Geometry

# Louisiana Student Standards: Companion Document for Teachers 2.0

This document is designed to assist educators in interpreting and implementing the Louisiana Student Standards for Mathematics. Found here are descriptions of each standard which answer questions about the standard's meaning and application to student understanding. Also included are the intended level of rigor and coherence links to prerequisite and corequisite standards. Examples are samples only and should not be considered an exhaustive list.

Additional information on the Louisiana Student Standards for Mathematics, including how to read the standards' codes, a listing of standards for each grade or course, and links to additional resources, is available on the Louisiana Department of Education [K-12 Math Planning Page](). Please direct any questions to [STEM@la.gov]().

Updated August 15, 2022

## Table of Contents

**Introduction**

[How to Read Guide](#) ........ 2
[Classification of Major, Supporting, and Additional Work](#) ........ 3
[Components of Rigor](#) ........ 3

**Grade Level Standards and Sample Problems**

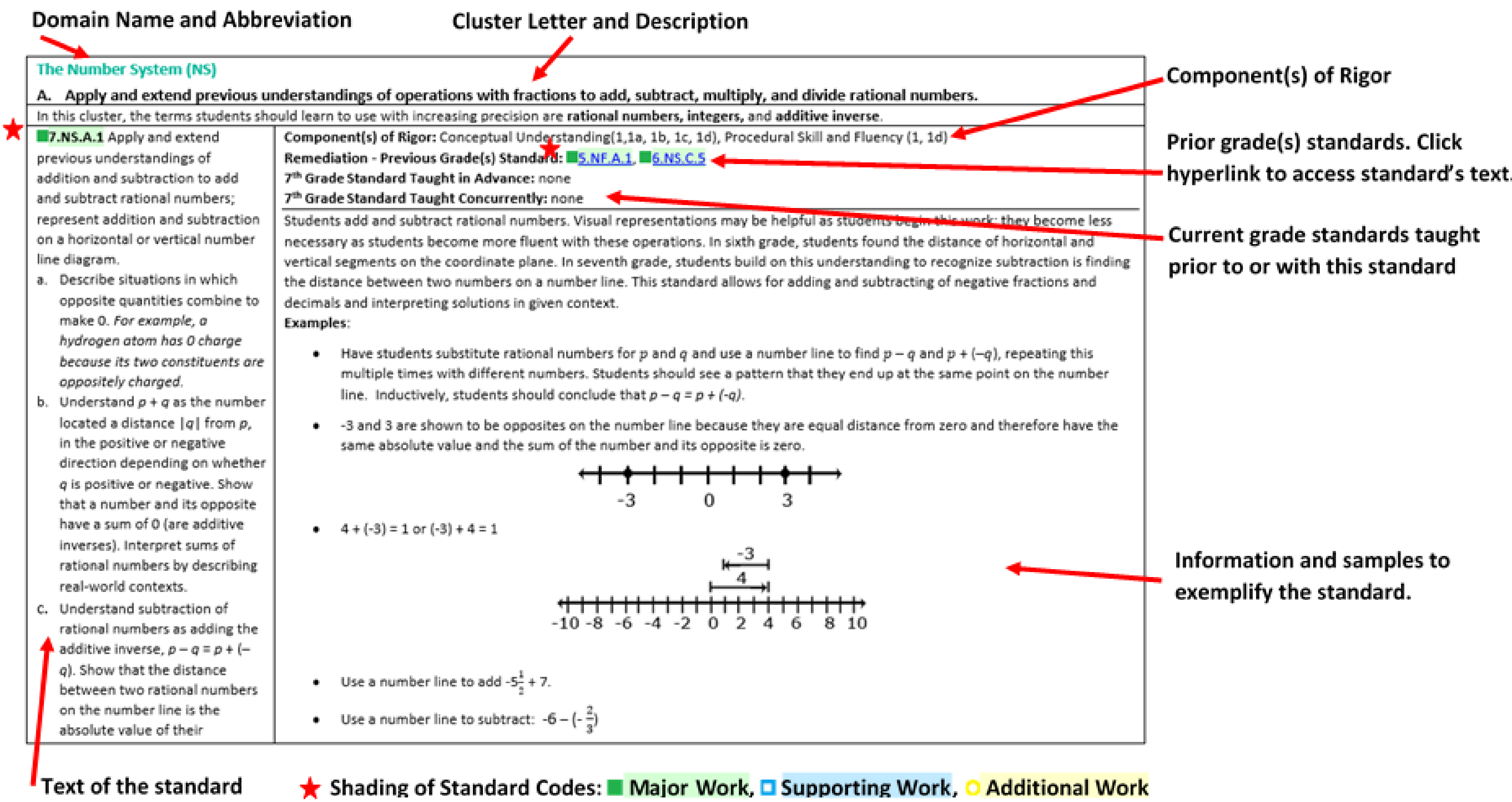
[Standards for Mathematical Practice](#) ........ 4
[Modeling Standards](#) ........ 6
Geometry
[Congruence G-C0](#) ........ 8
[Similarity, Right Triangles, and Trigonometry G-SRT](#) ........ 17
[Circles G-C](#) ........ 24
[Expressing Geometric Properties with Equations G-GPE](#) ........ 28
[Geometric Measurement and Dimension](#) ........ 30
[Modeling with Geometry](#) ........ 33
Statistics and Probability
[Conditional Probability and the Rules of Probability](#) ........ 35

**Lower Grade Standards for Addressing Unfinished Learning**

[Grade 4 Standards](#) ........ 41
[Grade 5 Standards](#) ........ 41
[Grade 6 Standards](#) ........ 42
[Grade 7 Standards](#) ........ 42
[Grade 8 Standards](#) ........ 43
[Algebra I Course Standards](#) ........ 44

## How-to-Read Guide

The diagram below provides an overview of the information found in all companion documents. Definitions and more complete descriptions are provided on the next page.




The Number System (NS)

A. Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers.

In this cluster, the terms students should learn to use with increasing precision are **rational numbers, integers,** and **additive inverse**.

| | |
|---|---|
| **7.NS.A.1** Apply and extend previous understandings of addition and subtraction to add and subtract rational numbers; represent addition and subtraction on a horizontal or vertical number line diagram.<br>a. Describe situations in which opposite quantities combine to make 0. *For example, a hydrogen atom has 0 charge because its two constituents are oppositely charged.*<br>b. Understand $p + q$ as the number located a distance $\|q\|$ from $p$, in the positive or negative direction depending on whether $q$ is positive or negative. Show that a number and its opposite have a sum of 0 (are additive inverses). Interpret sums of rational numbers by describing real-world contexts.<br>c. Understand subtraction of rational numbers as adding the additive inverse, $p - q = p + (-q)$. Show that the distance between two rational numbers on the number line is the absolute value of their | **Component(s) of Rigor:** Conceptual Understanding(1,1a, 1b, 1c, 1d), Procedural Skill and Fluency (1, 1d)<br>**Remediation - Previous Grade(s) Standard:** 5.NF.A.1, 6.NS.C.5<br>**7th Grade Standard Taught in Advance:** none<br>**7th Grade Standard Taught Concurrently:** none<br>Students add and subtract rational numbers. Visual representations may be helpful as students begin this work; they become less necessary as students become more fluent with these operations. In sixth grade, students found the distance of horizontal and vertical segments on the coordinate plane. In seventh grade, students build on this understanding to recognize subtraction is finding the distance between two numbers on a number line. This standard allows for adding and subtracting of negative fractions and decimals and interpreting solutions in given context.<br>**Examples:**<br>• Have students substitute rational numbers for $p$ and $q$ and use a number line to find $p - q$ and $p + (-q)$, repeating this multiple times with different numbers. Students should see a pattern that they end up at the same point on the number line. Inductively, students should conclude that $p - q = p + (-q)$.<br>• -3 and 3 are shown to be opposites on the number line because they are equal distance from zero and therefore have the same absolute value and the sum of the number and its opposite is zero.<br>-3 0 3<br>• 4 + (-3) = 1 or (-3) + 4 = 1<br>-3 4<br>-10 -8 -6 -4 -2 0 2 4 6 8 10<br>• Use a number line to add $-5\frac{1}{2} + 7$.<br>• Use a number line to subtract: $-6 - (-\frac{2}{3})$ |

1. **Domain Name and Abbreviation:** A grouping of standards consisting of related content that are further divided into clusters. Each domain has a unique abbreviation and is provided in parentheses beside the domain name.
2. **Cluster Letter and Description:** Each cluster within a domain begins with a letter. The description provides a general overview of the focus of the standards in the cluster.
3. **Previous Grade(s) Standards:** One or more standards that students should have mastered in previous grades to prepare them for the current grade standard. If students lack the pre-requisite knowledge and remediation is required, the previous grade standards provide a starting point.
4. **Standards Taught in Advance:** These current grade standards include skills or concepts on which the target standard is built. These standards are best taught before the target standard.
5. **Standards Taught Concurrently:** Standards which should be taught with the target standard to provide coherence and connectedness in instruction.
6. **Component(s) of Rigor:** See full explanation on components of rigor.
7. **Sample Problem:** The sample provides an example how a student might meet the requirements of the standard. Multiple examples are provided for some standards. However, sample problems should not be considered an exhaustive list. Explanations, when appropriate, are also included.
8. **Text of Standard:** The complete text of the targeted Louisiana Student Standards of Mathematics is provided.

## Classification of Major, Supporting, and Additional Work

Students should spend the large majority of their time on the ■ major work of the grade. ◘ Supporting work and, where appropriate, ○ additional work can engage students in the major work of the grade. Each standard is color-coded to quickly and simply determine how class time should be allocated. Furthermore, standards from previous grades that provide foundational skills for current grade standards are also color-coded to show whether those standards are classified as ■ major, ◘ supporting, or ○ additional in their respective grades.

## Components of Rigor

The K-12 mathematics standards lay the foundation that allows students to become mathematically proficient by focusing on conceptual understanding, procedural skill and fluency, and application.

**Conceptual Understanding** refers to understanding mathematical concepts, operations, and relations. It is more than knowing isolated facts and methods. Students should be able to make sense of why a mathematical idea is important and the kinds of contexts in which it is useful. It also allows students to connect prior knowledge to new ideas and concepts.

**Procedural Skill and Fluency** is the ability to apply procedures accurately, efficiently, and flexibly. It requires speed and accuracy in calculation while giving students opportunities to practice basic skills. Students' ability to solve more complex application tasks is dependent on procedural skill and fluency.

**Application** provides a valuable content for learning and the opportunity to solve problems in a relevant and a meaningful way. It is through real-world application that students learn to select an efficient method to find a solution, determine whether the solution makes sense by reasoning, and develop critical thinking skills.

