



BALDWINSVILLE
PUBLIC LIBRARY



**Common Core
Geometry Booklet**

Volume I: revised



By

Robert F. Loftus, MSLIS



Introduction

This booklet employs a very linear approach to the Common Core Geometry standards. Each standard is presented in the same order and language used in the New York State p-12 Common Core Learning Standards for Mathematics, which were published by the New York State Education Department. Interpretive paragraphs and examples are offered, along with links to instructional materials.

The Common Core Learning Standards are arranged into *Conceptual Categories, Domains, Clusters, Standards*, and sometimes *Standards components*. This is a hierarchical sorting system. You may remember the mnemonic from high-school: “Kings play chess on funny green squares”; with the “funny green squares” referring to the family, genus and species of a particular animal. In the Common Core learning standards, Domains, Clusters and Standards are your funny green squares, or -more directly- Domains are to Clusters and Standards as Family is to Genus and Species.

The *Appendix: Resources* section provides explanations of how to use resources from websites cited in this document, all of which are Open Source or Public Domain sites that do not require a subscription. Some of the textbooks cited are older, but algebra -as taught at the high-school level- has not changed significantly in the last 100 years, and carefully selected passages from older textbooks can still be very helpful. Where possible, links to variety of instructional materials are offered to meet the learning needs of different students. It isn't necessary for a student to work through every link, but the student should keep working through the materials until they are confident they've mastered the standard concept.

This guide covers the *Congruency* and *Right Triangles and Trigonometry* domains of the Common Core standards. Later standards addressing properties of circles, Geometric measurement and modeling will be addressed in Volume 2. All of the material addressed in this guide coincides with the selection of content outlined in the *State University of New York Educator's Guide to the Regents Examination in Geometry*. You will also notice some minor variations in how some of the standards are labeled when reviewing linked material. The suffixes used to label standards vary by state, but the overall content structure remains constant.

Each section includes a *Conceptual Category* (shown centered and underlined in 14 pt type), a *Content Domain* (left-justified, Bold 14 pt type), the relative *Clusters* (12 pt bold text) and the *individual standards* (numbered alpha-numerically in the format “x-x.x”), some entries also include standard components, which are labeled with “a, b, c, etc...” Explanatory language and links to online resources follow the individual standards.

PDF copies of this study guide are available from the Baldwinsville Public Library website at:

http://www.bville.lib.ny.us/content/pdf_handouts/CCGeomV1revised.pdf

Writing a study guide like this will always involve some amount of trial and error. Although I have done my best to ensure accuracy, the reader may occasionally encounter small errors in the text, or be aware of other examples or materials which may be more effective. I am eager to hear from both math educators and students who have suggestions on how to improve this text. Please direct your comments to the author's e-mail at: robertl@bville.lib.ny.us

Thank You,

Robert F. Loftus, MSLIS

April 10th, 2015

Congruency

G-CO.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.

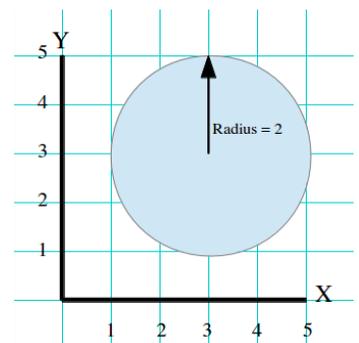
This is simply an understanding of the vocabulary of Geometry, so here's a list of definitions and examples.

Geometry: Merriam-Webster defines Geometry as: “a branch of mathematics that deals with points, lines, angles, surfaces, and solids.” The term *plane geometry* refers to the geometry of shapes, two-dimensional objects that can be drawn on a flat piece of paper. *Solid geometry* refers to the geometry of three-dimensional objects. *Analytic geometry* refers to figures that exist in a coordinate plane. *Analytic plane geometry* refers to figures that appear on a graph, and *analytic solid geometry* refers to figures that have depth and which are described on a three dimensional -often referred to as the “xyz-axis”, such as you might see on the screen of a 3D CAD program.

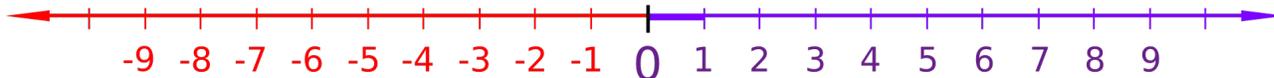
Congruency: Congruent figures are those which have the same shape, meaning you can lay one over the other, and they will appear identical.

Angle: The space -usually measured in degrees or radians- between two intersecting lines.

Circle: Circles are defined as round figures where all points along the perimeter are equidistant from the center of the figure. In the example at the right, you can see how the radius of the circle is denoted by a ray with a distance equal to two units. All points along the perimeter of that circle will be exactly 2 units distance from the center.



Distance along a line: A distance along a line is a measurement that's taken between two points that exist along a line. One of the easiest ways to think of distance along a line is to think of a number line. Imagine that each number on the line represents a value along your x or y axis. Length is found by subtracting the value to the right from the value to the left, or $x' - x$, so to get the length from 9 to -9 you would subtract $9 - (-9) = 18$. To find the length of a diagonal line on a graph, you sketch a right-triangle, then use the pythagorean theorem: $a^2 + b^2 = c^2$.



Distance around a circular arc: This is a measurement of a portion of the perimeter of a circle.

In the example at the top of the next page, the area described by the two rays has an interior angle of 90 degrees, and a radius of 2 units. The formula for the circumference of a circle equals $2\pi r$; since $r = 2$, then $2\pi(2) = 4\pi$, and since 90° equals $\frac{1}{4}$ of the circle, then the arc length = π .

Line: A line is defined as “an endless length without breadth”. In Geometry a line is considered to extend into infinity, but to have no width. Again, this is counter to the depictions of lines you may draw in class, which must have width in order to be visible, and where you are only graphing a tiny little portion of the line.

Line Segment: A line segment is a portion of a line.

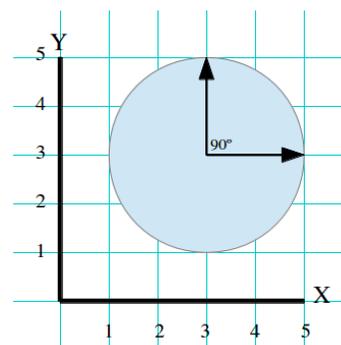
Perpendicular lines: Perpendicular lines are two lines that intersect each other at exactly 90 degrees.

Parallel lines: Parallel lines are two lines that have the exact same orientation, so that they are always the same distance from each other, and never intersect.

