+) Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).</td>
</tr>
</tbody>
</table>

### Sample Assessments

- **Unit 2**
  - Focus Standards
  - Related Standards
  - Learning Objectives

- **Unit 2**
  - Sample Investigations and Assignments
  - Honors Extensions

### Follow That Dot
Students will learn how to represent linear motion, both symbolically and graphically and they are going to connect what they know about components of a vector to write new equations for the path of each kind of motion, starting with linear motion in this investigation.

### What Goes Up Must Come Down
In this investigation, students study the effect of gravity on the height, time in flight, and horizontal distance of a projectile. Familiar examples include pitching a softball or a horseshoe or hitting a baseball.

### Honors Extensions

- **Lesson 1**: OYO #E23, p. 126
- **Lesson 2**: OYO #E25 or E26, pgs. 153-154
- **Lesson 3**: OYO #E17, or E19, or E20, pgs. 174-176

### Project
*Take Home Test Problems 1-3*
<table>
<thead>
<tr>
<th>Focus Standards</th>
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<tbody>
<tr>
<td>G-CO.5, 10: Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another; Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180°; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.</td>
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<tr>
<td>G-GPE.1, 3, 4: Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation. (+) Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant. Given a quadratic equation of the form $ax^2 + by^2 + cx + dy + e = 0$, use the method for completing the square to put the equation into standard form; identify whether the graph of the equation is a circle, ellipse, parabola, or hyperbola and graph the equation. Use coordinates to prove simple geometric theorems algebraically. Use coordinates to prove simple geometric theorems algebraically.</td>
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<tr>
<td>G-SRT.1, 8*: Verify experimentally the properties of dilations given by a center and a scale factor. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems. Derive and use the trigonometric ratios for special right triangles (30°, 60°, 90° and 45°, 45°, 90°).</td>
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</tbody>
</table>
**Math 4 Scope and Sequence**

**Unit 3 Algebraic Functions and Equations**

### Unit 3 Learning Goals:
- **Description**
- **Focus Standards**
- **Related Standards**
- **Learning Objectives**
- **Sample Investigations and Assignments**
- **Honors Extensions**

#### Unit 3 Algebraic Functions and Equations:
- This unit reviews and extends student understanding of properties of polynomial and rational functions and skills in manipulating algebraic expressions and solving polynomial and rational equations, and develops student understanding of complex number representations and operations.

#### Unit 3 Learning Goals:
- Review and extend student skill in work with polynomials and polynomial functions to model graph patterns and conditions of quantitative relationships.
- Develop basic properties of polynomial functions like zeroes, local max/min points, end behavior, and representation in standard, factored, and nested multiplication forms.
- Develop understanding and skill in division of polynomials and the division algorithm.
- Develop concepts of complex numbers and their representation in a + bi form and as points/vectors on the coordinate grid.
- Develop definitions and skill in operations on complex numbers.
- Review and extend student understanding and skill in work with rational expressions and rational functions to model generalized inverse variation relationships.
- Enhance student skill in analyzing rational functions and their graphs to identify domain, asymptotes, zeroes, and local max/min points.
- Extend student skill in combining rational expressions and their graphs to identify domain, asymptotes, zeroes, and local max/min points.

#### Unit 3 Focus Standards:

#### Number and Quantity:
- **N-CN.1, 2, 3, 4, 5, 6, 7, 8**: Know there is a complex number $i$ such that $i^2 = -1$, and every complex number has the form $a + bi$ with $a$ and $b$ real. Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers. (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers. (+) Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number. (+) Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. (+) Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints. Solve quadratic equations with real coefficients that have complex solutions. (+) Extend polynomial identities to the complex numbers.

#### Algebra
- **A-APR.1, 2, 3, 4, 6, 7**: Understand that polynomials form a system analogous to the integers; namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials. Know and apply the Remainder Theorem. For a polynomial $p(x)$ and a number $a$, the remainder on division by $x - a$ is $p(a)$, so $p(a) = 0$ if and only if $(x - a)$ is a factor of $p(x)$. Identify zeroes of polynomials when the remainder is zero.
- **A-APR.6**: Use definitions of addition, subtraction, multiplication, and division of complex numbers to establish algebraic properties of complex number operations.
- **A-APR.7**: Develop geometric representation of complex numbers, including absolute value for magnitude, and the connection between complex numbers and their representations in standard, factored, and nested multiplication forms.

#### Students will...:
- Fit polynomial function models to data and graph patterns using problem conditions, statistical regressions, and the method of undetermined coefficients.
- Extend the relationship between standard, factored, and nested multiplication forms of polynomials.
- Develop polynomial division and the division algorithm $p(x) = (x-k)q(x) + r(x)$.
- Solve polynomial equations and inequalities.
- Develop understanding of the need for complex numbers to solve quadratic equations and the definition of the new numbers in the form $a + bi$, with $a$ and $b$ real numbers and $i = \sqrt{-1}$.
- Use definitions of addition, subtraction, multiplication, and division of complex numbers to establish algebraic properties of complex number operations.
- Develop geometric representation of complex numbers, including absolute value for magnitude, and the connection between complex numbers and their representations in standard, factored, and nested multiplication forms.

#### Constructing Polynomial Function Models:
This investigation compares three strategies for finding polynomial functions whose graphs match given geometric patterns. These strategies include using a generalization of the property of polynomial functions where when $p(x)$ has a zero at $x = k$, then $p(x)$ has a factor $(x - k)$; revisiting statistical regression applied to key control points; and introducing an exact method called the method of undetermined coefficients.