## Standards for Mathematical Practice

The Louisiana Standards for Mathematical Practice are expected to be integrated into every mathematics lesson for all students in grades K-12. Below are a few examples of how these practices may be integrated into tasks that high school students complete.

| Louisiana Standard | Explanations and Examples |
|---|---|
| **HS.MP.1** Make sense of problems and persevere in solving them. | High school students start to examine problems 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. By high school, 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. They check their answers to problems using different methods and continually ask themselves, "Does this make sense?" They can understand the approaches of others to solving complex problems and identify correspondences between different approaches. |
| **HS.MP.2** Reason abstractly and quantitatively. | High school students seek to make sense of quantities and their relationships in problem situations. They abstract a given situation and represent it symbolically, manipulate the representing symbols, and pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Students use quantitative reasoning to create coherent representations of the problem at hand; consider the units involved; attend to the meaning of quantities, not just how to compute them; and know and flexibly use different properties of operations and objects. |
| **HS.MP.3** Construct viable arguments and critique the reasoning of others. | High school 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. High school students are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and—if there is a flaw in an argument—explain what it is. High school students learn to determine domains, to which an argument applies, listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments. |
| **HS.MP.4** Model with mathematics. | High school students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. High school students make 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. |

| Louisiana Standard | Explanations and Examples |
|---|---|
| **HS.MP.5** Use appropriate tools strategically. | High school 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. High school students should be 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, 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. They 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. |
| **HS.MP.6** Attend to precision. | High school students try to communicate precisely to others by using clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, specify units of measure, and label axes to clarify the correspondence between quantities in a problem. They calculate accurately and efficiently, expressing numerical answers with a degree of precision appropriate for the problem context. By the time they reach high school they have learned to examine claims and make explicit use of definitions. |
| **HS.MP.7** Look for and make use of structure. | By high school, students look closely to discern a pattern or structure. 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 $y$. High school students use these patterns to create equivalent expressions, factor and solve equations, and compose functions, and transform figures. |
| **HS.MP.8** Look for and express regularity in repeated reasoning. | High school students notice if calculations are repeated, and look both for general methods and for shortcuts. 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, derive formulas or make generalizations, high school students maintain oversight of the process, while attending to the details. They continually evaluate the reasonableness of their intermediate results. |

## Modeling Standards

Modeling is best interpreted not as a collection of isolated topics but rather in relation to other standards. Making mathematical models is a Standard for Mathematical Practice, and specific modeling standards appear throughout the high school standards indicated by a star symbol (★).

## What is modeling?

Modeling links classroom mathematics and statistics to everyday life, work, and decision-making. Modeling is the process of choosing and using appropriate mathematics and statistics to analyze empirical situations, to understand them better, and to improve decisions. Quantities and their relationships in physical, economic, public policy, social, and everyday situations can be modeled using mathematical and statistical methods. When making mathematical models, technology is valuable for varying assumptions, exploring consequences, and comparing predictions with data.

A model can be very simple, such as writing total cost as a product of unit price and number bought, or using a geometric shape to describe a physical object like a coin. Even such simple models involve making choices. It is up to us whether to model a coin as a three-dimensional cylinder, or whether a two-dimensional disk works well enough for our purposes. Other situations—modeling a delivery route, a production schedule, or a comparison of loan amortizations—need more elaborate models that use other tools from the mathematical sciences. Real-world situations are not organized and labeled for analysis; formulating tractable models, representing such models, and analyzing them is appropriately a creative process. Like every such process, this depends on acquired expertise as well as creativity.

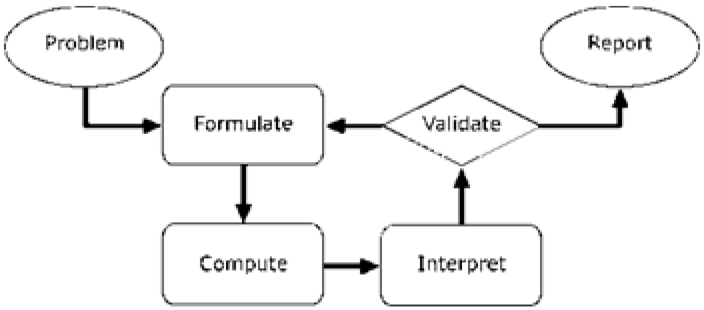
Some examples of such situations might include:

- Estimate how much water and food is needed for emergency relief in a devastated city of 3 million people, and how it might be distributed.
- Plan a table tennis tournament for 7 players at a club with 4 tables, where each player plays against each other player.
- Design the layout of the stalls in a school fair so as to raise as much money as possible.
- Analyze the stopping distance for a car.
- Model a savings account balance, bacterial colony growth, or investment growth.
- Engage in critical path analysis, e.g., applied to turnaround of an aircraft at an airport.
- Analyze the risk in situations such as extreme sports, pandemics, and terrorism.
- Relate population statistics to individual predictions.

In situations like these, the models devised depend on a number of factors: How precise an answer do we want or need? What aspects of the situation do we most need to understand, control, or optimize? What resources of time and tools do we have? The range of models that we can create and analyze is also constrained by the limitations of our mathematical, statistical, and technical skills, and our ability to recognize significant variables and relationships among them. Diagrams of various kinds, spreadsheets and other technology, and algebra are powerful tools for understanding and solving problems drawn from different types of real-world situations.

One of the insights provided by mathematical modeling is that essentially the same mathematical or statistical structure can sometimes model seemingly different situations. Models can also shed light on the mathematical structures themselves, for example, as when a model of bacterial growth makes more vivid the explosive growth of the exponential function.

The basic modeling cycle is summarized in the diagram. It involves (1) identifying variables in the situation and selecting those that represent essential features, (2) formulating a model by creating and selecting geometric, graphical, tabular, algebraic, or statistical representations that describe relationships between the variables, (3) analyzing and performing operations on these relationships to draw conclusions, (4) interpreting the results of the mathematics in terms of the original situation, (5) validating the conclusions by comparing them with the situation, and then either improving the model or, if it is acceptable, (6) reporting on the conclusions and the reasoning behind them. Choices, assumptions, and approximations are present throughout this cycle.

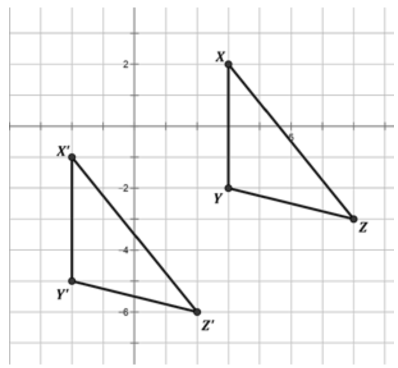



In descriptive modeling, a model simply describes the phenomena or summarizes them in a compact form. Graphs of observations are a familiar descriptive model—for example, graphs of global temperature and atmospheric $CO_2$ over time.

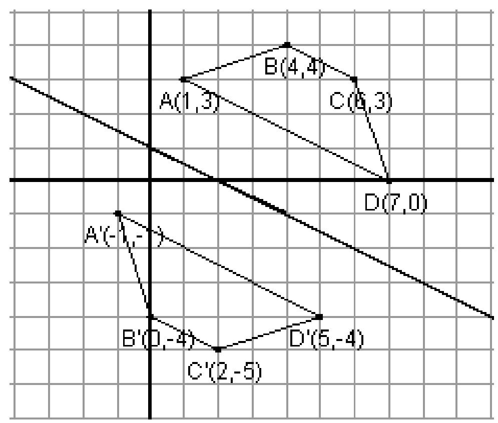
Analytic modeling seeks to explain data on the basis of deeper theoretical ideas, albeit with parameters which are empirically based; for example, exponential growth of bacterial colonies (until cut-off mechanisms such as pollution or starvation intervene) follows from a constant reproduction rate. Functions are an important tool for analyzing such problems.

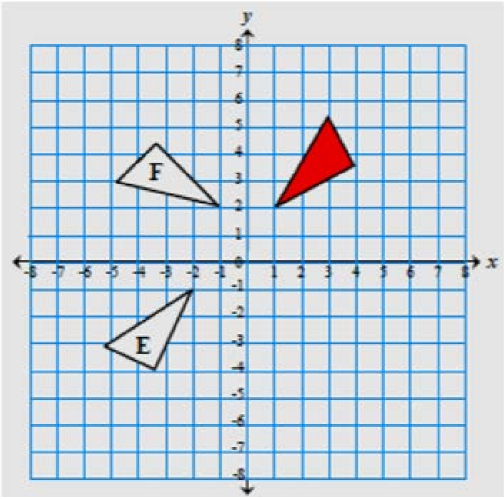
Graphing utilities, spreadsheets, computer algebra systems, and dynamic geometry software are powerful tools that can be used to model purely mathematical phenomena (e.g., the behavior of polynomials) as well as physical phenomena.

<table>
<tr><td colspan="2">Geometry: Congruence (G-CO)<br>A. Experiment with transformations in the plane.</td></tr>
<tr><td colspan="2">In this cluster, the terms students should learn to use with increasing precision are definitions for angle, circle, perpendicular line, parallel line, and line segment; transformation, rotation, reflection, translation, and sequence of transformations.</td></tr>
<tr><td>Louisiana Standard</td><td>Explanations and Examples</td></tr>
<tr><td>GM: G-CO.A.1 Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.</td><td>Component(s) of Rigor: Conceptual Understanding<br>Remediation - Previous Grade(s) Standard: 4.MD.C.5, 4.G.A.1, 4.G.A.2<br>Geometry Standard Taught in Advance: none<br>Geometry Standard Taught Concurrently: none<br><br>Students recognize the importance of having precise definitions and use the vocabulary to accurately describe figures and relationships among figures. Students define angles, circles, perpendicular lines, parallel lines, and line segments precisely using the undefined terms.<br><br>Example:<ul><li>Draw an example of each of the following and justify how it meets the definition of the term.<br>a. Angle<br>b. Circle<br>c. Perpendicular lines<br>d. Parallel lines<br>e. Line segment</li><li>Defining Parallel Lines: https://www.illustrativemathematics.org/content-standards/HSG/CO/A/1/tasks/1543</li><li>Defining Perpendicular lines: https://www.illustrativemathematics.org/content-standards/HSG/CO/A/1/tasks/1544</li></ul></td></tr>
<tr><td>GM: G-CO.A.2 Represent transformations in the plane using, e.g., transparencies, tracing paper, or 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><td>Component(s) of Rigor: Conceptual Understanding<br>Remediation - Previous Grade(s) Standard: 8.G.A.1, 8.G.A.2, 8.G.A.3, 8.G.A.4, A1: F-BF.B.3<br>Geometry Standard Taught in Advance: none<br>Geometry Standard Taught Concurrently: GM: G-CO.A.3, GM: G-CO.A.5<br><br>Students describe and compare function transformations on a set of points as inputs to produce another set of points as outputs and is an extension of the work started in Grade 8. They distinguish between transformations that are rigid (preserve distance and angle measure: reflections, rotations, translations, or combinations of these) and those that are not (dilations or rigid motions followed by dilations). Transformations produce congruent figures while dilations produce similar figures.</td></tr>
</table>

| | |
|---|---|
| **GM: G-CO.A.2** *continued* | **Examples:**<br>• A plane figure is translated 3 units right and 2 units down. The translated figure is then dilated with a scale factor of 4, centered at the origin.<br>a. Draw a plane figure and represent the described transformation of the figure in the plane.<br>b. Explain how the transformation is a function with inputs and outputs.<br>c. Determine if the relationship between the pre-image and the image after a series of transformations. Provide evidence to support your answer.<br>• Transform $\Delta ABC$ with vertices $A$ $(1,1)$, $B$ $(6,3)$ and $C$ $(2,13)$ using the function rule $(x, y) \rightarrow (-y, x)$ and describe the transformation as completely as possible.<br>• Dilations and Distances: https://www.illustrativemathematics.org/content-standards/HSG/CO/A/2/tasks/1546<br>• Horizontal Stretch of the Plane: https://www.illustrativemathematics.org/content-standards/HSG/CO/A/2/tasks/1924<br>• Complete the rule for the transformation below: $(x, y) \rightarrow (\_\_\_, \_\_\_)$ and determine if the transformations preserve distance and angle. Provide justification for your answer.<br> |
| **GM: G-CO.A.3** Given a rectangle, parallelogram, trapezoid, or regular polygons, describe the rotations and reflections that carry it onto itself. | **Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency<br>**Remediation - Previous Grade(s) Standard:** 8.G.A.2, 8.G.A.3<br>**Geometry Standard Taught in Advance:** none<br>**Geometry Standard Taught Concurrently:** GM: G-CO.A.2, GM: G-CO.A.4, GM: G-CO.A.5<br>Students describe and illustrate how a rectangle, parallelogram, isosceles trapezoid or regular polygon are mapped onto themselves using transformations. Students determine the number of lines of reflection symmetry and the degree of rotational symmetry of any regular polygon.<br><br>**Example:** |

| | |
|---|---|
| | • Symmetries of rectangles: https://www.illustrativemathematics.org/content-standards/HSG/CO/A/3/tasks/1469<br>• Origami regular octagon: https://www.illustrativemathematics.org/content-standards/HSG/CO/A/3/tasks/1487 |