Point: A point has no dimension, only position. In Geometry points and lines are somewhat theoretical in nature, any representation you create of a point will have some height or width, otherwise it would be invisible to you, but when we are graphing figures, we act as if that point occupies no physical space.

Online resources related to this standard:

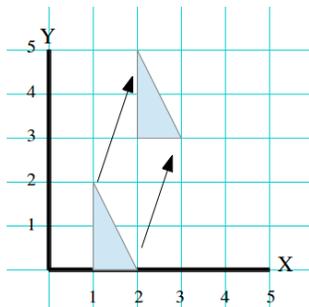
- **Wentworth's Plane Geometry:** Pages 1 through 7 offer a comprehensive treatment of a number of Geometric terms.
<https://archive.org/details/wentworthsplaneg00wentrich>
- **CK12.org:** HSC.GO.A.1
<http://www.ck12.org/ccss/high-school:-geometry/congruence>
- **Khan Academy:** Geometric Definitions
https://www.khanacademy.org/math/geometry/intro_euclid/e/geometric-definitions



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

A transformation is any movement that changes the shape or location of a figure. Transformations include translations (also called “slides”), rotations, reflections and stretches. A translation or slide is a movement of a figure across the coordinate plane. You translate a figure by adding a constant value to all of the x-coordinates, and another constant value to all of the y-coordinates of a figure. In the example you see below, there is a triangle that's translated 1 space to the right, and 3 spaces upward.

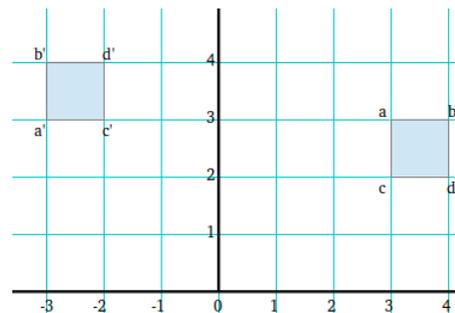
If the coordinates of each point are represented by (x, y) , then the translation of each coordinate will be $(x + a, y + b)$. In the example above, $a = 1$, and $b = 3$.



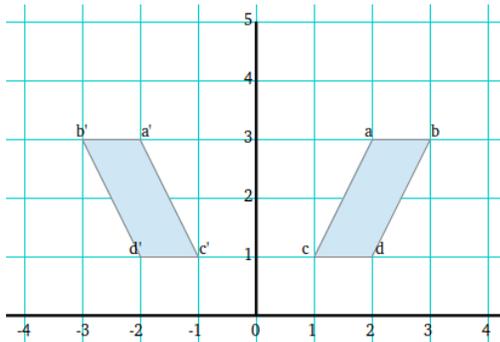
(x, y)	$x + a$	$y + b$	$(x+a, y+b)$
(1,2)	$1 + 1$	$2 + 3$	(2, 5)
(2,0)	$2 + 1$	$0 + 3$	(3, 3)
(1,0)	$1 + 1$	$0 + 3$	(2, 3)

Another form of transformation is a rotation, which is when a figure rotates around the origin. The following table includes the transformations of coordinates to achieve rotations in intervals of 90° .

90° rotation	$(x, y) = (-y, x)$
180° rotation	$(x, y) = (-x, -y)$
270° rotation	$(x, y) = (y, -x)$



This example shows a 90 degree rotation of a square. Notice how the coordinates of each figure match the patterns described in the table at the right.



Reflections are copies of a figure reflected across either the X or Y axis. To reflect a figure across the y-axis multiply all of the x-values for coordinates by -1. To reflect a figure across the x-axis, multiply all the y-coordinates of a figure by -1. Once again, you can see how this works by comparing the coordinates of the original figure to the coordinates of the reflected figure -which is marked with an apostrophe after each letter.

Reflections and rotations are both examples of transformations that preserve symmetry. Preserving symmetry means that the size of the figure, the ratios of sides and interior angles are all preserved, so that the original figure, and the transformed figure are congruent. Not all transformations preserve congruency. Horizontal and vertical stretches are examples of transformations that do not preserve congruency.

x	y	(2x, 2y)
1	0	(2,0)
2	0	(4,0)
1	2	(2,4)

In this example, we'll create a dilation, which stretches the figure horizontally and vertically by multiplying all of the coordinates of the figure by 2. The

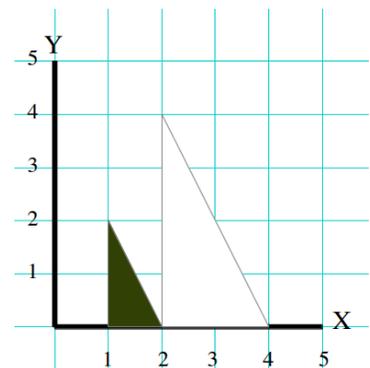


figure will move to the right, and be stretched to twice it's original height and width. Begin this process by creating a table of values, which includes the original x and y coordinates of the figure, along with a third column which shows transformed coordinates. You can see the effects of this dilation by graphing out the coordinates in the (2x, 2y) column. If the figure originally appeared to the left of the Y-axis, it would have stretched farther to the left. If the y-coordinate of the two lowest points of the triangle had been above the x-axis, the figure would have appeared vertically higher on the graph, etc.

http://Online resources related to this standard:

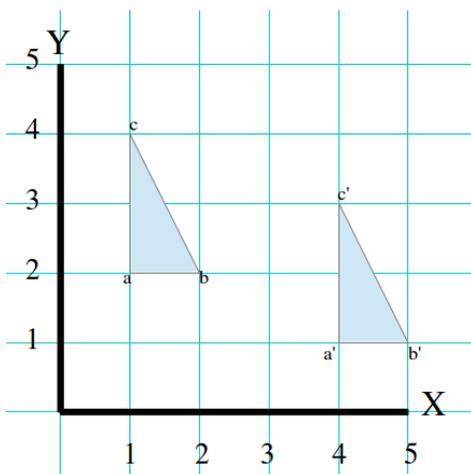
- **CK12.org:**
<http://www.ck12.org/geometry/Geometric-Translations/lesson/Geometric-Translations/>

- **Khan Academy:**

<https://www.khanacademy.org/math/geometry/transformations>

G-CO.3: Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.

This standard is very closely related to the last one. In G-CO.2 you were given sets of coordinates, asked to apply a translation, and then asked to graph the translation of the original figure. In this standard, you're given two figures on a coordinate plane, and asked to recognize the translations required to create the second figure. The key to mastering this standard is to practice creating rotations and reflections of figures, until you reach the point where you can observe two figures on the coordinate plane, and recognize the rotations and reflections that are necessary to move the figure from its original position to its new position.