#### Division of Polynomials:
The goals of this investigation are to develop student understanding and modest skill in work with the standard long division procedure for polynomials and to establish the simplest case of what is commonly called the division algorithm for polynomials. Students then draw on factoring skills, this division algorithm and end behavior of polynomials to solve polynomial equations and inequalities.
Unit 3 Assessments:
- **Assessment for Learning** - Feedback given in many forms such as direct teacher conversations and revision suggestions, mini-quizzes, peer grading rubrics, and self-grading will help students to improve their quality of work and deepen their understanding. Informal daily assessments will be used daily by teachers through warm ups, journaling, questioning, and observations. Informal observations are important for teachers to conduct daily to get the pulse of the classroom and see how students are internalizing the content and procedures.
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<tbody>
<tr>
<td>Expressions and equations by addition, subtraction, multiplication, and division and in solving equations involving rational expressions.</td>
<td>Develop skill in analyzing expressions and solving equations that involve radicals.</td>
<td>Reflect on generalizable strategies for solving algebraic problems by analysis of the forms of symbolic expressions and equations as well as by routine symbol manipulation.</td>
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<tr>
<td>A-CED.1*, 2*, 3*</td>
<td>A-REI.12, 3, 4, 6, 8, 9</td>
<td>A Complex Solution - In this investigation, students will be asked to follow the reasoning that leads to the creation of complex numbers and to reasonable definitions of addition, subtraction, multiplication and division for these new numbers.</td>
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<tr>
<td>Rational Function Models - In this investigation, students will analyze models proposed for the relationship between drop height and number of drops required. This will build on previous work with rational functions from course 3 and the algebraic forms should be somewhat familiar.</td>
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<td>Seeing the Big Picture - In this investigation, students are asked to review the strategies that they have learned for solving general classes of algebra problems and to reflect on how choice of method depends on the way they size up the problem that they are given. They are then given some specific algebra problems and prompted to use their symbol sense to reason about those problems with an eye to thinking strategically about the problems rather than simply applying routine algebraic procedures.</td>
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use of structure, and expressing regularity in repeated reasoning. The benchmark exams will be common assessments that will provide data to further drive changes in teaching strategies in order to enhance student success.

- **Writing to Learn**: Students will keep a mathematics journal to write about their thinking during investigations and projects. Students will be required to justify their reasoning during any investigation and be able to summarize their conclusions. Writing about the mathematics will encourage students to construct viable arguments and critique the reasoning of others.

- **Performance Assessments**: There will be smaller projects and key assignments during the year in which students will show their mastery of the content through a project that allows students to display their learning using multiple representations.

- **Common Assessments**: Each unit will culminate in a district-wide common unit assessment (year 1 implementation will use Core-Plus provided assessments).

**A-SSE.1*, 2, 3*: Interpret expressions that represent a quantity in terms of its context. Interpret parts of an expression, such as terms, factors, and coefficients. Interpret complicated expressions by viewing one or more of their parts as a single entity. Use the structure of an expression to identify ways to rewrite it. Write expressions in equivalent forms to solve problems. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. Factor a quadratic expression to reveal the zeroes of the function it defines. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines. Use the properties of exponents to transform expressions for exponential functions.

**Functions**

**F-BF.1**: Write a function that describes a relationship between two quantities. Determine an explicit expression, a recursive process, or steps for calculation from a context. Combine standard function types using arithmetic operations. (+) Compose functions.
**Focus Standards**

<table>
<thead>
<tr>
<th>Unit 3 Related Standards:</th>
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<tbody>
<tr>
<td><strong>N-VM.8, 10:</strong> Add, subtract, and multiply matrices of appropriate dimensions; (+) Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.</td>
</tr>
</tbody>
</table>

**Modeling**

*all standards marked with asterisks are modeling standards*

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<td><strong>A-CED.4:</strong> Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.</td>
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<td>Unit 3</td>
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</tbody>
</table>
| ● Description  
● Learning Goals  
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● Honors Extensions |

**A-REI.1**: Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

**A-SSE.4***: Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems.

**G-GPE.4**: Use coordinates to prove simple geometric theorems algebraically.

**G-MG.1*, 3***: Use geometric shapes, their measures, and their properties to describe objects. Apply geometric methods to solve design problems.

**S-ID.6***: Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Informally assess the fit of a function by plotting and analyzing residuals. Fit a linear function for a scatter plot that suggests a linear association.
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<tr>
<th>Unit 4</th>
<th>Description</th>
<th>Learning Goals</th>
<th>Focus Standards</th>
<th>Related Standards</th>
<th>Learning Objectives</th>
<th>Sample Investigations and Assignments</th>
<th>Honors Extensions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit 4 Trigonometric Functions and Equations:</strong></td>
<td>This unit extends student understanding of, and ability to reason with, trigonometric functions to prove or disprove potential trigonometric identities and to solve trigonometric equations; develops student ability to geometrically represent complex numbers and their operations and to find powers and roots of complex numbers expressed in trigonometric form.</td>
<td><strong>Unit 4 Focus Standards:</strong></td>
<td><strong>Number &amp; Quantity</strong></td>
<td>N-CN.2, 3, 4, 5, 9: Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties of numbers to add, subtract, and multiply complex numbers. (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers. (+) Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number. (+) Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. (+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.</td>
<td><strong>Students will...</strong></td>
<td><strong>Trigonometric Identities:</strong> This investigation introduces strategies for proving trigonometric identities restricted to those involving sine, cosine, and tangent functions. Students are encouraged to use visual reasoning based on the symmetry of the unit circle to reconstruct these identities rather than memorize them.</td>
<td><strong>Extending the Family of Trigonometric Functions:</strong> This investigation introduces the three reciprocal trigonometric functions, secant, cosecant, and cotangent and their graphs. By the end of this investigation, students will have derived a variety of fundamental trigonometric identities and will extend their abilities for proving identities and finding values for trig and angles.</td>
</tr>
<tr>
<td><strong>Unit 4 Learning Goals:</strong></td>
<td>Know and be able to use the definitions of the six trigonometric functions of an angle in standard position.</td>
<td><strong>Algebra</strong></td>
<td>A-REI.1: Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method. A-SSE.1*, 2, 3*: Interpret expressions that represent a quantity in terms of its context. Interpret parts of an expression, such as terms, factors, and coefficients. Interpret complicated expressions by viewing one or more of their parts as a single entity. Use the structure of an expression to identify ways to rewrite it. Write expressions in equivalent forms to solve problems. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. Factor a quadratic expression to reveal the zeros of the function it defines. Complete the square</td>
<td><strong>A-REI.1:</strong> Describe the graph and period of each trigonometric function. Derive and use the fundamental trigonometric identities. Develop strategies for proving trigonometric identities. Derive and use the opposite-angle, cofunction, sum, difference, and double-angle identities for sine and cosine. Solve linear and quadratic trigonometric equations. Solve equations of the form $aT(bx + c) = d$, where $T$ is a trigonometric function. Express the general solutions of a trigonometric equation in forms such as $x = a + 2\pi n$ or $x = a + 360n$, for any integer $n$. Use identities to transform trigonometric equations into more easily solved forms. Express a complex number in both standard and trigonometric forms. Use complex number multiplication and division to size transform, rotate, or rotate and size transform the point or vector associated with a complex number.</td>
<td><strong>Using Identities to Solve Trigonometric Equations:</strong> In this investigation, students extend their work using previous strategies learned and trig identities to transform relatively complex...</td>
<td><strong>Extending the Family of Trigonometric Functions:</strong> This investigation introduces the three reciprocal trigonometric functions, secant, cosecant, and cotangent and their graphs. By the end of this investigation, students will have derived a variety of fundamental trigonometric identities and will extend their abilities for proving identities and finding values for trig functions and angles.</td>
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Unit 4
- Description
- Learning Goals
- Key Assessments

