

# State of Oregon 2009 High School Mathematics Academic Content Standards

Adopted June 2009  
By the State Board of Education

As part of the new Oregon High School Diploma, the State Board has asked the Oregon Department of Education (ODE) to develop "core standards" for all academic content areas. This directive is, in part, a response to the widely held view that current content standards (both in Oregon and in the U.S. at large) are too numerous and mandate the creation of "mile wide, inch deep" curricula. Based in part on the WestEd review of Oregon's content standards, Oregon's Core Standards will be designed to:

- Focus instruction by identifying the key ideas to be covered in each particular subject and grade. This will allow teachers and students to concentrate on fewer key learning objectives each year, resulting in greater depth of teaching and learning.
- Incorporate other content standards in that in-depth understanding of each core standard will imply, and be supported by, understanding of the underlying content standards.
- Carefully articulate clear grade level progression in both knowledge and skills.

## Mathematics Standards

Mathematics is the science of numbers and space configurations and their operations, interrelations, combinations, generalizations, and abstractions. These mathematics standards define the high school-level mathematics content knowledge and essential skill that all students are expected to learn during high school mathematics instruction in Oregon. Mastery of the skills, concepts, and knowledge outlined in these standards will prepare students for a variety of career or education paths.

The new high school mathematics standards include three disciplines of mathematics – Algebra, Geometry and Measurement, and Statistics and Probability. Within each strand there are two to three core standards. These core standards provide the major concepts and processes for teaching and learning across the grades. Underneath each of these core standards are from three to eight content standards which provide the details necessary for curriculum and assessment.

The standards were written to create “a focused, coherent progression of mathematics learning, with an emphasis on proficiency with key topics.” The overlap and spiraling of content from previous grade levels has been minimized in an effort to create standards which resembles the same philosophy and scope as the recently revised K-8 Math standards. These standards also include the instructional contexts through which these knowledge and skills are expected to be addressed. These contexts, or processes, as defined by the National Council of the Teachers of Mathematics (NCTM), are *problem solving*, *reasoning and probability*, *communication*, *connections*, and *representation*. See Table 1 (p. 8) for definitions of the NCTM process standards and how they align with the “Apply Math” essential skill.

## The Review and Revision Process

As members of the Mathematics Content and Assessment Panel began work on revising the high school mathematics standards, they adopted several guiding principles. These included:

- Consider the mathematics all Oregon students should know and be able to do
- Identify topics that build on the core foundations of mathematics established in the 2007 K-8 Mathematics Content Standards
- Emphasize the importance of the National Council of Teachers of Mathematics (NCTM) Process Standards and embed the Oregon Essential Skills in a core standards structure
- Reflect the recommendations of the National Mathematics Advisory Panel
- Strive for coherence, clarity, and measurability.

The revision of Oregon's high school mathematics content standards began in September 2008 with an extensive two-day review of the latest national and international mathematics education research. From this work session, the panel created the initial draft of the high school content standards. This first draft was posted as a news announcement, advertised in various ODE publications, and posted on-line at: <http://www.ode.state.or.us/search/page/?=1148>.

Between September 2008 and March 2009, the panel met for six two-day work sessions. ODE staff collected public input on the draft standards and the panel carefully reviewed the information prior to updating each subsequent version. In between each monthly session, ODE posted news announcements of the latest drafts and sent out messages via the Superintendent's Pipeline, the Curriculum Director's listserv, the Oregon Mathematics Teacher Update monthly e-newsletter, and to mathematics professional organizations, universities, and community colleges. In addition, ODE representatives gave presentations on the mathematics standards revision at conferences and board meetings around the state including the Oregon Council of Teachers of Mathematics, Oregon Mathematics Education Council, Teachers of Teachers of Mathematics Council, Teacher Standards and Practices Commission, OASSA/OESPA Principal's Conference, Oregon School Improvement Facilitators, district, school and ESD meetings.