In the example at the left, $\Delta a'b'c'$ is a translation of Δabc . If we compare the coordinates of a versus a' , b versus b' and c versus c' , we can look at the common differences, and surmise the translation that was applied.

	x	y	x'	y'	Common Difference
a	1	2	4	1	(+3, -1)
b	2	2	5	1	(+3, -1)
c	1	4	4	3	(+3, -1)

By comparing the differences between the original coordinates, and the coordinates of the translated figure, we can see immediately that a Slide was applied, and that slide had a value of 3 steps to the right, and 1 step down, or (+3, -1). With practice, you'll be able to recognize what transformation was applied just by looking at a figure, and creating a table of x and y values will be your process for checking whether or not your first impression was correct.

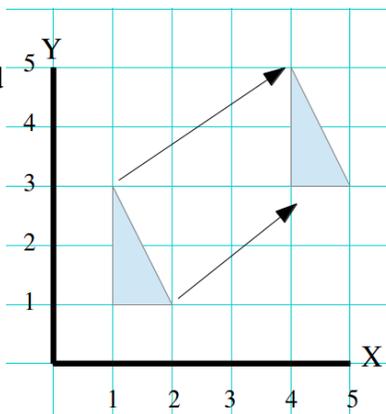
Online resources related to this standard:

- **CK12.org: Work through the reading sections and videos**
<http://www.ck12.org/geometry/Composition-of-Transformations/>
- **Khan Academy:**
<https://www.khanacademy.org/math/geometry/transformations/exploring-rigid-transformations/v/determining-a-translation-for-a-shape>

G-CO.4: Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.

In G-CO.3 you were asked to describe the series of transformations involved in moving a figure across the coordinate plane. This standard extends that process by asking you to describe your reasoning for the answer you give. To put that more plainly: This standard asks you to be able to state “This transformation is a <name the type of transformation> because....<give your reasoning for that answer>. Look at the example on the top of the next page; here we see a (+4, +2) *slide*, and you need to create an argument to support your choice of that answer.

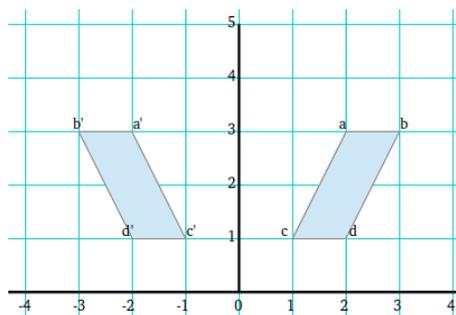
A mnemonic to help remember this standard is the name “AMOS”, which stands for “Angles, Movement, Orientation and Sides. Use AMOS to compare two figures, then compare the characteristics of the transformation to definitions of different types of transformations. *Angles* refers to the internal angles of the figure. In this case, it appears that the figure has consistent angles – it has not been skewed or stretched, which is consistent with the definition of a slide. *Movement* refers to how far like points of the figure have traveled across the coordinate plane. If



you mark the first triangle with the letters a , b and c , with a correlating to the right angle at the base of the triangle and proceeding clockwise, then mark the second figure as a' , b' and c' , also with a' correlating to the right angle at the base of the triangle and proceeding clockwise, then you will see that common points on the second figure have moved 4 units to the right, and 2 units upward, which is also consistent with a slide. *Orientation* refers to how the figure relates to the X and Y axes. In this case, the shortest side of both figures is parallel to the x-axis, and the longest side of both figures is parallel to the y-axis, indicating that there hasn't been any change

in orientation. “Sides” refers to the length of the sides of the figure. If you'd marked the sides a , b , c and a' , b' and c' as mentioned above, you'd see that \overline{ab} and $\overline{a'b'}$ both equal 2 units, \overline{bc} and $\overline{b'c'}$ both equal $\sqrt{3}$, and lines \overline{ca} and $\overline{c'a'}$ both equal one unit. Equality of like sides of both figures is also consistent with a slide. Because our angles, orientation and sides are all equal, it means the two figures are congruent, and slides preserve congruency. Since the only change is in the location of the figure -our movement- we can say that this is definitely an example of a slide. Because the figure has moved 4 units to the right, and 2 units up, we say it's a “(+4, +2) slide.

One other element to remember when dealing with this standard is that when dealing with reflections or rotations, like points on two figures will be equidistant from the origin. Using the example at the left of a y-axis reflection, inspection of the graph will show that (the “o” in the line name indicates the origin, where $x=0$ and $y=0$) $\overline{ao} = \overline{a'o}$, $\overline{bo} = \overline{b'o}$, $\overline{co} = \overline{c'o}$, etc. If the distance from the origin to like points of a figure are not equal, then you're looking at a combination of two transformations.



Online resources related to this standard:

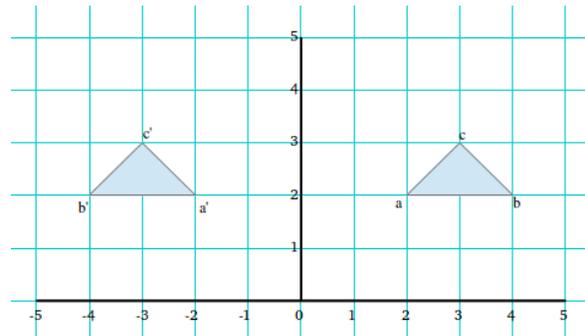
- **CK12.org:**
<http://www.ck12.org/geometry/Basic-Geometric-Definitions/>
- **Khan Academy:**
<https://www.khanacademy.org/math/geometry/transformations/exploring-rigid-transformations/v/translations-of-polygons>

G-CO.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.

The language of this standard is pretty clear. An example of a problem related to standard would read: “Look at the figure in the example at the right. Use the definition of a reflection to graph that figure reflected across the y-axis.” Looking back at GCO-1, we see that to reflect a figure across the y-axis you multiply all of the figures x-coordinates by -1. The first

step to graphing a reflection of this figure is to label each coordinate, create a table of values, then graph the transformed figure.

x and y coordinates		
	(x, y)	(-x, y)
a	(2, 2)	(-2, 2)
b	(4, 2)	(-4, 2)
c	(3, 3)	(-3, -3)



Here is the original figure, plus it's reflection. Inspect the coordinate plane to find the coordinates.

Use the pythagorean theorem to compare the distance of common points (a and a', b and b', c and c') from the origin. As a recap, the process for graphing a transformation is to:

1. Create a table of values showing the x and y coordinates of the original figure, and describing the pattern of changes to apply to those coordinates
2. Fill out that table, then graph the new coordinates from your table of values

Online resources related to this standard:

- **CK12.org:** Work through the exercises and critical thinking sections
<http://www.ck12.org/geometry/Composition-of-Transformations/>
- **Khan Academy:**
<https://www.khanacademy.org/math/basic-geo/transformations-congruence-similarity-geo/copy-of-transformations-congruence-similarity/v/rotating-segment-about-origin-example>

G-CO.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.