Unit 4
- Focus Standards
- Related Standards

Unit 4
- Learning Objectives

Unit 4
- Sample Investigations and Assignments
- Honors Extensions

will be used daily by teachers through warm ups, journaling, questioning, and observations. Informal observations are important for teachers to conduct daily to get the pulse of the classroom and see how students are internalizing the content and procedures.

- **Assessment of Learning** - Small quizzes, larger unit tests, and benchmark exams will assess what students have learned. Small quizzes and unit tests will be made up of highly contextualized problems and more procedural problems. The contextualized problems will assess students’ ability to make sense of problems, reason abstractly, and construct viable arguments as well as modeling with mathematics. Procedural problems will focus on assessing students’ use of tools, attending to precision, making use of structure, and expressing regularity in repeated reasoning. The benchmark exams will be common assessments that will provide data to further drive changes in teaching strategies in order to enhance student success.

- **Writing to Learn** - Students will keep a mathematics journal to write about their thinking during investigations and projects. Students will be required to justify their reasoning during any investigation and be able to summarize their conclusions. Writing about the mathematics will encourage students to construct viable arguments and critique the reasoning of others.

- **Performance Assessments** - There will be smaller projects and key assignments

in a quadratic expression to reveal the maximum or minimum value of the function it defines. Use the properties of exponents to transform expressions for exponential functions.

### Functions

**F-IF.4*, 7*, 8:** For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

**F-TF.3, 4, 5*, 6, 7*, 8, 9:** (+) Use special triangles to determine geometrically the values of sine, cosine, tangent for π/3, π/4 and π/6, and use the unit circle to express the values of sine, cosine, and tangent for π–x, π+x, and 2π–x in terms of their values for x, where x is any real number. (+) Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions. Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline. (+) Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed. (+) Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context. Prove the Pythagorean identity sin²(θ) + cos²(θ) = 1 and use it to find sin(θ), cos(θ), or tan(θ) given sin(θ), cos(θ), or tan(θ) and the quadrant of the angle. (+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.

- Understand and use De Moivre’s Theorem.
- Determine all the n⁰ roots of a complex number and represent them geometrically.

- **Trigonometric Form of Complex Numbers** - In this investigation, students learn to write complex numbers in trigonometric form, and then they find products and quotients of complex numbers using the trigonometric form and interpret these operations geometrically as rotations and/or size transformations of the corresponding vector or point.

- **Honors Extensions** -
  - **Lesson 1:** OYO #E32, pick 4, p. 294
  - **Lesson 2:** OYO #E18, p. 309
  - **Lesson 3:** OYO #E23, p. 327

- **Project:** Exploring Sums of Trigonometric Functions
during the year in which students will show their mastery of the content through a project that allows students to display their learning using multiple representations.

- **Common Assessments** – Each unit will culminate in a district-wide common unit assessment (year 1 implementation will use Core-Plus provided assessments).

**Geometry**

G-CO.2: Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not.

G-SRT.8*: Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems. Derive and use the trigonometric ratios for special right triangles (30°, 60°, 90°) and (45°, 45°, 90°).

**Modeling**

*all standards marked with asterisks are modeling standards

**Unit 4 Related Standards:**

N-VM.4, 5: (+) Add and subtract vectors. (+) Multiply a vector by a scalar.

A-CED.2*: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

A-REI.4, 10, 11: Represent and solve equations and inequalities graphically. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

F-BF.1*, 3: Write a function that describes a relationship between two quantities. Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology.

G-SRT.10, 11: (+) Prove the Laws of Sines and Cosines and use them to solve problems. (+) Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles.
### Math 4 Scope and Sequence
#### Unit 5 – Exponential Functions, Logarithms, and Data Modeling