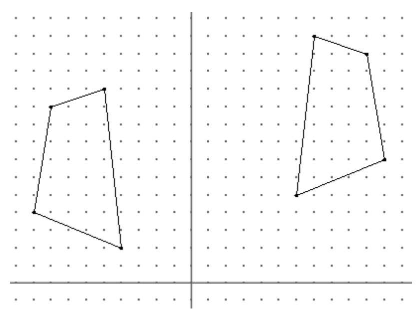
| | |
|---|---|
| **GM: G-CO.A.4** Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments. | **Component(s) of Rigor:** Conceptual Understanding<br>**Remediation - Previous Grade(s) Standard:** 8.G.A.1, 8.G.A.3<br>**Geometry Standard Taught in Advance:** GM: G-CO.A.1<br>**Geometry Standard Taught Concurrently:** GM: G-CO.A.3<br><br>Students develop the definition of each transformation in regards to the characteristics between pre-image and image points.<br>• <u>For a *translation*:</u> connecting any point on the pre-image to its corresponding point on the translated image, and connecting a second point on the pre-image to its corresponding point on the translated image, the two segments are equal in length, translate in the same direction, and are parallel.<br>• <u>For a *reflection*:</u> connecting any point on the pre-image to its corresponding point on the reflected image, the line of reflection is a perpendicular bisector of the line segment.<br>• <u>For a *rotation*:</u> connecting the center of rotation to any point on the pre-image and to its corresponding point on the rotated image, the line segments are equal in length and the measure of the angle formed is the angle of rotation.<br><br>**Example:**<br>• Is quadrilateral A'B'C'D' a reflection of quadrilateral ABCD across the given line? Justify your reasoning.<br><br><br>• Identifying Translations: https://www.illustrativemathematics.org/content-standards/HSG/CO/A/4/tasks/1912<br>• Identifying Rotations: https://www.illustrativemathematics.org/content-standards/HSG/CO/A/4/tasks/1913 |

| | |
|---|---|
| GM: G-CO.A.5 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. | **Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency<br>**Remediation - Previous Grade(s) Standard:** 8.G.A.2, 8.G.A.3<br>**Geometry Standard Taught in Advance:** none<br>**Geometry Standard Taught Concurrently:** GM: G-CO.A.2, GM: G-CO.A.3<br><br>Students transform a geometric figure given a rotation, reflection, or translation. They create sequences of transformations that map a geometric figure onto itself and another geometric figure. Students predict and verify the sequence of transformations (a composition) that will map a figure onto another.<br><br>**Example:**<br>• Reflected Triangles: https://www.illustrativemathematics.org/content-standards/HSG/CO/A/5/tasks/31<br>• Showing a triange congruence: a particular case https://www.illustrativemathematics.org/content-standards/HSG/CO/A/5/tasks/1547<br>• Showing a triange congruence: the general case https://www.illustrativemathematics.org/content-standards/HSG/CO/A/5/tasks/1549<br>• **Part 1**<br>Draw the shaded triangle after:<br>a. It has been translated −7 units horizontally and +1 units vertically. Label your answer A.<br>b. It has been reflected over the *x*-axis. Label your answer B.<br>c. It has been rotated 90° clockwise about the origin. Label your answer C.<br>d. It has been reflected over the line *y* = *x*. Label your answer D.<br>**Part 2**<br>Describe fully the single transformation that:<br>a. Takes the shaded triangle onto the triangle labeled F.<br>b. Takes the shaded triangle onto the triangle labeled E.<br> |

## Geometry: Congruence (G-CO)

### B. Understand congruence in terms of rigid motions.

In this cluster, the terms students should learn to use with increasing precision are **rigid motion, congruent, corresponding sides, corresponding angles, criteria for triangle congruence (ASA, SSS, and SAS).**

| Louisiana Standard | Explanations and Examples |
|---|---|
| **GM: G-CO.B.6** 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. | **Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency<br>**Remediation - Previous Grade(s) Standard:** 8.G.A.2<br>**Geometry Standard Taught in Advance:** GM: G-CO.A.5<br>**Geometry Standard Taught Concurrently:** none<br><br>Students use descriptions of rigid motion and transformed geometric figures to predict the effects rigid motion has on figures in the coordinate plane. Students recognize rigid transformations preserve size and shape or distance and angle and develop the definition of congruent. Students determine if two figures are congruent by determining if rigid motions will turn one figure into the other.<br>**Examples**:<br>• Consider parallelogram ABCD with coordinates A(2,-2), B(4,4), C(12,4) and D(10,-2). Perform the following transformations. Make predictions about how the lengths, perimeter, area and angle measures will change under each transformation.<br>a. A reflection over the x-axis.<br>b. A rotation of 270° counter-clockwise about the origin.<br>c. A dilation of scale factor 3 about the origin.<br>d. A translation to the right 5 and down 3.<br><br>Verify your predictions. Compare and contrast which transformations preserved the size and/or shape with those that did not preserve size and/or shape. Generalize, how could you determine if a transformation maintains congruency from the pre-image to the image?<br>• Determine if the figures below are congruent. If so, tell what rigid motions were used.<br><br>• Building a tile by reflecting hexagons: |

| | |
|---|---|
| | https://www.illustrativemathematics.org/content-standards/HSG/CO/B/6/tasks/1338 |
| **GM: G-CO.B.7** Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent. | **Component(s) of Rigor:** Conceptual Understanding<br>**Remediation - Previous Grade(s) Standard:** 8.G.A.2<br>**Geometry Standard Taught in Advance:** GM: G-CO.B.6<br>**Geometry Standard Taught Concurrently:** none<br>A rigid motion is a transformation of points in space consisting of a sequence of one or more translations, reflections, and/or rotations. Rigid motions are assumed to *preserve distances and angle measures*. Two triangles are said to be congruent if one can be exactly superimposed on the other by a rigid motion, and the congruence theorems specify the conditions under which this can occur.<br><br>Students identify corresponding sides and corresponding angles of congruent triangles. Explain that in a pair of congruent triangles, corresponding sides are congruent (distance is preserved) and corresponding angles are congruent (angles measure is preserved). They demonstrate that when distance is preserved (corresponding sides are congruent) and angle measure is preserved (corresponding angles are congruent) the triangles must also be congruent.<br><br>**Example:**<br>• Properties of Congruent Triangles: http://www.illustrativemathematics.org/illustrations/1637 |
| **GM: G-CO.B.8** Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions. | **Component(s) of Rigor:** Conceptual Understanding<br>**Remediation - Previous Grade(s) Standard:** 8.G.A.2<br>**Geometry Standard Taught in Advance:** GM: G-CO.B.7<br>**Geometry Standard Taught Concurrently:** none<br>Students list the sufficient conditions to prove triangles are congruent: ASA, SAS, and SSS. They map a triangle with one of the sufficient conditions (e.g., SSS) onto the original triangle and show that corresponding sides and corresponding angles are congruent.<br><br>**Examples:**<br>• Why Does SAS Work?: http://www.illustrativemathematics.org/illustrations/109<br>• Why Does ASA Work?: http://www.illustrativemathematics.org/illustrations/339<br>• Why Does SSS Work?: http://www.illustrativemathematics.org/illustrations/110 |

| Geometry: Congruence (G-CO)<br>C. Prove and apply geometric theorems. | |
|---|---|
| In this cluster, the terms students should learn to use with increasing precision are **proof and theorem.** | |
| **Louisiana Standard** | **Explanations and Examples** |
| **GM: G-CO.C.9** Prove and apply theorems about lines and angles. *Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.* | **Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency<br>**Remediation - Previous Grade(s) Standard:** 4.MD.C.7, 7.G.B.5, 8.G.A.5<br>**Geometry Standard Taught in Advance:** GM.G-CO.A.1<br>**Geometry Standard Taught Concurrently:** none<br><br>Encourage multiple ways of writing proofs, such as *narrative paragraphs*, using *flow diagrams*, and *two-column format.* Students should be encouraged to focus on the validity of the underlying reasoning while exploring a variety of formats for expressing that reasoning. Geometry is visual and should be taught in ways that leverage this aspect. Sketching, drawing and constructing figures and relationships between and within geometric objects should be central to any geometric study and certainly to proof. The use of dynamic geometry software, such as GeoGebra, can be important tools for helping students conceptually understand important geometric concepts. GeoGebra is a free app for tablets, phones and desktops. Click here to download GeoGebra.<br><br>**Examples:**<br>• Tangent Lines and the Radius of a Circle: https://www.illustrativemathematics.org/content-standards/HSG/CO/C/9/tasks/963<br>• Congruent angles made by parallel lines and a transverse: https://www.illustrativemathematics.org/content-standards/HSG/CO/C/9/tasks/1922<br>• Points equidistant from two points in a the plane: https://www.illustrativemathematics.org/content-standards/HSG/CO/C/9/tasks/967 |