This standard is essentially identical to the last one, except instead of being shown a figure and its reflection, you are given an original figure and required to create the transformed figure. The student is also asked to create a “congruence statement”, to determine if the transformed figure is congruent to the first. In the example below you have a triangle, and are asked to draw the triangle rotated 90° about the axis. First, we create a table of values, and fill out our first two columns with the points of the triangle, and their original coordinates, then (looking back at G-CO.1) we see that the pattern for creating a 90° rotation is $(-y, x)$, so we fill out the final column with those values.

90° rotation		
<i>point</i>	(x, y)	(-y, x)
a	(1, 1)	(-1, 1)
b	(4, 1)	(-1, 4)
c	(3, 3)	(-3, 3)

Remember that when graphing this kind of equation, the expression $(-y, x)$ is used to show how to move values around, so the value of $(-1, 1)$ for a in the transformed figure is $(-1, 1)$ on the coordinate plane, and does not mean that the coordinates were written down in the wrong order.

Try graphing the original, and rotated coordinates on a piece of graph paper to see how the figure changes, then work through the processes presented in the ck12.org link below to create a congruence statement.

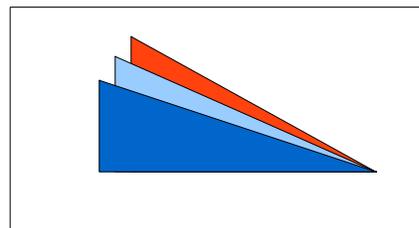
Online resources related to this standard:

- **CK12.org:**
<http://www.ck12.org/geometry/Congruence-Statements/>
- **Khan Academy**
<https://www.khanacademy.org/math/geometry/congruent-triangles>

G-CO.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.

Remember how in a previous standard you used the name “AMOS” as a mnemonic for remembering the process to tell if two figures are congruent? In this standard, you're referring specifically to triangles, and you're only using internal angles, and the lengths of sides. Trigonometry is the part of geometry that deals specifically with triangles. In trigonometry, you'll deal with Sins, Cosines and Tangents, all of which are ratios of the lengths of the sides of a triangle. This standard is a precursor to dealing with sin, cosine and tangent problems. If the lengths of all three sides of a triangle are equal, and the angles inside the triangle are equal, then those triangles are congruent.

In Geometry you'll deal with several methods of establishing the congruence of triangles: those methods are *Side-Side-Side* (labeled as “SSS”), *Side-Angle-Side* (SAS), *Angle-Side-Angle* (ASA), *Angle-Angle-Side* (AAS). As an aide in thinking about triangle congruence, look at the image on the right. As the length of any side of a triangle changes, the internal angles of that triangle change as well. In the image at the right, you can see how as the left side of the triangle becomes longer, the shape of the triangle changes. You cannot change the lengths of the sides of a triangle without changing the interior angles as well, and that is why it's possible to create congruence statements based upon sides and angles. All of the methods you see listed above: SSS, SAS, ASA, AAS, represent the minimum amount of information necessary to prove that two triangles are congruent.



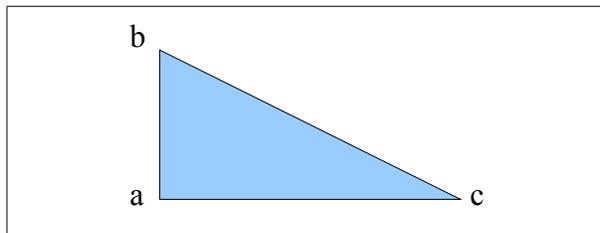
Online resources related to this standard:

- **CK12.org: Triangle Congruence**
<http://www.ck12.org/geometry/HL-Triangle-Congruence/>
- **Khan Academy: Triangle Congruence**
https://www.khanacademy.org/math/geometry/congruent-triangles/cong_triangle/v/congruent-triangles-and-sss

G-CO.8: Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.

The definition of congruence in rigid motions states that if it's possible to lay one figure over another so that they overlap perfectly (think of AMOS again – congruency requires that you be able to identify a series of Movements to lay one figure over another so their angles, sides and orientation are clearly identical.) As mentioned in the prior standard, ASA, SAS and SSS congruence represent the minimum information necessary to prove that two triangles are congruent. All triangles have interior angles that add up to 180° , and all triangles have three sides that are joined at their ends, so you cannot change the length of a side, or the measure of an internal angle without changing the characteristics of that triangle. All of the forms of congruence are precursors to problems involving sines, cosines and tangents that you will encounter later when you study trigonometry.

Angle-Side-Angle congruence states that if you know what two adjacent angles of a triangle are, and you know how long the length between those two angles are, then you can determine the form of that triangle. Look at the example at the right. IF you know the measure of $\angle a$ and $\angle b$, then you also know the measure of $\angle c$, because the internal angles of a triangle always equal 180° , so



$$m\angle c = 180^\circ - (m\angle a + m\angle b)$$

The “m” symbol in the above equation stands for “measure in degrees”. Since having two angles of a triangle effectively means you have all three, that means that having the additional side gives you all key characteristics of that triangle, as the *sin*, *cosine* and *tangent* values of an angle are based on the relationships of the sides.

Side-Angle-Side works on the same principles. Look at the graphic again and think about the measure of $\angle a$. If you know the measure of that angle, and you know the length of \overline{ab} and \overline{ac} , and \overline{bc} closes the triangle, then you have the information you need to define the figure. You cannot change the angle of connection, or the length of line \overline{bc} without failing to connect the sides of the figure.

Side-Side-Side congruence is based on the fact that changing the length of any one side

of a triangle will necessitate changing the length of at least one other side or at least two interior angles. Again, you can visualize this by looking at the example: if you increase the length of \overline{ab} , then either $\angle a$ has to change, or \overline{bc} has to become longer to connect the sides of the figure. If you look at the other sides of the triangle, you see this applies to all of the sides. Again, this relates to properties of sines, cosines and tangents that you will study in later chapters.

Online resources related to this standard:

- **CK12.org:**
<http://www.ck12.org/geometry/ASA-and-AAS-Triangle-Congruence/>
<http://www.ck12.org/geometry/SSS-Triangle-Congruence/>
- **Khan Academy: Congruent Triangles 2**
https://www.khanacademy.org/math/geometry/congruent-triangles/cong_triangle/e/congruent_triangles_2

Prove geometric theorems

G-CO.9: Prove 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.