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<td><strong>Honors Extensions</strong></td>
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<tr>
<td><strong>Unit 5 Exponential Functions, Logarithms, and Data Modeling</strong></td>
<td><strong>Algebra</strong></td>
<td><strong>Students will...</strong></td>
<td><strong>What is e? 335-</strong></td>
</tr>
<tr>
<td>● This unit extends student understanding of exponential and logarithmic functions to the case of natural exponential and logarithmic functions, solution of exponential growth and decay problems, and use of logarithms for linearization and modeling of data patterns.</td>
<td>A-SSE.1*, 2*: Interpret expressions that represent a quantity in terms of its context. Interpret parts of an expression, such as terms, factors, and coefficients. Interpret complicated expressions by viewing one or more of their parts as a single entity. Use the structure of an expression to identify ways to rewrite it. Write expressions in equivalent forms to solve problems.</td>
<td>● Understand e as the limit of ((1 + \frac{1}{n})^n) as (n \to \infty).</td>
<td>In this investigation, we motivate the consideration of the sequence and limit that leads to e by revisiting compound growth examples with which students are familiar.</td>
</tr>
<tr>
<td>● Use (e^r) as an approximation for ((1 + \frac{1}{n})^n).</td>
<td>Functions F-IF.4*, 7*, 8: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. F-BF.5: (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents. F-LE.4*, 5*: For exponential models, express as a logarithm the solution to (ab^x = d) where (a, c,) and (d) are numbers and the base (b) is 2, 10, or (e); evaluate the logarithm using technology. Prove simple laws of logarithms. Use the definition of logarithms to translate between logarithms in any base. Understand and use the properties of logarithms to simplify logarithmic numeric expressions and to identify their approximate values. Interpret expressions for functions in terms of the situation they model.</td>
<td>● Use (e^r) as an approximation for ((1 + \frac{1}{n})^n) and (e^r) as an approximation for ((1 + \frac{1}{n})^n).</td>
<td>Applications of (e^r) and (\ln x): The basic objectives of this investigation are to introduce natural or base-e logarithms and to develop student skill in using them to solve typical problems that involve exponential growth and decay.</td>
</tr>
<tr>
<td>● Use functions of the form (y = Ae^{rt}) to solve exponential growth and decay problems.</td>
<td>● Use functions of the form (y = Ae^{rt}) to solve exponential growth and decay problems.</td>
<td>● Show how any exponential function can be expressed in equivalent form using base e and how any logarithm can be expressed in equivalent form using base 10 or base e.</td>
<td>Assessing the Fit of a Linear Model: This investigation looks at the question of whether the given data points appear to follow in a linear pattern. Students are asked to inspect the relationship between the given data points and the linear regression equation derived from that data and to calculate and plot the residuals to see if there is any revealing pattern in those residuals.</td>
</tr>
<tr>
<td>● Show how any exponential function can be expressed in equivalent form using base e and how any logarithm can be expressed in equivalent form using base 10 or base e.</td>
<td>● Use properties of exponents and logarithms to write algebraic expressions in equivalent forms and solve equations involving logs and exponents.</td>
<td>● Use logarithmic transformations of data to</td>
<td>Log Transformations: Students learn how a log transformation of the</td>
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<tr>
<td><strong>Unit 5 Assessments:</strong></td>
<td><strong>Related Standards</strong></td>
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assessments will be used daily by teachers through warm ups, journaling, questioning, and observations. Informal observations are important for teachers to conduct daily to get the pulse of the classroom and see how students are internalizing the content and procedures.

- **Assessment of Learning** - Small quizzes, larger unit tests, and benchmark exams will assess what students have learned. Small quizzes and unit tests will be made up of both highly contextualized problems and more procedural problems. The contextualized problems will assess students’ ability to make sense of problems, reason abstractly, and construct viable arguments as well as modeling with mathematics. Procedural problems will focus on assessing students’ use of tools, attending to precision, making use of structure, and expressing regularity in repeated reasoning. The benchmark exams will be common assessments that will provide data to further drive changes in teaching strategies in order to enhance student success.

- **Writing to Learn** - Students will keep a mathematics journal to write about their thinking during investigations and projects. Students will be required to justify their reasoning during any investigation and be able to summarize their conclusions. Writing about the mathematics will encourage students to construct viable arguments and critique the reasoning of others.

- **Performance Assessments** - There will be smaller projects and key assignments during the year in which students will show their mastery of the content through a project that allows students to display their learning using multiple representations.

- **Common Assessments** - Each unit will culminate in a district-wide common unit assessment (year 1 implementation will use Core-Plus provided assessments).

Interpret the parameters in a linear or exponential function in terms of a context.

**Statistics & Probability**

**S-ID.6**: Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. *Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.* Informally assess the fit of a function by plotting and analyzing residuals. Fit a linear function for a scatter plot that suggests a linear association.

**Modeling**

*all standards marked with asterisks are modeling standards

**Unit 5 Related Standards:**

- **A-REI.1:** Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.
- **F-IF.3:** Recognize that sequences are functions, sometimes-defined recursively, whose domain is a subset of the integers.
- **G-MG.2**:* Apply concepts of density based on area and volume in modeling situations.

- find linearized data patterns.
- Use linear regression equations and back transformation (solving for $y$) to determine exponential and power functions that model data patterns.

Honors Extensions -

**Lesson 1:** OYO #E32 or E33, p. 357

**Lesson 2:** OYO #E26 or E27, p. 384-385

**Project:** Saving, Spending and Spreadsheets (requires access to spreadsheet program such as Excel. If not available, use Take Home Test)
### Math 4 Scope and Sequence