| | |
|---|---|
| **GM: G-CO.C.10** Prove and apply 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.* | **Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency<br>**Remediation - Previous Grade(s) Standard:** 7.G.A.2, 8.G.A.5<br>**Geometry Standard Taught in Advance:** GM: G-CO.B.8, GM: G-CO.C.9<br>**Geometry Standard Taught Concurrently:** none<br><br>Encourage multiple ways of writing proofs, such as *narrative paragraphs*, using *flow diagrams*, and *two-column format.* Students should be encouraged to focus on the validity of the underlying reasoning while exploring a variety of formats for expressing that reasoning. Geometry is visual and should be taught in ways that leverage this aspect. Sketching, drawing and constructing figures and relationships between and within geometric objects should be central to any geometric study and certainly to proof. The use of dynamic geometry software, such as GeoGebra, can be important tools for helping students conceptually understand important geometric concepts. GeoGebra is a free app for tablets, phones and desktops. Click here to download GeoGebra.<br><br>**Examples of Theorems and Applications:** https://www.illustrativemathematics.org/HSG-CO.C.10 |
| **GM: G-CO.C.11** Prove and apply theorems about parallelograms. *Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.* | **Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency<br>**Remediation - Previous Grade(s) Standard:** 5.G.B.3<br>**Geometry Standard Taught in Advance:** GM: G-CO.B.8, GM: G-CO.C.9<br>**Geometry Standard Taught Concurrently:** none<br><br>Encourage multiple ways of writing proofs, such as *narrative paragraphs*, using *flow diagrams*, and *two-column format.* Students should be encouraged to focus on the validity of the underlying reasoning while exploring a variety of formats for expressing that reasoning. Geometry is visual and should be taught in ways that leverage this aspect. Sketching, drawing and constructing figures and relationships between and within geometric objects should be central to any geometric study and certainly to proof. The use of dynamic geometry software, such as GeoGebra, can be important tools for helping students conceptually understand important geometric concepts. GeoGebra is a free app for tablets, phones and desktops. Click here to download GeoGebra.<br><br>**Examples:**<br>• Congruence of parallelograms: https://www.illustrativemathematics.org/content-standards/HSG/CO/C/11/tasks/1517<br>• Is this a parallelogram: https://www.illustrativemathematics.org/content-standards/HSG/CO/C/11/tasks/1321<br>• Midpoints of the sides of a parallelogram: https://www.illustrativemathematics.org/content-standards/HSG/CO/C/11/tasks/35<br>• Parallelograms and Translations: https://www.illustrativemathematics.org/content-standards/HSG/CO/C/11/tasks/1511 |

## Geometry: Congruence (G-CO)

### D. Make geometric constructions.

In this cluster, the terms students should learn to use with increasing precision are **formal geometric construction, bisect, perpendicular bisector, regular polygon, and inscribed.**

| Louisiana Standard | Explanations and Examples |
|---|---|
| **GM: G-CO.D.12** Make formal geometric constructions with a variety of tools and methods, e.g., compass and straightedge, string, reflective devices, paper folding, or dynamic geometric software. *Examples: copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.* | **Component(s) of Rigor:** Procedural Skill and Fluency<br>**Remediation - Previous Grade(s) Standard:** 4.MD.C.6, 7.G.A.2<br>**Geometry Standard Taught in Advance:** GM: G-CO.A.1<br>**Geometry Standard Taught Concurrently:** none<br>Free resources for this standard include:<br>• Java Applets and Other Interactive Material: David Little, Penn State University: http://www.personal.psu.edu/dpl14/java/geometry/ (requires newer version of Java)<br>• Animated Geometric Constructions (compass/straight edge): http://www.mathsisfun.com/geometry/constructions.html<br>**Examples:**<br>• Construction of perpendicular bisector: https://www.illustrativemathematics.org/content-standards/HSG/CO/D/12/tasks/966<br>• Origami regular octagon: https://www.illustrativemathematics.org/content-standards/HSG/CO/D/12/tasks/1487 |
| **GM: G-CO.D.13** Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle. | **Component(s) of Rigor:** Procedural Skill and Fluency<br>**Remediation - Previous Grade(s) Standard:** 7.G.A.2<br>**Geometry Standard Taught in Advance:** GM: G-CO.C.9, GM: G-CO.D.12<br>**Geometry Standard Taught Concurrently:** none<br>In high school, students perform formal geometry constructions using a variety of tools. Students utilize proofs to justify validity of their constructions.<br>**Students complete three specific constructions:**<br>• Equilateral triangle inscribed in a circle: https://www.youtube.com/watch?v=C6FiPa-aQ-Y<br>• Square inscribed In a circle: https://www.youtube.com/watch?v=2gNfltBkbkI<br>• Regular hexagon inscribed in a circle: https://www.youtube.com/watch?v=mjjs-xs6FVQ |

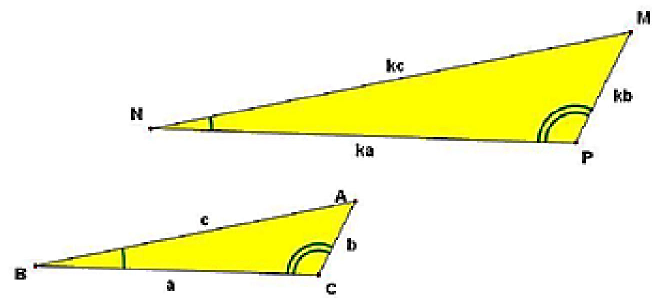
<table>
<tr><td colspan="2">Geometry: Similarity, Right Triangles, and Trigonometry (G-SRT)<br>A. Understand similarity in terms of similarity transformations.</td></tr>
<tr><td colspan="2">In this cluster, the terms students should learn to use with increasing precision are verify, dilation, similar figures, similarity transformation, and proportionality of sides.</td></tr>
<tr><td>Louisiana Standard</td><td>Explanations and Examples</td></tr>
<tr><td>GM: G-SRT.A.1 Verify experimentally the properties of dilations given by a center and a scale factor:<br>a. Dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.<br>b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.</td><td>Component(s) of Rigor: Conceptual Understanding (1, 1a, 1b)<br>Remediation - Previous Grade(s) Standard: 8.G.A.4<br>Geometry Standard Taught in Advance: GM: G-CO.A.2<br>Geometry Standard Taught Concurrently: none<br><br>Students should understand that a dilation is a transformation that moves each point along the ray through the point emanating from a fixed center, and multiplies distances from the center by a common scale factor.<br><br>Students perform a dilation with a given center and scale factor on a figure in the coordinate plane.<br><br>Example:<br>• Given $\Delta ABC$ with $A\ (-2,-4)$, $B\ (1,2)$ and $C\ (4,-3)$ apply the rule $(x,y)$→$(3x,3y)$<br><br>Students verify that when a side passes through the center of dilation, the side and its image lie on the same line and the remaining corresponding sides of the pre-image and images are parallel.<br><br>Example:<br>• Using $\Delta ABC$ and its image $\Delta A'B'C'$ from the previous example, connect the corresponding pre-image and image points. Describe how the corresponding sides are related. Determine the center of dilation.<br><br>Students verify that a side length of the image is equal to the scale factor multiplied by the corresponding side length of the pre-image.<br><br>Examples:<br>• Dilating a line: https://www.illustrativemathematics.org/content-standards/HSG/SRT/A/1/tasks/602</td></tr>
</table>

| | |
|---|---|
| **GM: G-SRT.A.2** Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides. | **Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency<br>**Remediation - Previous Grade(s) Standard:** 8.G.A.4<br>**Geometry Standard Taught in Advance:** GM: G-SRT.A.1<br>**Geometry Standard Taught Concurrently:** none<br><br>Students use the idea of dilation transformations to develop the definition of similarity. They understand that a similarity transformation is a rigid motion followed by a dilation. Students demonstrate that in a pair of similar triangles, corresponding angles are congruent (angle measure is preserved) and corresponding sides are proportional. They determine that two figures are similar by verifying that angle measure is preserved and corresponding sides are proportional.<br><br>**Example:**<br>• Are they similar: https://www.illustrativemathematics.org/content-standards/HSG/SRT/A/2/tasks/603<br>• Similar quadrilaterals: https://www.illustrativemathematics.org/content-standards/HSG/SRT/A/2/tasks/1858<br>• Similar triangles: https://www.illustrativemathematics.org/content-standards/HSG/SRT/A/2/tasks/1890 |

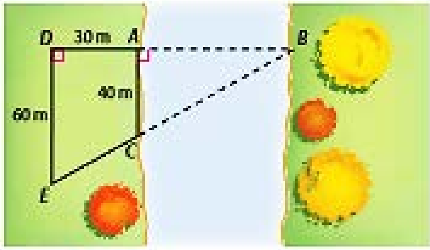
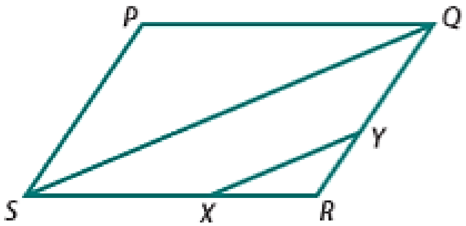
## Geometry: Similarity, Right Triangles, and Trigonometry (G-SRT)

### A. Understand similarity in terms of similarity transformations.

In this cluster, the terms students should learn to use with increasing precision are **mapping and AA similarity criterion.**

| Louisiana Standard | Explanations and Examples |
|---|---|
| **GM: G-SRT.A.3** Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar. | **Component(s) of Rigor:** Conceptual Understanding<br>**Remediation - Previous Grade(s) Standard:** 8.G.A.4, 8.G.A.5<br>**Geometry Standard Taught in Advance:** GM: G-SRT.A.2<br>**Geometry Standard Taught Concurrently:** none<br>Students can use the theorem that the angle sum of a triangle is 180° and verify that the AA criterion is equivalent to the AAA criterion.<br><br>Given two triangles for which AA holds, students use rigid motions to map a vertex of one triangle onto the corresponding vertex of the other in such a way that their corresponding sides are in line. Then show that dilation will complete the mapping of one triangle onto the other.<br><br>**Examples:**<br>• Given that $\Delta MNP$ is a dilation of $\Delta ABC$ with scale factor $k$, use properties of dilations to show that the AA criterion is sufficient to prove similarity.<br>• Similar Triangles: https://www.illustrativemathematics.org/content-standards/HSG/SRT/A/3/tasks/1422 |

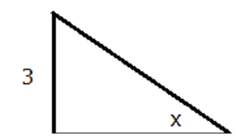
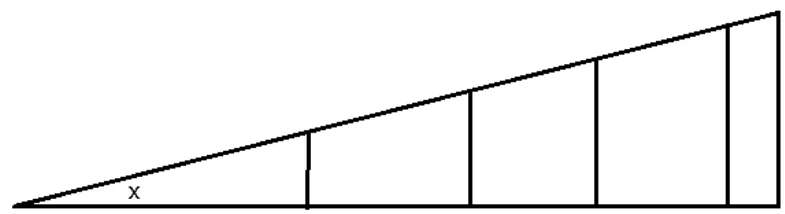
<table>
<tr><td colspan="2">Geometry: Similarity, Right Triangles, and Trigonometry (G-SRT)<br>B. Prove theorems involving similarity.</td></tr>
<tr><td colspan="2">In this cluster, the terms students should learn to use with increasing precision are proof, theorem, converse, and triangle congruence and similarity criteria.</td></tr>
<tr><td>Louisiana Standard</td><td>Explanations and Examples</td></tr>
<tr><td>GM: G-SRT.B.4 Prove and apply theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity; SAS similarity criteria, SSS similarity criteria, AA similarity criteria.</td><td>Component(s) of Rigor: Conceptual Understanding, Procedural Skill and Fluency<br>Remediation - Previous Grade(s) Standard: 8.G.B.6<br>Geometry Standard Taught in Advance: GM: G-SRT.A.3<br>Geometry Standard Taught Concurrently: none<br>Use AA, SAS, and SSS similarity theorems to prove triangles are similar. Use triangle similarity to prove other theorems about triangles.<br><br>Examples:<ul><li>Joining two midpoints of sides of a trainable: https://www.illustrativemathematics.org/content-standards/HSG/SRT/B/4/tasks/1095</li><li>Pythagorean Theorem: https://www.illustrativemathematics.org/content-standards/HSG/SRT/B/4/tasks/1568</li></ul></td></tr>
</table>