You've seen examples in textbooks where a problem is worked out in a stepwise fashion, and each step includes a brief bit of text describing why that step was taken. A geometric proof is basically the same thing. You will be given a geometric figure along with several pieces of information and asked to prove some characteristic of that figure. You proceed by comparing the information you have to various Geometric Theorems and Postulates. You are supporting your reasoning for each step in the process of answering a problem by citing work that others have done before, just like when you add a citation to a research paper. A list of Geometric Theorems and Postulates that you can use to assist you in creating proofs may be found here:

<http://www.regentsprep.org/regents/math/geometry/gpb/theorems.htm>

When looking at reference materials, you will often see this method referred to as “two-column proofs”, because just like you see in the textbook, there's one column showing a series of markings applied to the figure, and another showing the reasoning for each step in the proof process.

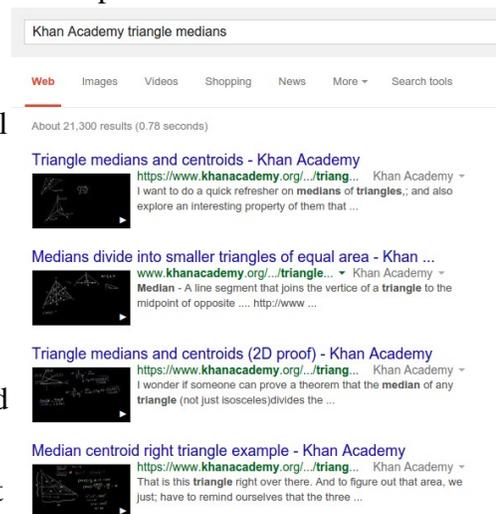
Online resources related to this standard:

- **CK12.org: Geometric proofs**
<http://www.ck12.org/geometry/Two-Column-Proofs/>
- **Khan Academy: Line and angle proofs**
https://www.khanacademy.org/math/geometry/parallel-and-perpendicular-lines/ang_intro/e/line-and-angle-proofs

G-CO.10: Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180° ; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.

As mentioned in the last standard, when writing a proof you're simply giving an answer for each step in the process of answering a problem, then describing your reasoning and citing postulates and theorems to back up that reasoning. You can find proofs of theorems and postulates by searching online. Khan Academy and CK12.org, the two sites referred to throughout this series of study guides, are both excellent sources of instructional content.

At the right is a list of results that appeared after Googling the search string “Khan Academy triangle medians”. As you can see, the list of results includes a variety of materials that all relate to the last theorem listed in this standard. You can use this same method to find Khan Academy or CK12 resources about other topics that



you encounter in school. Just make sure that you specify a particular source -either Khan Academy, CK12, or another site that's recommended by a teacher or tutor, to avoid ending up with a list of answers from people who want to sell you Common Core instructional books, apps and CDs.

- **CK12.org: Properties of triangles**
<http://www.ck12.org/book/CK-12-Foundation-and-Leadership-Public-Schools,-College-Access-Reader:-Geometry/section/3.0/>
 - **Khan Academy: Congruent Triangles**
<https://www.khanacademy.org/math/geometry/congruent-triangles>
-

G-CO.11: Prove 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.

There are numerous resources online to prove theorems about geometry, and high quality websites such as Khan Academy, CK12 and EngageNY are helpful

One key to remember when dealing with this standard is that the definition of a figure is a viable reason for making a statement in a proof. Students sometimes overlook this, thinking that it seems too simple, but if a problem states -for example- that a figure is a rhombus, then you can automatically state that all four sides of the figure are of equal length, and that opposite sides of the figure are parallel, because those are the conditions stated in the definition of a rhombus.

Also remember that doing proofs is similar to adding citations to a research paper. Writing a geometric proof is the process of taking information about a figure that's given to you in the problem, using that information to deduce additional information about that figure, then supporting your answer by referring to postulates and theorems that are known to be true.

Online resources related to this standard:

- **CK12.org: Quadrilaterals that are parallelograms**
<http://www.ck12.org/geometry/Quadrilaterals-that-are-Parallelograms/lesson/user:ZGF3bi5zdGVyemluZ2VyQG1hcnNoYWxsLmsxMi5tbi51cw./Quadrilaterals-that-are-Parallelograms-Workbook/>

- **CK12.org: Parallelogram classification**
<http://www.ck12.org/geometry/Parallelogram-Classification/lesson/user:ZGV2aW4ub25rc3RAZmF5ZXR0ZS5reXNjaG9vbHMudXM./Theorems-about-Quadrilaterals/>
 - **CK12.org: Parallelograms in the coordinate plane**
<http://www.ck12.org/geometry/Parallelograms-in-the-Coordinate-Plane/studyguide/user:cmF5bmEuc2NobG9zc2JlcmdAZ21haWwuY29t/Parallelograms-in-the-Coordinate-Plane/>
 - **CK12.org: Properties of parallelograms**
<http://fileserv.net-texts.com/asset.aspx?dl=no&id=56269>
 - **Khan Academy: Quadrilaterals and Polygons**
<https://www.khanacademy.org/math/geometry/quadrilaterals-and-polygons>
 - **RegentsPrep.org: Theorems dealing with parallelograms**
<http://www.regentsprep.org/regents/math/geometry/gp9/lparallelogram.htm>
-

Make geometric constructions

G-CO.12: Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). 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.

In geometry, the term “Construction” means to create an accurate visual depiction of a figure. As this standard includes a wide range of activities, there are a variety of links that you can follow on this page that address the tasks named in the standard. This guide will focus on creating constructions using pencil, ruler and compass, as using physical objects, or geometry software is specific to the instructor and the classroom environment.

The resources listed below include instructions on how to create various constructions.

- **CK12.org: Bisectors of line segments and angles**
<http://www.ck12.org/geometry/Bisectors-of-Line-Segments-and-Angles/lesson/user:ZGV2aW4ub25rc3RAZmF5ZXR0ZS5reXNjaG9vbHMudXM./Bisectors-of-Line-Segments-and-Angles/>
 - **CK12.org: Parallel and perpendicular line constructions**
<http://www.ck12.org/geometry/Parallel-and-Perpendicular-Line-Constructions/lesson/Parallel-and-Perpendicular-Line-Constructions/r6/>
 - **Khan Academy: Geometric Constructions**
<https://www.khanacademy.org/math/geometry/geometric-constructions>
 - **Wentworth's Plane Geometry: This is a highly recommended textbook which has been in use for over 100 years. Students may want to print out pages 1 - 12 to keep as a reference booklet.**
<https://archive.org/details/wentworthsplane00wentrich>
-

G-CO.13: Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

As with the last standard, constructions refer to the creation of accurate depictions of figures. Incribing a regular polygon such as a equilateral triangle or a regular hexagon may be following a simple process:

Use a compass to draw a circle.