#### Unit 6 - Surfaces and Cross Sections -

<table>
<thead>
<tr>
<th>Unit 6</th>
<th>Description</th>
<th>Learning Goals</th>
<th>Related Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>●</td>
<td>● Description</td>
<td>● Focus Standards</td>
<td>● Learning Objectives</td>
</tr>
<tr>
<td>●</td>
<td>● Surfaces and Cross Sections</td>
<td>● G-GMD.2, 4:</td>
<td>Students will…</td>
</tr>
<tr>
<td>●</td>
<td>● Dimensional Space -</td>
<td>● Functions</td>
<td>● Using Data to Determine Surfaces-</td>
</tr>
<tr>
<td>●</td>
<td>● Relations Among Points in Three-Dimensional Space-</td>
<td>● Geometry</td>
<td>● This investigation simulates the activity of NASA as it gathered data on Venus, Mars, and other planets to create contour maps of the planets’ surfaces.</td>
</tr>
<tr>
<td>●</td>
<td>● Surfaces of Revolution and Cylindrical Surfaces-</td>
<td>● Algebra</td>
<td>● Visualizing and Reasoning with Cross Sections-</td>
</tr>
<tr>
<td>●</td>
<td>● Assessment for Learning- Feedback given in many forms such as direct teacher conversations and revision suggestions, mini-quizzes, peer grading</td>
<td>● A-CED.2*: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.</td>
<td>● This investigation introduces topographic profiles and students learn how to draw and interpret a topographic profile given a contour diagram. They also use horizontal and vertical cross sections of three-dimensional figures to determine and sketch the figures.</td>
</tr>
<tr>
<td>●</td>
<td>● Sample Investigations and Assignments</td>
<td>● A-REI.4: Solve quadratic equations in one variable.</td>
<td>● Relations Among Points in Three-Dimensional Space-</td>
</tr>
<tr>
<td>●</td>
<td>● Honors Extensions</td>
<td>● A-REI.4:</td>
<td>Many people find it difficult to visualize objects or surfaces in three dimensions. In this investigation, students are asked to think about ideas involving coordinates in three dimensions by first thinking about analogous cases in two dimensions.</td>
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<td>● Sample Investigations and</td>
<td>● A-CED.2*:</td>
<td>● Surfaces of Revolution and Cylindrical Surfaces-</td>
</tr>
<tr>
<td>●</td>
<td>Assignments</td>
<td>● Functions</td>
<td>Students will explore surfaces of revolution and develop equations for these surfaces. They will explore cylindrical surfaces, which are perpendicular to the coordinate plane. As they work, they will be encouraged to physically model the</td>
</tr>
<tr>
<td>●</td>
<td>● Honors Extensions</td>
<td>● Geometry</td>
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</table>

#### Unit 6 Focus Standards:

- **Algebra**
  - A-CED.2*: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
  - A-REI.4: Solve quadratic equations in one variable.
- **Functions**
  - F-IF.7*, 8: Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.
- **Geometry**
  - G-GMD.2, 4: (+) Give an informal argument using Cavalieri’s principle for the formulas for the volume of a sphere and other solid figures. Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects, and surfaces in space.
  - Use the three-dimensional coordinate system to locate points and represent data, objects, and surfaces in space.
  - Use information revealed by the form of an equation of a three-dimensional surface to visualize, characterize, and sketch the surface.
  - Identify and sketch surfaces of revolution and cylindrical surfaces.
  - Identify and sketch surfaces of revolution and develop equations for these surfaces.
  - Identify and sketch graphs of conic sections given an equation in the form $ax^2 + by^2 + cx + dy + e = 0$.
  - Derive equations for circles given the center and radius.
  - Derive equations for parabolas given a focus and directrix.
  - Derive equations for ellipses and hyperbolas given the foci.
  - Find the length of a segment that joins two points in space.
  - Find the coordinates of the midpoint of a line segment in space.
  - Describe the relationship between the coordinates of two points that are symmetric with respect to a coordinate plane or axis.
  - Many people find it difficult to visualize objects or surfaces in three dimensions. In this investigation, students are asked to think about ideas involving coordinates in three dimensions by first thinking about analogous cases in two dimensions.
rubrics, and self-grading will help students to improve their quality of work
and deepen their understanding. Informal daily assessments will be used daily by
teachers through warm ups, journaling, questioning, and observations. Informal
observations are important for teachers to conduct daily to get the pulse of the
classroom and see how students are internalizing the content and procedures.

- **Assessment of Learning**: Small quizzes, larger unit tests, and benchmark exams
  will assess what students have learned. Small quizzes and unit tests will be made
  up of both highly contextualized problems and more procedural problems. The contextualized problems will assess
  students’ ability to make sense of problems, reason abstractly, and construct
  viable arguments as well as modeling with mathematics. Procedural problems
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  of structure, and expressing regularity in repeated reasoning. The benchmark
  exams will be common assessments that will provide data to further drive changes in teaching strategies in order to enhance
  student success.

- **Writing to Learn**: Students will keep a
  mathematics journal to write about their
  thinking during investigations and projects. Students will be required to
  justify their reasoning during any investigation and be able to summarize
  their conclusions. Writing about the mathematics will encourage students to
  objects generated by rotations of two-dimensional objects.

  **G-GPE.1, 2, 3**: Derive the equation of a circle of given
center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a
circle given by an equation. Derive the equation of a parabola given a focus and directrix. (+) Derive the
  equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances
  from the foci is constant. Given a quadratic equation of the form \(ax^2 + by^2 + cx + dy + e = 0\), use the method
  for completing the square to put the equation into standard form; identify whether the graph of the equation is a circle, ellipse, parabola, or hyperbola and
  graph the equation.

  **G-MG.1*, 2*, 3*:** Use geometric shapes, their
  measures, and their properties to describe objects. Apply concepts of density based on area and volume
  in modeling situations. Apply geometric methods to solve design problems (e.g., designing an object or
  structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).

  **Modeling**: *all standards marked with asterisks are modeling
  standards

  **Unit 6 Related Standards:**

  **N-VM.4**: (+) Add and subtract vectors.
  Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of
  a sum of two vectors is typically not the sum of the magnitudes. Given two vectors in magnitude and
  direction form, determine the magnitude and direction of their sum. Understand vector subtraction \(v - w\) as \(v + (-w)\), where \(-w\) is the additive inverse of \(w\), with the same magnitude as \(w\) and pointing in the opposite
  ideas of cylindrical surface and surface revolution.

  **Honors Extensions**
  **Lesson 1**: OYO #E31 or E32 or E34, p. 426–427
  **Lesson 2**: OYO #E31, p. 460
  **Project**: Take Home Test – #1 and 2 or #3 (need access to modeling clay)
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- **Unit 6**
  - Description
  - Learning Goals
  - Key Assessments

- **Performance Assessments** - There will be smaller projects and key assignments during the year in which students will show their mastery of the content through a project that allows students to display their learning using multiple representations.