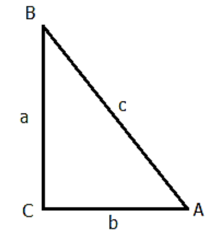
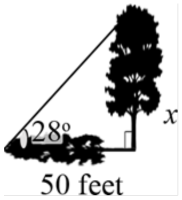
| | |
|---|---|
| GM: G-SRT.B.5 Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures. | **Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency, Application<br>**Remediation - Previous Grade(s) Standard:** none<br>**Geometry Standard Taught in Advance:** GM: G-CO.B.8, GM:G-SRT.A.3<br>**Geometry Standard Taught Concurrently:** none<br><br>The similarity postulates include SSS, SAS, and AA. The congruence postulates include SSS, SAS, ASA, AAS, and H-L. Students apply triangle congruence and triangle similarity to solve problem situations (e.g., indirect measurement, missing side(s)/angle measure(s), side splitting).<br><br>**Example:**<br>• Calculate the distance across the river, *AB*.<br><br>• In the diagram, quadrilateral *PQRS* is a parallelogram, *SQ* is a diagonal, and *SQ* \|\| *XY*.<br>a. Prove that $\Delta XYR \sim \Delta SQR$.<br>b. Prove that $\Delta XYR \sim \Delta QSP$.<br> |

## Geometry: Similarity, Right Triangles, and Trigonometry (G-SRT)

### C. Define trigonometric ratios and solve problems involving right triangles.

In this cluster, the terms students should learn to use with increasing precision are **right triangle, side ratios, special right triangles (30-30-90 and 45-45-90), acute angle, trigonometric ratios (sine, cosine, tangent), complementary angles, and "solve a right triangle."**

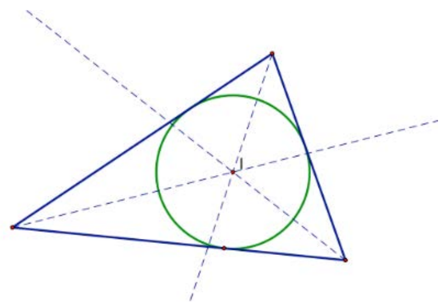
| Louisiana Standard | Explanations and Examples |
|---|---|
| **GM: G-SRT.C.6** Understand that by similarity, side ratios in right triangles, including special right triangles (30-60-90 and 45-45-90) are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles. | **Component(s) of Rigor:** Conceptual Understanding<br>**Remediation - Previous Grade(s) Standard:** none<br>**Geometry Standard Taught in Advance:** GM: G-SRT.A.2<br>**Geometry Standard Taught Concurrently:** none<br><br>Students establish that the side ratios of a right triangle are equivalent to the corresponding side ratios of similar right triangles and are a function of the acute angle(s).<br><br>**Examples:**<br>• Find the sine, cosine, and tangent of *x*.  <br>• Explain why the sine of *x* is the same regardless of which triangle is used to in the figure to the right.   find it<br>• Defining Trigonometric Ratios: https://www.illustrativemathematics.org/content-standards/HSG/SRT/C/6/tasks/1635 |

| | |
|---|---|
| **GM: G-SRT.C.7** Explain and use the relationship between the sine and cosine of complementary angles. | **Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency<br>**Remediation - Previous Grade(s) Standard:** 7.G.B.5<br>**Geometry Standard Taught in Advance:** GM: G-SRT.C.6<br>**Geometry Standard Taught Concurrently:** none<br><br>Students can explain why the sine of an acute angle in a right triangle is the cosine of complementary angle in the same right triangle. Students use the relationship to solve problems.<br><br><br>**Examples:**<br>• Using the diagram at the right, provide an argument justifying why $sin\ A = cos\ B$.<br>• Complete the following statement: If $sin\ 30° = \frac{1}{2}$, then $cos$ _____ $= \frac{1}{2}$<br>• Given: Angle *F* and angle *G* are complementary. As the measure of angle *F* varies from a value of *x* to a value of *y*, $sin\ (F)$ increases by 0.2. How does $cos\ (G)$ change as *F* varies from $x$ to $y$? |
| **GM: G-SRT.C.8** Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems. ★ | **Component(s) of Rigor:** Application<br>**Remediation - Previous Grade(s) Standard:** 8.G.B.7<br>**Geometry Standard Taught in Advance:** GM: G-SRT.B.4<br>**Geometry Standard Taught Concurrently:** none<br><br>This is a modeling standard which means students choose and use appropriate mathematics to analyze situations. Thus, contextual situations that require students to determine the correct mathematical model and use the model to solve problems are essential.<br><br>**Examples:**<br>• Find the height of a tree to the nearest tenth if the angle of elevation of the sun is 28° and the shadow of the tree is 50 ft.<br><br>• A new house is 32 feet wide. The rafters will rise at a 36° angle and meet above the centerline of the house. Each rafter also needs to overhang the side of the house by 2 feet. How long should the carpenter make each rafter? |

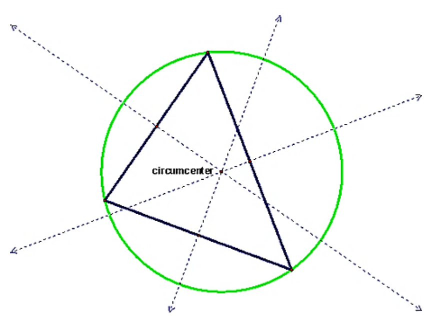
<table>
<tr><td colspan="2">Geometry: Circles (GM: G-C)<br>A. Understand and apply theorems about circles.</td></tr>
<tr><td colspan="2">In this cluster, the terms students should learn to use with increasing precision are proof, theorem, circle, central angle, radii, chords, tangent segment/line, inscribed and circumscribed (angles and figures).</td></tr>
<tr><td>Louisiana Standard</td><td>Explanations and Examples</td></tr>
<tr><td>GM: G-C.A.1 Prove that all circles are similar.</td><td>Component(s) of Rigor: Conceptual Understanding<br>Remediation - Previous Grade(s) Standard: none<br>Geometry Standard Taught in Advance: GM: G-SRT.A.2<br>Geometry Standard Taught Concurrently: none<br><br>Students use the fact that the ratio of diameter to circumference is the same for all circles to prove that all circles are similar. Students use any two circles in a plane and show that they are related by dilation.<br><br>Example:<ul><li>Similar circles: https://www.illustrativemathematics.org/content-standards/HSG/C/A/1/tasks/1368</li></ul></td></tr>
<tr><td>GM: G-C.A.2 Identify and describe relationships among inscribed angles, radii, and chords, including the following: the relationship that exists between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; and a radius of a circle is perpendicular to the tangent where the radius intersects the circle.</td><td>Component(s) of Rigor: Conceptual Understanding<br>Remediation - Previous Grade(s) Standard: none<br>Geometry Standard Taught in Advance: GM: G-CO.C.10<br>Geometry Standard Taught Concurrently: none<br><br>Students can:<ul><li>Identify central angles, inscribed angles, circumscribed angles, diameters, radii, chords, and tangents.</li><li>Describe the relationship between a central angle and the arc it intercepts.</li><li>Describe the relationship between an inscribed angle and the arc it intercepts.</li><li>Describe the relationship between a circumscribed angle and the arcs it intercepts.</li><li>Recognize that an inscribed angle whose sides intersect the endpoints of the diameter of a circle is a right angle.</li><li>Recognize that the radius of a circle is perpendicular to the tangent where the radius intersects the circle.</li></ul>Example:<ul><li>Right Triangles Inscribed by Circles I:<br>https://www.illustrativemathematics.org/content-standards/HSG/C/A/2/tasks/1091</li><li>Right Triangles Inscribed by Circles II<br>https://www.illustrativemathematics.org/content-standards/HSG/C/A/2/tasks/1093</li></ul></td></tr>
</table>

| | |
|---|---|
| **GM: G-C.A.3** Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle. | **Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency<br>**Remediation - Previous Grade(s) Standard:** none<br>**Geometry Standard Taught in Advance:** GM: G-C.A.2<br>**Geometry Standard Taught Concurrently:** none |

Students construct the inscribed circle whose center is the point of intersection of the angle bisectors (the center).



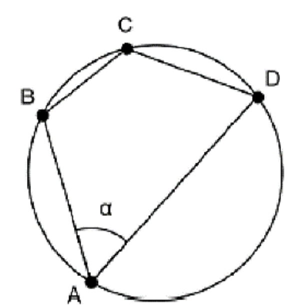
Students construct the circumscribed circle whose center is the point of intersection of the perpendicular bisectors of each side of the triangle (the circumcenter).

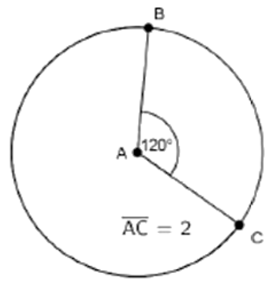



Students prove properties of angles for a quadrilateral inscribed in a circle.

**Example:**

- Given the inscribed quadrilateral to the right, prove that m∠ *B* is supplementary to m∠*D*.