The revision work included alignment with over twenty different states' mathematics standards, curricular expectations from national organizations such as Achieve, College Board, National Council of Teachers of Mathematics, International Baccalaureate, and National Assessment of Education Progress. Various drafts of the high school math standards also underwent external review by members of the National Council of Teachers of Mathematics and Northwest Regional Education Laboratory staff.

### Role of Technology

The Mathematics Content and Assessment Panel unanimously gave support to the use of technology as an aid to increase student learning and ultimately prepare students for an increasingly technology-focused work and life environment. However, the panel also agreed that much of mathematics should be developed first without the aid of technology. Therefore, teachers need to be knowledgeable about how technology can support students in learning mathematics without compromising mathematical fluency – number sense, procedural knowledge, and declarative knowledge. The panel trusts that educators will make appropriate choices regarding the use of technology.

**2009**  
**High School Mathematics**  
**Academic Content Standards**

**Algebra**

It is essential that the high school mathematics content standards be addressed in instructional contexts that promote *problem solving, reasoning and proof, communication, making connections, designing and analyzing representations, and reflecting on solutions*. Every student should understand and apply all mathematical concepts and skills from previous grade levels to these standards.

**H.1A Algebra and Numeracy: Demonstrate a deep understanding of real numbers and algebraic symbols by fluently creating, manipulating, computing with, and determining equivalent expressions, both numeric and symbolic.**

- H.1A.1 Compare, order, and locate real numbers on a number line.
- H.1A.2 Evaluate, compute with, and determine equivalent numeric and algebraic expressions with real numbers and variables that may also include absolute value, integer exponents, square roots, pi, and/or scientific notation.
- H.1A.3 Express square roots in equivalent radical form and their decimal approximations when appropriate.
- H.1A.4 Develop, identify, and/or justify equivalent algebraic expressions, equations, and inequalities using the properties of exponents, equality and inequality, as well as the commutative, associative, inverse, identity, and distributive properties.
- H.1A.5 Factor quadratic expressions limited to factoring common monomial terms, perfect-square trinomials, differences of squares, and quadratics of the form  $x^2 + bx + c$  that factor over the integers.

**H.2A Algebra: Use linear equations and functions to represent relationships and solve linear equations, linear inequalities, systems of linear equations, and systems of linear inequalities.**

- H.2A.1 Identify, construct, extend, and analyze linear patterns and functional relationships that are expressed contextually, numerically, algebraically, graphically, in tables, or using geometric figures.
- H.2A.2 Given a rule, a context, two points, a table of values, a graph, or a linear equation in either slope intercept or standard form, identify the slope of the line, determine the x and/or y intercept(s), and interpret the meaning of each.

- H.2A.3 Determine the equation of a line given any of the following information: two points on the line, its slope and one point on the line, or its graph. Also, determine an equation of a new line, parallel or perpendicular to a given line, through a given point.
- H.2A.4 Fluently convert among representations of linear relationships given in the form of a graph of a line, a table of values, or an equation of a line in slope-intercept and standard form.
- H.2A.5 Given a linear function, interpret and analyze the relationship between the independent and dependent variables. Solve for  $x$  given  $f(x)$  or solve for  $f(x)$  given  $x$ .
- H.2A.6 Analyze how changing the parameters transforms the graph of  $f(x) = mx + b$ .
- H.2A.7 Write, use, and solve linear equations and inequalities using graphical and symbolic methods with one or two variables. Represent solutions on a coordinate graph or number line.
- H.2A.8 Solve systems of two linear equations graphically and algebraically, and solve systems of two linear inequalities graphically.

**H.3A Algebra: Use quadratic and exponential equations and functions to represent relationships.**

- H.3A.1 Given a quadratic or exponential function, identify or determine a corresponding table or graph.
- H.3A.2 Given a table or graph that represents a quadratic or exponential function, extend the pattern to make predictions.
- H.3A.3 Compare the characteristics of and distinguish among linear, quadratic, and exponential functions that are expressed in a table of values, a sequence, a context, algebraically, and/or graphically, and interpret the domain and range of each as it applies to a given context.
- H.3A.4 Given a quadratic or exponential function, interpret and analyze the relationship between the independent and dependent variables, and evaluate the function for specific values of the domain.
- H.3A.5 Given a quadratic equation of the form  $x^2 + bx + c = 0$  with integral roots, determine and interpret the roots, the vertex of the parabola that is the graph of  $y = x^2 + bx + c$ , and an equation of its axis of symmetry graphically and algebraically.