- **Common Assessments** - Each unit will culminate in a district-wide common unit assessment (year 1 implementation will use Core-Plus provided assessments).

- **Learning Objectives**
  - Construct viable arguments and critique the reasoning of others.
  - **Performance Assessments** - There will be smaller projects and key assignments during the year in which students will show their mastery of the content through a project that allows students to display their learning using multiple representations.

- **Related Standards**

- **Focus Standards**

- **Sample Investigations and Assignments**

- **Honors Extensions**

- **A-CED.1**, **3**: Create equations and inequalities in one variable including ones with absolute value and use them to solve problems. *Include equations arising from linear and quadratic functions, and simple rational and exponential functions.* Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.

- **F-BF.3**: Identify the effect on the graph of replacing \( f(x) \) by \( f(x) + k \), \( k f(x) \), \( f(kx) \), and \( f(x + k) \) for specific values of \( k \) (both positive and negative); find the value of \( k \) given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology.

- **G-CO.5, 6**: Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another. Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.

- **G-GPE.4**: Use coordinates to prove simple geometric theorems algebraically.

- **S-ID.1**: Represent data with plots on the real number line (dot plots, histograms, and box plots).
## Math 4 Scope and Sequence

### Unit 7 - Concepts of Calculus

#### Unit 7 Description
- This unit develops student understanding of fundamental calculus ideas through explorations in a variety of applied problem contexts and their representations to in function tables and graphs.

#### Unit 7 Learning Goals:
- Develop the concept of instantaneous rate of change in a continuous variable and strategies for estimating those rates of change.
- Define the derivative of a function at a point in its domain.
- Connect the derivative of a function to local approximation of slope of its graph.
- Develop derivative formulas for linear and quadratic functions.
- Develop the connection between area under a rate function graph and accumulation of change.
- Define the definite integral of a function and its application to problems.

#### Unit 7 Assessments:
- **Assessment for Learning:** Feedback given in many forms such as direct teacher conversations and revision suggestions, mini-quizzes, peer grading rubrics, and self-grading will help students to improve their quality of work and deepen their understanding. Informal daily assessments will be used daily by teachers through warm ups, journaling, questioning, and observations. Informal observations are important for teachers to conduct daily to get

### Unit 7 Focus Standards:

#### Functions
- **F-IF.1, 2, 4*, 6*, 7*, 8, 9:** Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If \( f \) is a function and \( x \) is an element of its domain, then \( f(x) \) denotes the output of \( f \) corresponding to the input \( x \). The graph of \( f \) is the graph of the equation \( y = f(x) \). Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. **Key features include intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.** Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. Graph linear and quadratic functions and show intercepts, maxima, and minima; Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions. Graph polynomial functions, identifying zeroes when suitable factorizations are available, and showing end behavior. \((+) \) Graph rational functions, identifying zeroes and asymptotes when suitable factorizations

#### Algebra
- **A-SSE.1*:** Interpret expressions that represent a quantity in terms of its context. Interpret parts of an expression, such as terms, factors, and coefficients. Interpret complicated expressions by viewing one or more of their parts as a single entity.

### Related Standards

### Learning Objectives

**Students will...**
- Develop the concept of instantaneous rate of change in a continuous variable and strategies for estimating those rates of change.
- Define the derivative of a function at a point in its domain.
- Connect the derivative of a function to local approximation of slope of its graph.
- Develop derivative formulas for linear and quadratic functions.
- Develop understanding of the connection between cumulative change and area bounded by a rate of change graph.
- Develop beginning understanding of the ways that areas (and thus definite integrals) can be approximated by Riemann sums and the effects of refining the approximation by letting \( \Delta x \to 0 \).

### Sample Investigations and Assignments

### Rates of Change from Graphs and Tables-
- In this investigation, students begin comparing average rates of change over intervals to the kind of local or instantaneous rates of change that are indicated by speedometers like those in a car. They are asked to study rate of change in three different settings, with information provided in numeric and graphic form. The first two settings emphasize position and velocity of moving objects - the historic roots of calculus. The third setting looks at the rate of change of the profit of a business.

### The Derivative-
- In this investigation, students extend their informal understanding of instantaneous rates of change by analyzing formal definitions of the derivative for a function and then applying them to derive a few basic derivative rules.

### What is the Total?-
- In this investigation, students tackle the problem of working from a speed graph to
the pulse of the classroom and see how students are internalizing the content and procedures. **Assessment of Learning** - Small quizzes, larger unit tests, and benchmark exams will assess what students have learned. Small quizzes and unit tests will be made up of both highly contextualized problems and more procedural problems. The contextualized problems will assess students’ ability to make sense of problems, reason abstractly, and construct viable arguments as well as modeling with mathematics. Procedural problems will focus on assessing students’ use of tools, attending to precision, making use of structure, and expressing regularity in repeated reasoning. The benchmark exams will be common assessments that will provide data to further drive changes in teaching strategies in order to enhance student success.

- **Writing to Learn** - Students will keep a mathematics journal to write about their thinking during investigations and projects. Students will be required to justify their reasoning during any investigation and be able to summarize their conclusions. Writing about the mathematics will encourage students to construct viable arguments and critique the reasoning of others.

- **Performance Assessments** - There will be smaller projects and key assignments during the year in which students will show their mastery of the content through a project that allows students to display their learning using multiple representations.

- **Common Assessments** - Each unit will culminate in a district-wide common unit assessment (year 1 implementation will use Core-Plus provided assessments).

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*all standards marked with asterisks are modeling standards

**Unit 7 Related Standards:**

- **A-CED.1**: Create equations and inequalities in one variable including ones with absolute value and use them to solve problems.

- **G-GMD.1**: Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri’s principle, and information limit arguments.

- **F-TF.5**: Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.