Count up the number of vertices in a figure, an equilateral triangle has 3, and a regular pentagon has 5

Divide 360 by v , where v equals the number of vertices. In the case of an equilateral triangle you have 3 vertices, so $360^\circ \div 3 = 120^\circ$. A square has 4 vertices so the intervals are 90° each. A pentagon has 5 vertices so you get 72° . For a regular hexagon the intervals are 60° .

Use a protractor to mark off the angle intervals around the perimeter of your circle. Because the number of degrees of difference are equal, all of the points will be equidistant from each other around the perimeter of the circle.

Use a straight-edge to connect all of the points that you marked along the perimeter of the circle.

Online resources related to this standard:

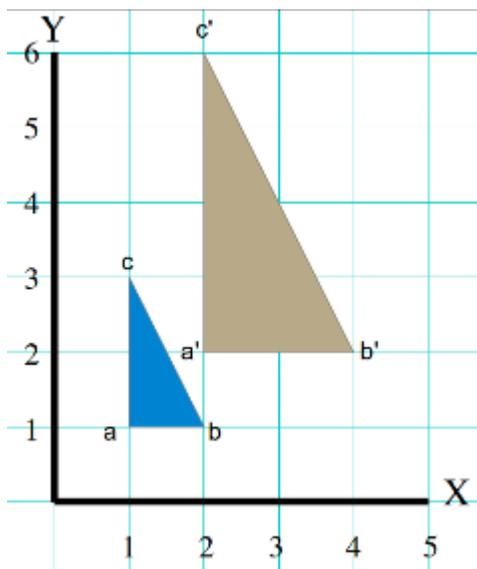
- **CK12.org: Inscribed and circumscribed circles of triangles**
<http://www.ck12.org/geometry/Inscribed-and-Circumscribed-Circles-of-Triangles/?by=all&difficulty=all>
- **CK12.org: Inscribed quadrilaterals in circles**
<http://www.ck12.org/geometry/Inscribed-Quadrilaterals-in-Circles/>
- **Khan Academy: Inscribed and central angles**
<https://www.khanacademy.org/math/geometry/cc-geometry-circles/central-inscribed-circumscribed/v/inscribed-and-central-angles>

Similarity, Right Triangles, & Trigonometry

Understand similarity in terms of similarity transformations

G-SRT.1: Verify experimentally the properties of dilations given by a center and a scale factor

In the G-CO standards you dealt with figures that are congruent. Congruent refers to figures that have the same size and shape. Figures that are similar have the same shape, but may be of different sizes. A dilation is when a figure is multiplied by a scale factor that will increase or decrease the size of the figure. Dilation factors of greater than 1 make the figure larger, while dilation factors of less than 1 make the figure smaller. You can perform a dilation by multiplying all of the coordinates of a figure by a scale factor.



In the example shown here you can see two figures: Δabc is our original figure, and $\Delta a'b'c'$ is that original figure, multiplied by a factor of 2.

Δabc	$\Delta a'b'c'$
a (1, 1)	a' (2, 2)
b (2, 1)	b' (4, 2)
c (1, 3)	c' (2, 6)

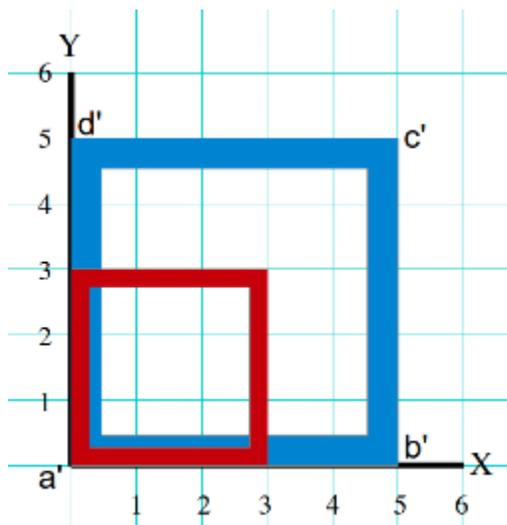
When you are creating figures on the coordinate plane, your “center” is the origin of the graph, and not the center of your figure. The reason that the dilation caused the figure to move up and to the right, is because the coordinates nearest to the origin were also multiplied by a factor of two, along with all the other points on the figure. Dilations are sometimes referred to as *scaling around a point*, because all changes to the figure are relative to the origin of your coordinate plane, and not the centerpoint of the figure.

Online resources related to this standard:

- **CK12.org: Dilation in the coordinate plane**
<http://www.ck12.org/geometry/Dilation-in-the-Coordinate-Plane/>
- **Khan Academy: Dilations or scaling around a point**
<https://www.khanacademy.org/math/geometry/transformations/dilations-scaling/e/dilations>

G-SRT.1a: 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.

You create a dilation by multiplying all of the points in a figure by a common factor. One of the results of this multiplication is that the space that exists between the edges of the figure is also increased by that common factor, so dilations will often cause figures to move farther away from the origin. Because any number multiplied by zero equals zero, when one or both of the coordinates of a figure are along the x or y axis, the new coordinates of that figure will remain along the axis. An illustration will make this concept easier to comprehend.



In the illustration to the left, the original figure abcd (in red) has the following coordinates:

a	(0, 0)
b	(3, 0)
c	(3, 3)
d	(0, 3)

In the expanded figure a'b'c'd' -in blue- all of those coordinates have been multiplied by a factor of $\frac{5}{3}$.

a'	(0, 0)
b'	(0, 5)
c'	(5, 5)
d'	(0, 5)

but since any number multiplied by 0 equals 0, that means that all of the coordinates that lay along either the x or y axis will still have a coordinate value of zero. Points c and c', which reside at (3, 3) and (5, 5) are an example of a point that moves farther away from the axis when the scale factor is applied.

You can observe the same phenomena when you look at the individual line segments that

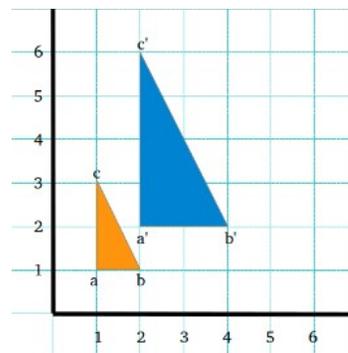
make up the figure. Lines \overline{ab} and $\overline{a'b'}$ are both horizontal lines with a slope intercept form of $y = 0$. Line \overline{bc} is a vertical line with slope intercept form $x = 3$, and line $\overline{b'c'}$ is a vertical line with slope intercept form of $x = 5$.