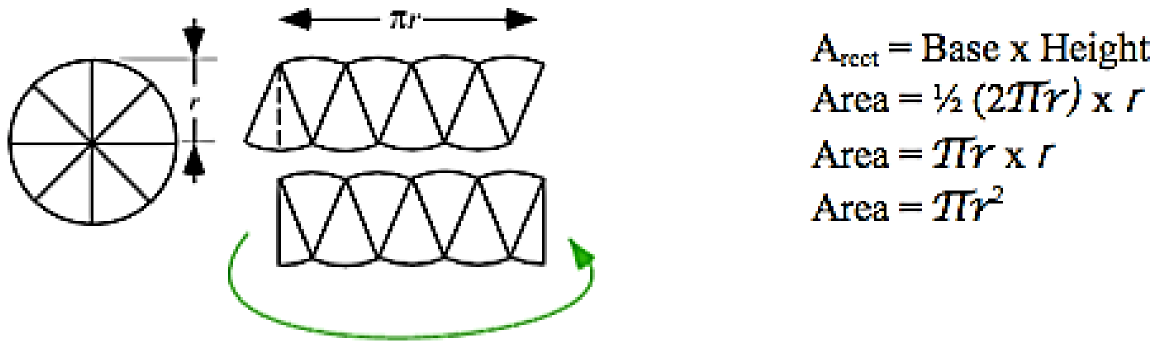


| Geometry: Circles (GM: G-C)<br>B. Find arc lengths and areas of sectors of circles. | |
|---|---|
| In this cluster, the terms students should learn to use with increasing precision are **arc length, intercepted arc, radian, and area of a sector.** | |
| **Louisiana Standard** | **Explanations and Examples** |
| **GM: G-C.B.5** Use similarity to determine that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector. | **Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency<br>**Remediation - Previous Grade(s) Standard:** none<br>**Geometry Standard Taught in Advance:** GM: G-CO.B.8, GM: G-C.A.2<br>**Geometry Standard Taught Concurrently:** none<br><br>All circles are similar (G-C.A.1). Sectors with the same central angle have arc lengths that are proportional to the radius. The radian measure of the angle is the constant of proportionality.<br><br>***Example:***<br>• Find the area of the sectors. What general formula can you develop based on this information?<br>• Find the area of a sector with an arc length of 40 cm and a radius of 12 cm.<br> |

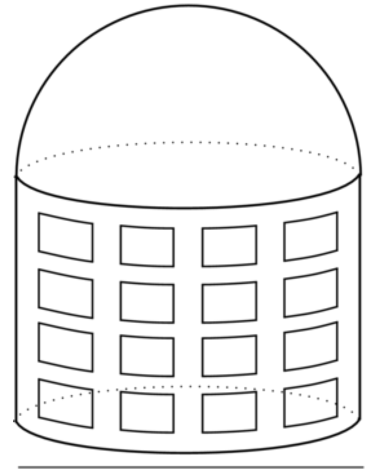
<table>
<tr><td colspan="2">Geometry: Expressing Geometric Properties with Equations (G-GPE)<br>A. Translate between the geometric description and the equation for a conic section.</td></tr>
<tr><td colspan="2">In this cluster, the terms students should learn to use with increasing precision are definition of circle on a coordinate plane, equation of a circle, $x$-coordinate, $y$-coordinate, center, and radius.</td></tr>
<tr><td>Louisiana Standard</td><td>Explanations and Examples</td></tr>
<tr><td>GM: G-GPE.A.1 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.</td><td>Component(s) of Rigor: Procedural Skill and Fluency<br>Remediation - Previous Grade(s) Standard: 8.G.B.8, A1: A-REI.B.4<br>Geometry Standard Taught in Advance: GM: G-SRT.B.4, GM: G-SRT.C.8<br>Geometry Standard Taught Concurrently: none<br><br>Students define a circle as the set of points whose distance from a fixed point is constant. Given a point on the circle and the fixed point, they identify that the difference in the $x$-coordinates represents the horizontal distance and the difference in the $y$-coordinates represents the vertical distance. Students apply the Pythagorean Theorem to calculate the distance between the two points. Generalizing this process, students derive the equation of a circle. Students connect the derivation of the equation of a circle to the distance formula.<br><br>Example:<ul><li>Write the equation of a circle that is centered at $(-1, 3)$ with a radius of 5 units.</li><li>Write an equation for a circle given that the endpoints of the diameter are $(-2, 7)$ and $(4, -8)$</li></ul></td></tr>
</table>

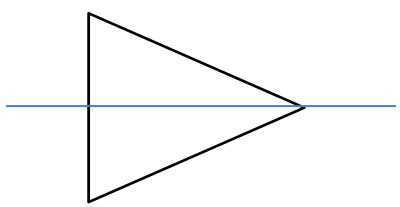
| Geometry: Expressing Geometric Properties with Equations (G-GPE)<br>**B. Use coordinates to prove simple geometric theorems algebraically.** | |
|---|---|
| In this cluster, the terms students should learn to use with increasing precision are **coordinates, coordinate plane, theorem, prove, disprove, slope criteria, parallel and perpendicular lines, directed line segment, partition, ratio, perimeter, area, and distance formula.** | |
| **Louisiana Standard** | **Explanations and Examples** |
| **GM: G-GPE.B.4** Use coordinates to prove simple geometric theorems algebraically. *For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point (1, √3) lies on the circle centered at the origin and containing the point (0, 2* | **Component(s) of Rigor:** Procedural Skill and Fluency<br>**Remediation - Previous Grade(s) Standard:** 8.G.B.8<br>**Geometry Standard Taught in Advance:** none<br>**Geometry Standard Taught Concurrently:** none<br><br>**Examples:**<br>• A midpoint miracle: https://www.illustrativemathematics.org/content-standards/HSG/GPE/B/4/tasks/605 |
| **GM: G-GPE.B.5** Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point). | **Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency<br>**Remediation - Previous Grade(s) Standard:** 8.EE.B.6, 8.F.A.3<br>**Geometry Standard Taught in Advance:** none<br>**Geometry Standard Taught Concurrently:** none<br><br>Students use the formula for the slope of a line to determine whether two lines are parallel or perpendicular. Two lines are parallel if they have the same slope and two lines are perpendicular if their slopes are opposite reciprocals of each other. In other words, the product of the slopes of lines that are perpendicular is $(-1)$. Additionally, students find the equations of lines that are parallel or perpendicular given certain criteria.<br><br>**Examples:**<br>• Suppose a line *k* in a coordinate plane has slope $\frac{c}{d}$.<br>a. What is the slope of a line parallel to *k*? Why must this be the case?<br>b. What is the slope of a line perpendicular to *k*? Why does this seem reasonable?<br><br>• Two points $A(0,-4)$, $B(2,-1)$ determines a line, $\overleftrightarrow{AB}$.<br>a. What is the equation of the line AB?<br>b. What is the equation of the line perpendicular to $\overleftrightarrow{AB}$. passing through the point $(2,-1)$? |

| | |
|---|---|
| **GM: G-GPE.B.6** Find the point on a directed line segment between two given points that partitions the segment in a given ratio. | **Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency<br>**Remediation - Previous Grade(s) Standard:** none<br>**Geometry Standard Taught in Advance:** GM: G-CO.C.9, GM: G-SRT.A.2<br>**Geometry Standard Taught Concurrently:** none<br><br>Students work with ratios began in Grade 6, and their understanding of a ratio will directly impact their ability to master this standard. If students (incorrectly) think a ratio is a fraction, they will likely miss every problem designed to assess this standard. Students must understand a ratio as a part to part relationship, not a part to whole relationship as is suggested by a fraction. If a line segment is partitioned into a ratio of $a$: $b$, then the line segment is made up of $a + b$ parts, not $b$ parts. If a student thinks a ratio is a fraction, he/she will also think the latter is true.<br>**Example:**<br>• Given $A(3, 2)$ and $B(6, 11)$,<br>a. Find the point that divides the line segment *AB* two-thirds of the way from *A* to *B*.<br>b. Find the midpoint of line segment *AB*.<br>• Given directed line segment $AB$ with $A(-1,2)$ and $B(7,14)$, find point *P* that partitions the segment into a ratio of 1:3.<br>• Scaling a Triangle in the Coordinate Plane: https://www.illustrativemathematics.org/content-standards/HSG/GPE/B/6/tasks/1867 |
| **GM: G-GPE.B.7** Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula. ★ | **Component(s) of Rigor:** Procedural Skill and Fluency<br>**Remediation - Previous Grade(s) Standard:** 8.G.B.8<br>**Geometry Standard Taught in Advance:** GM: G-SRT.B.4<br>**Geometry Standard Taught Concurrently:** none<br><br>This is a modeling standard which means students choose and use appropriate mathematics to analyze situations. Thus, contextual situations that require students to determine the correct mathematical model and use the model to solve problems are essential. This standard provides practice with the distance formula and its connection with the Pythagorean Theorem. Studetnts use the coordinates of the vertices of a polygon graphed in the coordinate plane and the distance formula to compute the perimeter and to find lengths necessary to compute the area.<br><br>**Examples**:<br>• Squares on a coordinate grid: https://www.illustrativemathematics.org/content-standards/HSG/GPE/B/7/tasks/1684<br>• Tringle perimeters: https://www.illustrativemathematics.org/content-standards/HSG/GPE/B/7/tasks/1816 |

| Geometry: Geometric Measurement and Dimension (G-GMD)<br>**A. Explain volume formulas and use them to solve problems.** | |
|---|---|
| In this cluster, the terms students should learn to use with increasing precision are **informal argument** | |
| **Louisiana Standard** | **Explanations and Examples** |
| **GM: G-GMD.A.1** Give an informal argument, e.g., dissection arguments, Cavalieri's principle, or informal limit arguments, for the formulas for the circumference of a circle; area of a circle; volume of a cylinder, pyramid, and cone. | **Component(s) of Rigor:** Conceptual Understanding<br>**Remediation - Previous Grade(s) Standard:** 7.G.B.4<br>**Geometry Standard Taught in Advance:** none<br>**Geometry Standard Taught Concurrently:** none<br><br>**Circumference of a circle:**<br>Students begin with the measure of the diameter of the circle or the radius of the circle. They can use string or pipe cleaner to represent the measurement. Next, students measure the distance around the circle using the measure of the diameter. They discover that there are 3 diameters around the circumference with a small gap remaining. Through discussion, students conjecture that the circumference is the length of the diameter $\pi$ times. Therefore, the circumference can be written as $C = \pi d$. When measuring the circle using the radius, students discover there are 6 radii around the circumference with a small gap remaining. Students conjecture that the circumference is the length of the radius $2\pi$ times. Therefore, the circumference of the circle can also be expressed using $C = 2\pi r$.<br><br>**Area of a circle:**<br>Students may use dissection arguments for the area of a circle. Dissect portions of the circle like pieces of a pie and arrange the pieces into a figure resembling a parallelogram as indicated below. Reason that the base is half of the circumference and the height is the radius. Students use the formula for the area of a parallelogram to derive the area of the circle.<br><br> |

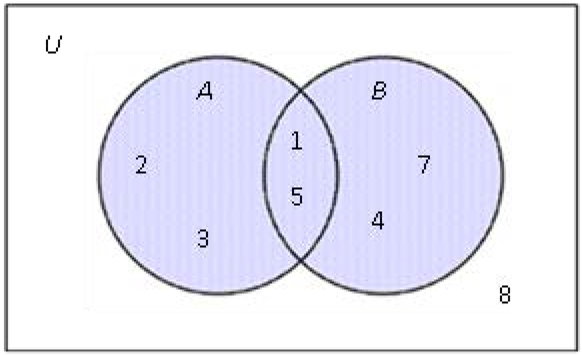
| | |
|---|---|
| **GM: G-GMD.A.1** *continued* | **Volume of a cylinder:**<br>Students develop the formula for the volume of a cylinder based on the area of a circle stacked over and over again until the cylinder has the given height. Therefore, the formula for the volume of a cylinder is $V = Bh$. This approach is similar to Cavalieri's principle. In Cavalieri's principle, the cross-sections of the cylinder are circles of equal area, which stack to a specific height.<br><br>**Volume of a pyramid or cone:**<br>For pyramids and cones, the factor $\frac{1}{3}$ will need some explanation. An informal demonstration can be done using a volume relationship set of plastic shapes that permit one to pour liquid or sand from one shape into another. Another way to do this for pyramids is with Geoblocks. The set includes three pyramids with equal bases and altitudes that will stack to form a cube. An algebraic approach involves the formula for the sum of squares ($1^2 + 2^2 + \cdots + n^2$). After the coefficient $\frac{1}{3}$ has been justified for the formula of the volume of the pyramid ($A = \frac{1}{3}Bh$), one can argue that it must also apply to the formula of the volume of the cone by considering a cone to be a pyramid that has a base with infinitely many sides. |