- **Geometry**

- **Calculus**

- **Modeling**

- **Honors Extensions** - Lesson 1: OYO #E30, p. 499-500
  
  **Lesson 2**: OYO #E21 or E25, p. 523-524

  **Project**: Finding Volume

**Determine total distance traveled over a time interval and from a flow rate graph to determine total flow over a time interval.**

**The Definite Integral** - The aim of this investigation is to introduce the notion of a definite integral as the limit of the kind of approximations that students have been calculating in this lesson. The focus is on the integral as a limit of approximating Riemann sums.

**Honors Extensions** - Lesson 1: OYO #E30, p. 499-500  
Lesson 2: OYO #E21 or E25, p. 523-524  
Project: Finding Volume
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<tr>
<td><strong>A-REI.1:</strong> Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.</td>
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<td><strong>F-BF.3:</strong> Identify the effect on the graph of replacing ( f(x) ) by ( f(x) + k ), ( k f(x) ), ( f(kx) ), and ( f(x + k) ) for specific values of ( k ) (both positive and negative); find the value of ( k ) given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.</td>
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<td><strong>F-IF.3, 8:</strong> Recognize that sequences are functions, sometimes-defined recursively, whose domain is a subset of the integers. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. Use the process of factoring and completing the square in a quadratic function to show zeroes, extreme values, and symmetry of the graph, and interpret these in terms of a context. Use the properties of exponents to interpret expressions for exponential functions.</td>
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<td><strong>G-CO.2:</strong> Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).</td>
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<td><strong>S-ID.1:</strong> Represent data with plots on the real number line (dot plots, histograms, and box plots).</td>
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## Math 4 Scope and Sequence
### Unit 8 - Counting Methods and Induction

### Learning Goals:
- Develop the skill of careful counting in a variety of contexts.
- Understand and apply a variety of counting techniques, including the Multiplication Principle of Counting, the Addition Principle of Counting, counting trees, and systemic lists.
- Understand and apply the issues of order and repetition when counting the number of possible choices form a collection.
- Solve counting problems involving combinations and permutations.
- Understand and apply the Binomial Theorem.
- Understand and apply connections among combinations, the Binomial Theorem, and Pascal’s triangle.
- Apply counting methods to probability situations in which all outcomes are equally likely.
- Extend understanding of and apply the General Multiplication Rule for Probability.
- Develop the skill of combinatorial reasoning, including use in proofs.
- Understand and carry out proofs by mathematical induction.
- Understand and carry out proofs using indirect reasoning and the Least Number Principle.

### Focus Standards:

- **Algebra**
  - A-APR.5: (+) Know and apply the Binomial Theorem for the expansion of $(x + y)^n$ in powers of $x$ and $y$ for a positive integer $n$, where $x$ and $y$ are any numbers, with coefficients determined for example by Pascal’s Triangle.
  - A-SSE.1*, 2: Interpret expressions that represent a quantity in terms of its context. Interpret parts of an expression, such as terms, factors, and coefficients. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret $P(1+r)^n$ as the product of $P$ and a factor not depending on $P$.
  - 2. Use the structure of an expression to identify ways to rewrite it. For example, see $x^2 - y^2$ as $(x-y)(x+y)$, thus recognizing it as a difference of squares that can be factored as $(x-y)^2 + y^2$.

- **Functions**
  - F-BF.1*, 2*: Write a function that describes a relationship between two quantities. Determine an explicit expression, a recursive process, or steps for calculation from a context. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model. (+) Compose functions. For example, if $T(y)$ is the temperature in the atmosphere as a function of height, and $h(t)$ is the height of a weather balloon as a function of time, then $T(h(t))$ is the temperature at the location of the weather balloon as a function of time. Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.

### Related Standards:
- **Statistics and Probability**
  - S-CP. 3*, 6*,7*, 8*, 9*: Understand the conditional probability of $A$ given $B$ as $P(A$ and $B)/P(B)$, and interpret independence of $A$ and $B$ as saying that the conditional

### Learning Objectives:
- Students will...
  - Develop the skill of systematic counting by thinking carefully about the number of possibilities in a variety of contexts.
  - Understand and apply basic counting strategies, such as making tree diagrams, making systematic lists, and using the Multiplication Principle of Counting and the Addition Principle of Counting.
  - Understand the importance of counting in many real-world contexts.
  - Understand and apply order and repetition in counting problems.
  - Create, analyze, apply and make sense of the formulas for counting permutations and combinations.
  - Solve counting problems by applying several methods and concepts in any given problem.
  - Understand, apply, and connect three basic counting problems - counting selections from

### Methods of Counting -
- In this investigation, students start thinking carefully about counting, and they see that counting is important in many contexts. Many counting issues and strategies are raised, to be studied explicitly in later lessons.

### Permutations and Combinations -
- In this investigation, students focus on permutations and combinations. They study a key example to ground their knowledge, learn definitions and develop, apply and make sense of the formulas.

### Collections, Sequences, This or That-
- In this investigation, students continue their study of counting situations that involve making selections from a collection of objects, especially as classified by the rules of order and repetition.

### Counting and Probability -
- In this investigation, students use counting methods to solve probability problems in which all outcomes are
### Unit 8 Assessments:

- **Assessment for Learning** - Feedback given in many forms such as direct teacher conversations and revision suggestions, mini-quizzes, peer grading rubrics, and self-grading will help students to improve their quality of work and deepen their understanding. Informal daily assessments will be used daily by teachers through warm ups, journaling, questioning, and observations. Informal observations are important for teachers to conduct daily to get the pulse of the classroom and see how students are internalizing the content and procedures.

- **Assessment of Learning** - Small quizzes, larger unit tests, and benchmark exams will assess what students have learned. Small quizzes and unit tests will be made up of both highly contextualized problems and more procedural problems. The contextualized problems will assess students’ ability to make sense of problems, reason abstractly, and construct viable arguments as well as modeling with mathematics. Procedural problems will focus on assessing students’ use of tools, attending to precision, making use of structure, and expressing regularity in repeated reasoning. The benchmark exams will be common assessments that will provide data to further drive changes in teaching strategies in order to enhance student success.