**2009**  
**High School Mathematics**  
**Academic Content Standards**

**Geometry**

It is essential that the high school mathematics content standards be addressed in instructional contexts that promote *problem solving, reasoning and proof, communication, making connections, designing and analyzing representations, and reflecting on solutions*. Every student should understand and apply all mathematical concepts and skills from previous grade levels to these standards.

**H.1G Geometry: Apply properties of two-dimensional figures.**

- H.1G.1 Identify, apply, and analyze angle relationships among two or more lines and a transversal to determine if lines are parallel, perpendicular, or neither.
- H.1G.2 Apply theorems, properties, and definitions to determine, identify, and justify congruency or similarity of triangles and to classify quadrilaterals.
- H.1G.3 Apply theorems of corresponding parts of congruent and similar figures to determine missing sides and angles of polygons.
- H.1G.4 Use trigonometric ratios (sine, cosine and tangent) and the Pythagorean Theorem to solve for unknown lengths in right triangles.
- H.1G.5 Determine the missing dimensions, angles, or area of regular polygons, quadrilaterals, triangles, circles, composite shapes, and shaded regions.
- H.1G.6 Determine if three given lengths form a triangle. If the given lengths form a triangle, classify it as acute, right, or obtuse.
- H.1G.7 In problems involving circles, apply theorems and properties of chords, tangents, and angles; and theorems and formulas of arcs and sectors.

**H.2G Geometry: Apply properties of three-dimensional solids.**

- H.2G.1 Identify, classify, model, sketch, and label representations of three-dimensional objects from nets and from different perspectives.
- H.2G.2 Identify and apply formulas for surface area and volume of spheres; right solids, including rectangular prisms and pyramids; cones; and cylinders; and compositions thereof. Solve related context-based problems.
- H.2G.3 Identify and apply formulas to solve for the missing dimensions of spheres and right solids, including rectangular prisms and pyramids, cones, and cylinders, both numerically and symbolically.

**H.3G** Geometry: **Transform and analyze figures.**

- H.3G.1 Recognize and identify line and rotational symmetry of two-dimensional figures.
- H.3G.2 Identify and perform single and composite transformations of geometric figures in a plane, including translations, origin-centered dilations, reflections across either axis or  $y = \pm x$ , and rotations about the origin in multiples of  $90^\circ$ .
- H.3G.3 Apply a scale factor to determine similar two- and three-dimensional figures, are similar. Compare and compute their respective areas and volumes of similar figures.
- H.3G.4 Apply slope, distance, and midpoint formulas to solve problems in a coordinate plane.

# 2009

## High School Mathematics Academic Content Standards

# Statistics

It is essential that the high school mathematics content standards be addressed in instructional contexts that promote *problem solving, reasoning and proof, communication, making connections, designing and analyzing representations, and reflecting on solutions*. Every student should understand and apply all mathematical concepts and skills from previous grade levels to these standards.

### **H.1S** Data Analysis: Analyze and interpret empirical data.

- H.1S.1 Given a context, determine appropriate survey methods, analyze the strengths and limitations of a particular survey, observational study, experiment, or simulation, and the display of its data.
- H.1S.2 Evaluate data-based reports by considering the source of the data, the design of the study, and the way the data was analyzed and displayed.
- H.1S.3 Compare and draw conclusions about two or more data sets using graphical displays or central tendencies and range.
- H.1S.4 Use or construct a scatter plot for a given data set, determine whether there is a (n) linear, quadratic, exponential, or no trend. If linear, determine if there is a positive or negative correlation among the data; and, if appropriate, sketch a line of best fit, and use it to make predictions.
- H.1S.5 Construct, analyze, and interpret tables, scatter plots, frequency distributions, and histograms of data sets.