Online resources related to this standard:

- **CK12.org: Dilation**
<http://www.ck12.org/geometry/Dilation/>
- **Khan Academy: Dilating one line onto another**
<https://www.khanacademy.org/math/geometry/transformations/dilations-scaling/v/dilating-one-line-onto-another>

G-SRT.1b: The dilation of a line segment is longer or shorter in the ratio given by the scale factor.

When you multiply a figure in the coordinate plane by a scale factor, the size of the figure increases according to the ratio of the scale factor. In the example at the right, $\Delta a'b'c'$ is a dilation of Δabc . The scale factor of this dilation is 2. To see how the change in coordinates is applied, we'll look at a table of values for this figure:



Δabc	$\Delta a'b'c'$
a (1, 1)	a' (2, 2)
b (2, 1)	b' (4, 2)
c (1, 3)	c' (2, 6)

If you compare the lengths of line segments in the two figures, you can see how all of the line segments in the dilated figure are twice the length of the similar line segments in the original figure.

- $\overline{ab} = 1$ and $\overline{a'b'} = 2$

- $\overline{bc} = \sqrt{5}$ and $\overline{b'c'} = 2\sqrt{5}$
- $\overline{ca} = 2$ and $\overline{c'a'} = 4$

This corresponds to the fact that we applied a dilation factor of 2 to the original figure. Any time that you dilate figures in the coordinate plane, this similarity in the length of line segments will apply.

Online resources related to this standard:

- **CK12.org: Dilation of geometric shapes**
<http://www.ck12.org/book/CK-12-Algebra-I-Honors/r5/section/10.4/>
- Khan Academy: Comparing side lengths after dilations
<https://www.khanacademy.org/math/geometry/transformations/dilations-scaling/v/comparing-side-lengths-after-dilation>

G-SRT.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.

The definition of similarity for two dimensional figures is that “two figures are similar if they have the same shape, or if they are similar to a mirror image of each other. Sameness of shape may be established either by the two figures having the same order and measure of interior angles, or because the lengths of all sides of the figure are multiples of a common factor.”

Similarity transformations are those that preserve the shape of a figure. Similarity transformations include all of the congruency transformations plus dilations. Remember that when dealing with transformations, all congruent figures are similar, but not all similar figures are congruent.

In the *G-SRT.1* standard, you saw how when a figure is multiplied by a scale factor, then all of the sides of that

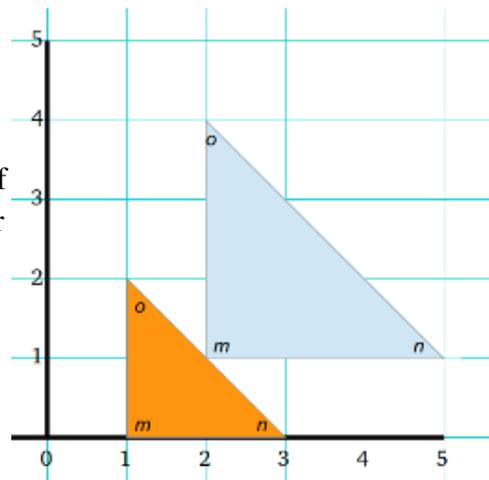


figure will be increased by the ratio of the scale factor. As long as all of the sides of the image are increased by the same ratio, then the dilated figure is similar to the original figure. You will learn to verify this property in greater depth when you get to the study of sines, cosines and tangents.

If the interior angles of two triangles are identical, then those triangles must be either congruent or similar. If the two triangles have the same side lengths they are congruent, if all side lengths are multiples of a common ratio they are similar.

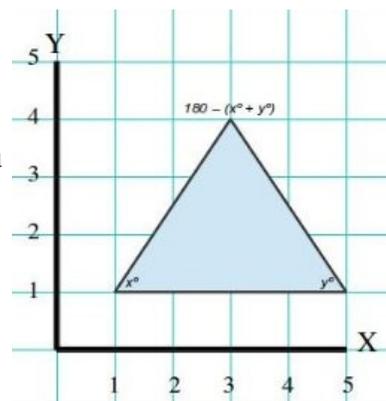
In the example at the right, since the angles in both figures are of the same order and measure, the two characters are similar, even if they are obviously of different sizes.

Online resources related to this standard:

- **CK12.org: Similar polygons and scale factors**
<http://www.ck12.org/geometry/Similar-Polygons-and-Scale-Factors/>
- **Khan Academy: Similar triangle basics**
<https://www.khanacademy.org/math/algebra-basics/core-algebra-geometry/copy-of-triangle-similarity/v/similar-triangle-basics>

G-SRT.3: Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.

Two triangles are similar if they have the same order and measures of interior angles. The *Triangle Sum Theorem* states that the interior angles of a triangle will always equal 180° , if you are given any two angles of a triangle you can always find the measure of the third angle by subtracting the sum of the first two angles from 180° . Where the two angles provided are x° and y° , you can always find the measure of the third interior angle of a triangle by: $180^\circ - (x^\circ + y^\circ)$.



- The sum of the interior angles of a triangle will always equal 180° .

- If two triangles both have two interior angles (represented here by x and y) that are equal, then the third must also be equal to $180^\circ - (x^\circ + y^\circ)$
- Any two triangles that have interior angles with the same measure are similar.

Online resources related to this standard

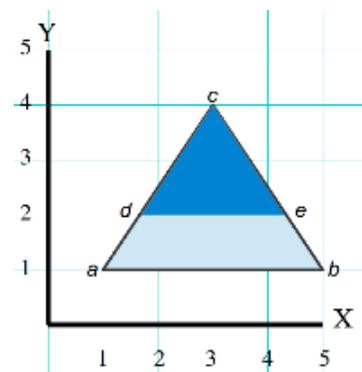
- **CK12.org: Triangles AA similarity**
<http://www.ck12.org/geometry/AA-Similarity/>
- Khan Academy: Triangle similarity postulates
<https://www.khanacademy.org/math/algebra-basics/core-algebra-geometry/copy-of-triangle-similarity/v/similarity-postulates>

Prove theorems involving similarity

G-SRT.4: Prove 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.

There are numerous standards related to similarity of triangles. We'll start with the two that are mentioned in the standard text, and additional theorems will be discussed in the CK12 and Khan Academy links. Please note that the prior standard: G-SRT.3 already referred to the *Triangle Sum Theorem*, which states that the interior angles of a triangle will always have a sum of 180° .