- **Writing to Learn** - Students will keep a mathematics journal to write about their thinking during investigations and projects. Students will be required to justify their reasoning during any investigation and be able to summarize their conclusions. Writing about the mathematics will

### Unit 8 Related Standards:

- **A-REI.1** - Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

- **S-CP.1**, **2**, **4** - Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events (“or,” “and,” “not”). Understand that two events $A$ and $B$ are independent if the probability of $A$ and $B$ occurring together is the product of their probabilities, and use this characterization to determine if they are independent. Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. For example, collect data from a random sample of students in your school or on your favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.

- **Unit 8 Learning Objectives** - a collection of objects (the four order and repetition problem types) counting the outcomes from a sequence of tasks (the Multiplication Principle of Counting), and counting the outcomes from a union (the Addition Principle of Counting).

- **Unit 8 Sample Investigations and Assignments** - Understand the importance of counting in many real-world contexts.

- **Unit 8 Honors Extensions** - Apply counting methods to probability situations in which all outcomes are equally likely.

- **Infinity, Recursion, and Mathematical Induction** - Review and apply the General Multiplication Rule for Probability; in particular, use the Multiplication Principle of Counting, permutations, and combinations.

- **Infinity, Recursion, and Mathematical Induction** - Understand and apply the Binomial Theorem.

- **Infinity, Recursion, and Mathematical Induction** - Understand and apply connections among combinations, the Binomial Theorem, and Pascal’s triangle.

- **Infinity, Recursion, and Mathematical Induction** - Develop the skill of combinatorial reasoning, including its use in proofs.
encourage students to construct viable arguments and critique the reasoning of others.

- **Performance Assessments** - There will be smaller projects and key assignments during the year in which students will show their mastery of the content through a project that allows students to display their learning using multiple representations.

- **Common Assessments** - Each unit will culminate in a district-wide common unit assessment (year 1 implementation will use Core-Plus provided assessments).

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<td><strong>Stem Majors: Understand the Least Number Principle and proofs using this principle along with indirect reasoning.</strong></td>
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**Honors Extensions** -
- **Lesson 1:** OYO #E18 or E21, p. 549
- **Lesson 2:** OYO #E18 or E20 and E21, p. 570-572
- **Lesson 3:** OYO #E16, or E17, pgs. 591-592
- **Lesson 4:** OYO #E22, p.609

**Project:** Take Home Test – Pick any one problem
The primary goals of the EUHSD Mathematics program are as follows: first, ensure students develop a deeper understanding of mathematics; second, prepare students to take on more advanced studies in math; third, personalize the pursuit of honors and advanced coursework; fourth, to focus on the level of rigor evidenced by the work produced by students. Accordingly, students who elect to participate in and produce honors level work will receive honors credit.

Students who earn the honors designation in these courses will produce work that addresses more sophisticated questions, delve more deeply into the mathematics of the course, and satisfy the California State Standards with added rigor. The honors modification applied to some course assignments will broaden the scope or deepen the examination of the course content.

The honors option is available to all students enrolled in Math 2, Math 3S, Math 3C, and Math 4, and will take place within those classrooms. Students are provided the opportunity to opt in to the Honors requirements. Only students in Math 4 will be eligible for the UC Honors designation (pending) and receive a weighted grade. Honors students in the Math 2 and Math 3 courses will not receive a weighted grade.
*I am enrolling in the HONORS OPTION for the above course. I understand that I will be expected to complete different and more challenging work than those students who do not register for the Honors Option.

*I also understand that if I change my mind and decide **not** to complete the HONORS OPTION, I must make that decision and petition to be released from the HONORS OPTION by the (INSERT DATE or 8 weeks in) of the semester in which this contract applies.

*HONORS OPTIONS drop dates are _________ and ____________ for the Fall and Spring semesters of the 2018-2019 school year, which are after the first unit exam of each semester.

*A **Petition to be Released from the Honors Option** form requires consultation with and signatures of 1) the course teacher, 2) a parent or guardian, and 3) the student. Form must be submitted to student’s counselor.

*I understand that if I decide not to continue with the HONORS OPTION but drop it by the deadline, my grade will be noted on my transcript as a regular letter grade with no penalty. However, if I do **not formally drop the HONORS OPTION by the required deadline**, I will remain in the Honors section and all HONORS OPTION requirements (complete or incomplete) will be counted in my final grade.

*I realize that the HONORS OPTION requirements will include attendance outside of school hours for a **Demonstration of Learning** one time per semester.

Student Signature_________________________________________  Date________________

Teacher Signature_________________________________________  Date________________

To be completed by the Parent(s)/Guardian(s) of the student

I understand the terms of the above contract.

Parent(s)/Guardian(s) Signature___________________________________ Date________________

---

This form must be submitted to the student’s counselor by the 20th day of the semester. For 2018 – 2019, those dates are:

**Fall Semester – September XX, 2018**  **Spring Semester – February XX, 2019**
Petition for Release from Honors Option Contract

Student Name___________________________________________   ID Number ___________________________

Course Name ___________________________________________     email _______________________________

Teacher Name___________________________________________   period___________

Semester: (circle)                     Fall     Spring                      School Year __________________

I request that I be released from the HONORS OPTION Contract in the above course for the following reason(s):

__________________________________________________________________________________________________
__________________________________________________________________________________________________

Student Signature_________________________________          Date_____________________

The student and I have discussed this matter and I DO / I DO NOT (circle one) agree with this decision

Teacher Signature_________________________________________  Date________________

To be completed by the Parent(s)/Guardian(s) of the student

I / We   DO / DO NOT  (circle one) agree with _______________________________’s decision to be released
from the HONORS OPTION in this course.

Parent(s)/Guardian(s) Signature____________________________   Date________________

This form must be submitted to the student’s counselor before the end of the first 6 week grading period (or whatever we propose)

For 2018 – 2019, those dates are:

Fall Semester – September XX, 2018 Spring Semester – February XX, 2019