<table>
<tr>
<td>GM: G-GMD.A.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems. ★</td>
<td>Component(s) of Rigor: Procedural Skill and Fluency, Application<br>Remediation - Previous Grade(s) Standard: 8.G.C.9<br>Geometry Standard Taught in Advance: GM: G-GMD.A.1<br>Geometry Standard Taught Concurrently: none<br><br>This is a modeling standard which means students choose and use appropriate mathematics to analyze situations. Thus, contextual situations that require students to determine the correct mathematical model and use the model to solve problems are essential.<br><br>Example:<br>• The Southern African Large Telescope (SALT) is housed in a cylindrical building with a domed roof in the shape of a hemisphere. The height of the building wall is 17 m and the diameter is 26 m. To program the ventilation system for heat, air conditioning, and dehumidifying, the engineers need the amount of space in the building. What is the volume, in cubic meters, of space in the building?<br><br></td>
</tr>
</table>

| Geometry: Geometric Measurement and Dimension (G-GMD)<br>**B. Visualize relationships between two-dimensional and three dimensional objects.** | |
|---|---|
| In this cluster, the terms students should learn to use with increasing precision are **cross section, two dimensional, three dimensional, generate, and rotation.** | |
| **Louisiana Standard** | **Explanations and Examples** |
| **GM: G-GMD.B.4** Identify the shapes of two-dimensional cross sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects. | **Component(s) of Rigor:** Conceptual Understanding<br>**Remediation - Previous Grade(s) Standard:** 7.G.A.3<br>**Geometry Standard Taught in Advance:** none<br>**Geometry Standard Taught Concurrently:** none<br><br>Students identify shapes of two-dimensional cross-sections of three-dimensional objects. The Cross Section Flyer at http://www.shodor.org/interactivate/activities/CrossSectionFlyer/ can be used to allow students to predict and verify the cross section of different three-dimensional objects.<br><br>**Example:**<br>• Identify two-dimensional cross sections of a rectangular prism.<br><br>Students identify three-dimensional objects generated by rotations of two-dimensional objects. The 3D Transmographer at http://www.shodor.org/interactivate/activities/3DTransmographer/ can be used to allow students to predict and verify three-dimensional objects generated by rotations of two-dimensional objects.<br><br>**Example:**<br>• Identify the object generated when the following object is rotated about the indicated line.<br> |

| Geometry: Modeling with Geometry ★ (G-MG)<br>**A. Apply geometric concepts in modeling situations.** | |
|---|---|
| In this cluster, the terms students should learn to use with increasing precision are **mathematical model, density, and design problem.** | |
| **Louisiana Standard** | **Explanations and Examples** |
| **GM: G-MG.A.1** Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder). ★ | **Component(s) of Rigor:** Conceptual Understanding<br>**Remediation - Previous Grade(s) Standard:** 6.G.A.4, 7.G.B.6<br>**Geometry Standard Taught in Advance:** none<br>**Geometry Standard Taught Concurrently:** none<br>Students recognize situations that require relating two- and three- dimensional objects**.** They estimate measures (circumference, area, perimeter, volume) of real-world objects using comparable geometric shapes or three-dimensional objects. Students apply the properties of geometric figures to comparable real-world objects (e.g., The spokes of a wheel of a bicycle are equal lengths because they represent the radii of a circle).<br><br>**Example:**<br>• Describe each of the following as a simple geometric shape or combination of shapes. Illustrate with a sketch and label dimensions important to describing the shape.<br>a. Soup can label<br>b. A bale of hay<br>c. Paperclip<br>d. Strawberry |
| **GM: G-MG.A.2** Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot). ★ | **Component(s) of Rigor:** Application<br>**Remediation - Previous Grade(s) Standard:** 7.G.B.6, 8.G.C.9<br>**Geometry Standard Taught in Advance:** GM: G-MG.A.1, GM: G-MG.A.3<br>**Geometry Standard Taught Concurrently:** none<br>**Example:**<br>• An antique waterbed has the following dimensions 72 in. x 84 in. x 9.5in. It takes 240.7 gallons of water to fill it, which would weigh 2071 pounds. What is the weight of a cubic foot of water?<br>• Wichita, Kansas has 344,234 people within 165.9 square miles. What is Wichita's population density? |

| | |
|---|---|
| **GM: G-MG.A.3** 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). ★ | **Component(s) of Rigor:** Application<br>**Remediation - Previous Grade(s) Standard:** 7.G.A.1, 7.G.B.6, 8.G.C.9<br>**Geometry Standard Taught in Advance:** none<br>**Geometry Standard Taught Concurrently:** none<br>**Examples:**<br>• Ice cream cone: https://www.illustrativemathematics.org/content-standards/HSG/MG/A/3/tasks/414<br>• Satellite: https://www.illustrativemathematics.org/content-standards/HSG/MG/A/3/tasks/416 |

<table>
<tr><td colspan="2">Statistics and Probability: Conditional Probability and the Rules of Probability ★ (S-CP)<br>A. Understand independence and conditional probability and use them to interpret data.</td></tr>
<tr><td colspan="2">In this cluster, the terms students should learn to use with increasing precision are sample space, event, outcome, union, intersection, complement of an event, independent event, probability of an event, conditional probability, frequency, and two-way frequency table.</td></tr>
<tr><td>Louisiana Standard</td><td>Explanations and Examples</td></tr>
<tr><td>GM: S-CP.A.1 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”). ★</td><td>Component(s) of Rigor: Conceptual Understanding<br>Remediation - Previous Grade(s) Standard: 7.SP.C.8<br>Geometry Standard Taught in Advance: none<br>Geometry Standard Taught Concurrently: none<br><br><u>Intersection</u>: The intersection of two sets A and B is the set of elements that are common to both set A and set B. It is denoted by A ∩ B and is read ‘A intersection B.’<br><ul><li>A ∩ B in the diagram is {1, 5}</li><li>this means: BOTH/AND</li></ul><br><br><u>Union</u>: The union of two sets A and B is the set of elements, which are in A or in B or in both. It is denoted by A ∪ B and is read ‘A union B.’<br><br>A ∪ B in the diagram is {1, 2, 3, 4, 5, 7}<ul><li>this means: EITHER/OR/ANY</li><li>could be both</li></ul><u>Complement</u>: The complement of the set A ∪ B is the set of elements that are members of the universal set U but are not in A ∪ B. It is denoted by (A ∪ B)’<br><br>(A ∪ B )’ in the diagram is {8}.</td></tr>
</table>

| | |
|---|---|
| **GM: S-CP.A.1** *continued* | Students define a sample space and events within the sample space. The sample space is the set of all possible outcomes of an experiment. Students describe sample spaces using a variety of different representations.<br><br>**Example:**<br>• Describe the sample space for rolling two number cubes. *Note: This may be modeled well with a 6x6 table with the rows labeled for the first event and the columns labeled for the second event.*<br>• Describe the sample space for picking a colored marble from a bag with red and black marbles. *Note: This may be modeled with set notation.*<br>• Andrea is shopping for a new cellphone. She is either going to contract with Company A (60% chance) or with Company B (40% chance). She must choose between phone Q (25% chance) or phone R (75% chance). Describe the sample space. *Note: This may be modeled well with an area model.*<br>• The 4 aces are removed from a deck of cards. A coin is tossed and one of the aces is chosen. Describe the sample space. *Note: This may be modeled well with a tree diagram.*<br><br>Students establish events as subsets of a sample space. An event is a subset of a sample space.<br><br>**Examples:**<br>• Describe the event of rolling two number cubes and getting evens.<br>• Describe the event of pulling two marbles from a bag of red/black marbles.<br>• Describe the event that the summing of two rolled number cubes is larger than 7 and even, and contrast it with the event that the sum is larger than 7 or even. |

| | |
|---|---|
| **GM: S-CP.A.2** 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. ★ | **Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency<br>**Remediation - Previous Grade(s) Standard:** none<br>**Geometry Standard Taught in Advance:** GM: S-CP.A.1<br>**Geometry Standard Taught Concurrently:** none<br><br>Students understand that two events A and B are independent when the probability that one event occurs in no way affects the probability of the other event occurring. In other words, the probability of A is the same even if event B has occurred. If events are independent then the $P(A \cap B) = P(A) \cdot P(B)$<br><br>**Example:**<br>• Determine if the events are independent or not. Explain your reasoning.<br>a. Flipping a coin and getting heads and rolling a number cube and getting a 4<br>b. When rolling a pair of number cubes consider the events: getting a sum of 7 and getting doubles<br>From a standard deck of cards consider the events: draw a diamond and draw an ace |

**GM: S-CP.A.3** 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 probability of *A* given *B* is the same as the probability of *A*, and the conditional probability of *B* given *A* is the same as the probability of *B*. ★

**Component(s) of Rigor:** Conceptual Understanding
**Remediation - Previous Grade(s) Standard:** none
**Geometry Standard Taught in Advance:** GM: S-CP.A.1, GM: S-CP.A.2
**Geometry Standard Taught Concurrently:** none

Students understand conditional probability as the probability of A occurring given B has occurred.

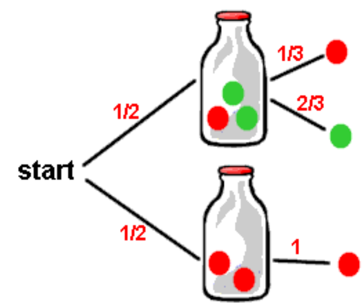
**Example:**

- What is the probability that the sum of two rolled number cubes is 6 given that you rolled doubles?