### **H.2S** Probability: Apply basic principles of probability.

- H.2S.1 Identify, analyze, and use experimental and theoretical probability to estimate and calculate the probability of simple events.
- H.2S.2 Determine the sample space of a probability experiment.
- H.2S.3 Compute and interpret probabilities for independent, dependent, complementary, and compound events using various methods (e.g., diagrams, tables, area models, and counting techniques).

**National Council of Teachers of Mathematics (NCTM) Process Standards:  
Definitions and Alignment to the *Apply Math* Essential Skill**

NCTM has described process standards which facilitate the acquisition of mathematics content knowledge. These process standards: *problem solving, reasoning, communication, making connections, and designing and analyzing representations*, are essential to the implementation of the high school mathematics standards. They should be part of the instruction and assessment of the content standards. In addition, the NCTM recommends students reflect on their solutions. The table below defines the process standards and demonstrates their alignment to Oregon’s “Apply Math” essential skill.

<b>NCTM Process Standard</b>	<b>Definition</b>	<b>Alignment to the Oregon <i>Apply Math</i> Essential Skill</b>
<b>Problem Solving</b>	<p>Build new mathematical knowledge through problem solving.</p> <p>Solve problems that arise in mathematics and in other contexts.</p> <p>Apply and adapt a variety of appropriate strategies to solve problems.</p> <p>Monitor and reflect on the process of mathematical problem solving.</p>	<p>Interpret a situation and apply workable mathematical concepts and strategies using appropriate technologies where applicable.</p>
<b>Reasoning and Proof</b>	<p>Recognize reasoning and proof as fundamental aspects of mathematics.</p> <p>Make and investigate mathematical conjectures.</p> <p>Develop and evaluate mathematical arguments and proofs.</p> <p>Select and use various types of reasoning and methods of proof.</p>	<p>Communicate and defend the verified process and solution using pictures, symbols, models, narrative, or other methods.</p>
<b>Communication</b>	<p>Organize and consolidate mathematical thinking through communication.</p> <p>Communicate mathematical thinking coherently and clearly to peers, teachers, and others.</p> <p>Analyze and evaluate the mathematical thinking and strategies of others.</p> <p>Use the language of mathematics to express mathematical ideas precisely.</p>	<p>Communicate and defend the verified process and solution using pictures, symbols, models, narrative, or other methods.</p>

<b>NCTM Process Standard</b>	<b>Definition</b>	<b>Alignment to the Oregon <i>Apply Math</i> Essential Skill</b>
<b>Connections</b>	<p>Recognize and use connections among mathematical ideas.</p> <p>Understand how mathematical ideas interconnect and build on one another to produce a coherent whole.</p> <p>Recognize and apply mathematics in contexts outside of mathematics.</p>	Interpret a situation and apply workable mathematical concepts and strategies using appropriate technologies where applicable.
<b>Representation</b>	<p>Create and use representations to organize, record, and communicate mathematical ideas.</p> <p>Select, apply, and translate among mathematical representations to solve problems.</p> <p>Use representations to model and interpret physical, social, and mathematical phenomena.</p>	Produce evidence such as graphs, data, or mathematical models to obtain and verify a solution.

**In addition to the processes defined above, high school students in Oregon will also be expected to:**

<b>Additional Expectation</b>	<b>NCTM Definition</b>	<b>Alignment to the Oregon <i>Apply Math</i> Essential Skill</b>
<b>Reflect on one's solution</b>	<p>Interpret a solution within the context of a problem</p> <p>Check the reasonableness of solutions</p> <p>Justify or validate a solution</p> <p>Generalize a solution</p>	<p>Communicate and defend the verified process and solution using pictures, symbols, models, narrative, or other methods.</p> <p>Produce evidence such as graphs, data, or mathematical models to obtain and verify a solution.</p>