- Each student in the junior class was asked if they had to complete chores at home and if they had a curfew. The table represents the data.
  a. What is the probability that a student who has chores also has a curfew?
  b. What is the probability that a student who has a curfew also has chores?
  c. Are the two events have chores and have a curfew independent? Explain.

| | | Curfew | | |
|---|---|---|---|---|
| | | Yes | No | Total |
| Chores | Yes | 51 | 24 | 75 |
| | No | 30 | 12 | 42 |
| | Total | 81 | 36 | 117 |

- There are two identical bottles. A bottle is selected at random and a single ball is drawn. Use the tree diagram at the right to determine each of the following:
  a. $P\ (red|bottle\ 1)$
  b. $P\ (red|bottle\ 2)$



| | |
|---|---|
| **GM: S-CP.A.4** 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 on their 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.* ★ | **Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency, Application<br>**Remediation - Previous Grade(s) Standard:** A1: S-ID.B.5<br>**Geometry Standard Taught in Advance:** GM: S-CP.A.2, GM: S-CP.A.3<br>**Geometry Standard Taught Concurrently:** none<br>Students:<br>• Determine when a two-way frequency table is an appropriate display for a set of data.<br>• Collect data from a random sample.<br>• Construct a two-way frequency table for the data using the appropriate categories for each variable.<br>• Calculate probabilities from the table.<br>• Use probabilities from the table to evaluate independence of two variables.<br><br>**Example:**<br><br>• Two-way tables and probability: https://www.illustrativemathematics.org/content-standards/HSS/CP/A/4/tasks/2045 |
| **GM: S-CP.A.5** Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. *For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.* ★ | **Component(s) of Rigor:** Conceptual Understanding<br>**Remediation - Previous Grade(s) Standard:** none<br>**Geometry Standard Taught in Advance:** GM: S-CP.A.3<br>**Geometry Standard Taught Concurrently:** none<br>**Examples:**<br><br>• Breakfast before school: https://www.illustrativemathematics.org/content-standards/HSS/CP/A/5/tasks/1019 |

**Statistics and Probability: Conditional Probability and the Rules of Probability ★(S-CP)**

**B. Use the rules of probability to compute probabilities of compound events in a uniform probability model.**

In this cluster, the terms students should learn to use with increasing precision are **conditional probability, Addition Rule, mutually exclusive, and disjoint.**

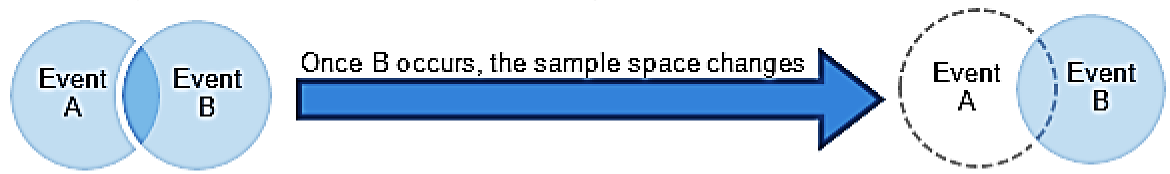
<table>
<tr><th>Louisiana Standard</th><th>Explanations and Examples</th></tr>
<tr><td>

**GM: S-CP.B.6** Find the conditional probability of *A* given *B* as the fraction of *B*’s outcomes that also belong to *A*, and interpret the answer in terms of the model. ★

</td><td>

**Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency, Application
**Remediation - Previous Grade(s) Standard:** none
**Geometry Standard Taught in Advance:** GM: S-CP.A.3
**Geometry Standard Taught Concurrently:** none

The sample space of an experiment can be modeled with a Venn diagram such as:




So, the $P(A|B) = \frac{P(A \text{ and } B)}{P(B)}$

**Example:**

- Peter has a bag of marbles. In the bag are 4 white marbles, 2 blue marbles, and 6 green marbles. Peter randomly draws one marble, sets it aside, and then randomly draws another marble. What is the probability of Peter drawing out two green marbles? *Note: Students must recognize that this a conditional probability P(green | green).*

- A teacher gave her class two quizzes. 30% of the class passed both quizzes and 60% of the class passed the first quiz. What percent of those who passed the first quiz also passed the second quiz?

- If a balanced tetrahedron with faces 1, 2, 3, 4 is rolled twice, what is the probability that the sum is prime (A) of those that show a 3 on at least one roll (B)?

</td></tr>
</table>

| | |
|---|---|
| **GM: S-CP.B.7** Apply the Addition Rule, *P*(*A* or *B*) = *P*(*A*) + *P*(*B*) – *P*(*A* and *B*), and interpret the answer in terms of the model. ★ | **Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency, Application<br>**Remediation - Previous Grade(s) Standard:** none<br>**Geometry Standard Taught in Advance:** GM: S-CP.A.1, GM: S-CP.A.3<br>**Geometry Standard Taught Concurrently:** none<br>Students understand that the $P\ (A\ or\ B)\ =\ P\ (A) + P\ (B)\ -\ P\ (A\ and\ B)$. Students may recognize that if two events *A* and *B* are mutually exclusive, also called *disjoint*, the rule can be simplified to $P\ (A\ or\ B)\ =\ P\ (A)\ +\ P\ (B)$ since for mutually exclusive events $P\ (A\ and\ B)\ =\ 0.$<br>**Examples:**<br>• In a math class of 32 students, 18 boys and 14 are girls. On a unit test, 5 boys and 7 girls made an A grade. If a student is chosen at random from the class, what is the probability of choosing a girl or an A student?<br>• Coffee at Mom's Diner: https://www.illustrativemathematics.org/content-standards/HSS/CP/B/7/tasks/1024<br>• Rain and Lightning: https://www.illustrativemathematics.org/content-standards/HSS/CP/B/7/tasks/1112<br>• The Addition Rule: https://www.illustrativemathematics.org/content-standards/HSS/CP/B/7/tasks/1885 |

## Grade 4 Standards

**4.MD.C.5** Recognize angles as geometric shapes that are formed wherever two rays share a common endpoint, and understand concepts of angle measurement.

a. An angle is measured with reference to a circle with its center at the common endpoint of the rays, by considering the fraction of the circular arc between the points where the two rays intersect the circle.
b. An angle that turns through 1/360 of a circle is called a "one-degree angle," and can be used to measure angles.
c. An angle that turns through *n* one-degree angles is said to have an angle measure of *n* degrees.

*Return to* GM: G-CO.A.1

**4.MD.C.6** Measure angles in whole-number degrees using a protractor. Sketch angles of specified measure. *Return to* GM: G-CO.D.12

**4.MD.C.7** Recognize angle measure as additive. When an angle is decomposed into non-overlapping parts, the angle measure of the whole is the sum of the angle measures of the parts. Solve addition and subtraction problems to find unknown angles on a diagram in real-world and mathematical problems, e.g., by using an equation with a letter for the unknown angle measure. *Return to* GM: G-CO.C.9

**4.G.A.1** Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures.
*Return to* GM: G-CO.A.1

**4.G.A.2** Classify two-dimensional figures based on the presence or absence of parallel or perpendicular lines, or the presence or absence of angles of a specified size. Recognize right triangles as a category, and identify right triangles. *Return to* GM: G-CO.A.1

## Grade 5 Standards

**5.G.B.3** Understand that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category. For example, all rectangles have four right angles and squares are rectangles, so all squares have four right angles. *Return to* GM: G-CO.C.11

## Grade 6 Standards

**6.G.A.4** Represent three-dimensional figures using nets made up of rectangles and triangles, and use the nets to find the surface area of these figures. Apply these techniques in the context of solving real-world and mathematical problems. *Return to* GM: G-MG.A.1

## Grade 7 Standards

**7.G.A.1** Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale. *Return to* GM: G-MG.A.3

**7.G.A.2** Draw (freehand, with ruler and protractor, or with technology) geometric shapes with given conditions. (Focus is on triangles from three measures of angles or sides, noticing when the conditions determine one and only one triangle, more than one triangle, or no triangle. *Return to* GM: G-CO.C.10, GM: G-CO.D.12, GM: G-CO.D.13

**7.G.A.3** Describe the two-dimensional figures that result from slicing three-dimensional figures, as in plane sections of right rectangular prisms and right rectangular pyramids. *Return to* GM: G-GMD.B.4

**7.G.B.4** Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle. *Return to* GM: G-GMD.A.1

**7.G.B.5** Use facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to write and solve simple equations for an unknown angle in a figure. *Return to* GM: G-CO.C.9, GM: G-SRT.C.7

**7.G.B.6** Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms. (Pyramids limited to surface area only.) *Return to* GM: G-MG.A.1, GM: G-MG.A.2, GM: G-MG.A.3

**7.SP.C.8** Find probabilities of compound events using organized lists, tables, tree diagrams, and simulation.

a. Understand that, just as with simple events, the probability of a compound event is the fraction of outcomes in the sample space for which the compound event occurs.
b. Represent sample spaces for compound events using methods such as organized lists, tables and tree diagrams. For an event described in everyday language (e.g., "rolling double sixes"), identify the outcomes in the sample space which compose the event.
c. Design and use a simulation to generate frequencies for compound events. *For example, use random digits as a simulation tool to approximate the answer to the question: If 40% of donors have type A blood, what is the probability that it will take at least 4 donors to find one with type A blood?*

*Return to* GM: S-CP.A.1

## Grade 8 Standards

**8.EE.B.6** Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation y = mx for a line through the origin and the equation $y = mx + b$ for a line intercepting the vertical axis at $b$. *Return to* GM: G-GPE.B.5

**8.F.A.3** Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; categorize functions as linear or nonlinear when given equations, graphs, or tables. *For example, the function $A = s^2$ giving the area of a square as a function of its side length is not linear because its graph contains the points (1, 1), (2, 4) and (3, 9), which are not on a straight line*. *Return to* GM: G-GPE.B.5

**8.G.A.1** Verify experimentally the properties of rotations, reflections, and translations:

a. Lines are taken to lines, and line segments to line segments of the same length.
b. Angles are taken to angles of the same measure.
c. Parallel lines are taken to parallel lines.

*Return to* GM: G-CO.A.2, GM: G-CO.A.4,

**8.G.A.2** Explain that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them. (Rotations are only about the origin and reflections are only over the $y$-axis and $x$-axis in Grade 8.) *Return to* GM: G-CO.A.2, GM: G-CO.A.3, GM: G-CO.A.5, GM: G-CO.B.6, GM: G-CO.B.7, GM: G-CO.B.8

**8.G.A.3** Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates. (Rotations are only about the origin, dilations only use the origin as the center of dilation, and reflections are only over the $y$-axis and $x$-axis in Grade 8.)
*Return to* GM: G-CO.A.2, GM: G-CO.A.3, GM: G-CO.A.4, GM: G-CO.A.5

**8.G.A.4** Explain that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them. (Rotations are only about the origin, dilations only use the origin as the center of dilation, and reflections are only over the $y$-axis and $x$-axis in Grade 8.)
*Return to* GM: G-CO.A.2, GM: G-SRT.A.1, GM: G-SRT.A.2, GM: G-SRT.A.3

**8.G.A.5** Use informal arguments to establish facts about the angle sum and exterior angle of triangles, about the angles created when parallel lines are cut by a transversal, and the angle-angle criterion for similarity of triangles. *For example, arrange three copies of the same triangle so that the sum of the three angles appears to form a line, and give an argument in terms of transversals why this is so*. *Return to* GM: G-CO.C.9, GM: G-CO.C.10, GM: G-SRT.A.3

**8.G.B.6** Explain a proof of the Pythagorean Theorem and its converse using the area of squares. *Return to* GM: G-SRT.B.4

**8.G.B.7** Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions. *Return to* GM: G-SRT.C.8

**8.G.B.8** Apply the Pythagorean Theorem to find the distance between two points in a coordinate system. *Return to* GM: G-GPE.A.1, GM: G-GPE.B.4. GM: GPE.B.7

**8.G.C.9** Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.
*Return to* GM: G-GMD.A.3, GM: G-MG.A.2, GM: G-MG.A.3

## Algebra I Course Standards

**A1: A-REI.B.4** Solve quadratic equations in one variable.

a. Use the method of completing the square to transform any quadratic equation in $x$ into an equation of the form $(x - p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.
b. Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as “no real solution.”

*Return to* GM: G-GPE.A.1

**A1: F-BF.B.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). Without technology, find the value of $k$ given the graphs of linear and quadratic functions. With technology, experiment with cases and illustrate an explanation of the effects on the graph that include cases where *f(x)* is a linear, quadratic, piecewise linear (to include absolute value) or exponential function.
*Return to* GM: G-CO.A.2

**A1: S-ID.B.5** Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data. *Return to* GM: S-CP.A.4