A line parallel to one side of a triangle divides the other two proportionally. In the example to the right, \overline{ab} and \overline{de} are parallel. Because those two lines are parallel, that means that $\triangle abc$ is similar to $\triangle dec$. Remember that similarity of these two triangles means they have the same measure of interior angles, and the same ratio of side lengths.



Online resources related to this standard

- **CK12.org: Triangle theorems involving similarity**
<http://www.ck12.org/book/CK-12-Geometry-Honors-Concepts/section/6.6/>.
 - **Khan Academy: Pythagorean theorem proof using triangle similarity**
<https://www.khanacademy.org/math/basic-geo/basic-geo-pythagorean-topic/basic-geo-pythagorean-proofs/v/pythagorean-theorem-proof-using-similarity>
-

G-SRT.5: Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

This standard asks you to take the principles covered in the previous SRT standards, and apply them to different types of congruence and similarity problems. Meeting this standard requires practice and persistence in solving triangle congruence and similarity problems, so here is a list of websites where you can find a variety of triangle congruence problems.

Online resources related to this standard:

- **CK12.org: Triangle identification as similar, congruent or neither**
<http://www.ck12.org/geometry/Triangle-Identification-as-Similar-Congruent-or-Neither/>
- **Khan Academy: Solving problems with similar and congruent triangles**
<https://www.khanacademy.org/math/geometry/similarity/cc-solving-prob-similar-tri/e/solving-problems-with-similar-and-congruent-triangles>
- **RegentsPrep.org: Practice proving triangles congruent**
<http://www.regentsprep.org/regents/math/geometry/gp4/PracCongTri.htm>
- **RegentsPrep.org: Similarity of triangles**
<http://www.regentsprep.org/regents/math/geometry/gp11/indexGP11.htm>
- **Wentworth's Plane Geometry: Pages 16 – 33**
<https://archive.org/stream/wentworthsplaneg00wentrich#page/16/mode/2up>

Define trigonometric ratios and solve problems involving right triangles

A word before getting started

One of the greatest problems that people have when they learn they'll be dealing with trigonometry problems that involve sin, cosine and tangents is they allow themselves to be intimidated by the terminology. They say "Why do I have to learn this stuff! I don't understand it anyways!" and they give up before they've even given themselves a chance to learn the material. The secret to mastering sin, cosine and tangent problems is to not let yourself be intimidated by the terminology and to realize that the trigonometric ratios are just a means of comparing the side lengths of a triangle. So long as you refuse to let yourself be frightened by the words "sin, cosine and tangent", you'll find these problems are very easy to handle.

G-SRT.6: Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.

Many students use the great volcano Sohcahtoa as a mnemonic for remembering trigonometric ratios ("Sohcahtoa" isn't really the name of a volcano, but there is one called Krakatoa.):

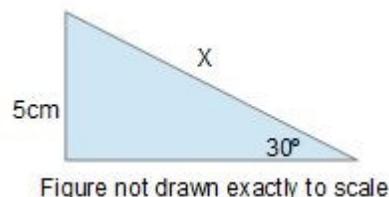
- Soh: $\text{Sin} = \frac{\textit{opposite}}{\textit{hypotenuse}}$
- Cah: $\text{Cosine} = \frac{\textit{adjacent}}{\textit{hypotenuse}}$
- Toa: $\text{Tangent} = \frac{\textit{opposite}}{\textit{adjacent}}$

Because triangles only have three sides and three angles, and because those three interior angles must always equal 180° , it isn't possible to change any one aspect of the form of a triangle without having an impact on all the other aspects of that triangle. By using trigonometric ratios, you can find the measure of an angle in a triangle by comparing the ratio of side lengths, then looking up that ratio in a reference table -or on your calculator- to determine what the angle is.

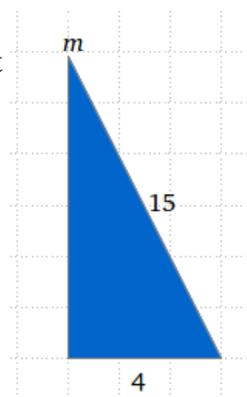
$$\mathbf{Sin} = \frac{\textit{opposite}}{\textit{hypotenuse}} \quad \mathbf{Cosine} = \frac{\textit{adjacent}}{\textit{hypotenuse}} \quad \mathbf{Tangent} = \frac{\textit{opposite}}{\textit{adjacent}}$$

When the equation says “opposite over hypotenuse”, it is in reference to the ratio of the length of the side opposite the key angle, over the length of the triangle's hypotenuse. Notice how in this example, there is the warning “Figure not drawn exactly to scale”, which is an indication that you should use the information that's given in the notation of the problem, and you should not try to solve the problem by a visual estimate, or using a ruler and protractor. In this case, we have an angle measure of 30° , and an opposite side length of 5 cm. So we take the information from our graphic to create the equation:

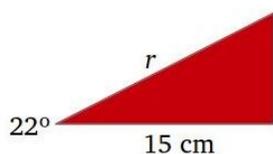
- $\frac{5}{x} = \sin 30^\circ$
- By looking at a table of trigonometric ratios, [like this](#), we see that the sin of 30° equals 0.5, so $\frac{5}{x} = 0.5$ which means that $x = 10$.



You can also use Sin to find the measure of an unknown angle. In the example at the right, we can find the measure of $\angle m$, because we know that the Sin of $\angle m = \frac{4}{15}$ or 0.266. Looking at our [table of trigonometric values](#) again, we see that a Sin of 0.266 correlates to an angle measure of approximately $15 \frac{1}{2}^\circ$. Notice how in this example, even though the drawing does not specifically state that the figure is not drawn exactly to scale, you should always take the information that's given to you in the problem notation, and avoid trying to use a ruler or protractor to measure the image.



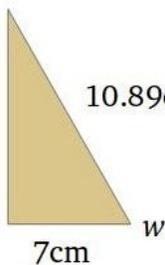
Cosine and tangent problems work in the same way. You either compare the length of a known side to the cosine or tangent of a known angle so you can find the unknown length of a side, or you compare the lengths of two sides of a triangle to determine the measure of an unknown angle.



The example at the left is a problem where you'll use your cosine ratio to find the unknown length of the hypotenuse r .

- From your trigonometric table: the cosine of $22^\circ = 0.9272$

- $\frac{15}{r} = 0.9272$ which can be manipulated to become $15 \div 0.9272 = r$
- Which also means that $r = 16.17$



You can also use cosine to find the measure of an unknown angle. In the example at the left you have two side lengths and want to find the measure of $\angle w$.

The cosine of $\angle w = \frac{7}{10.89}$ or 0.6428.

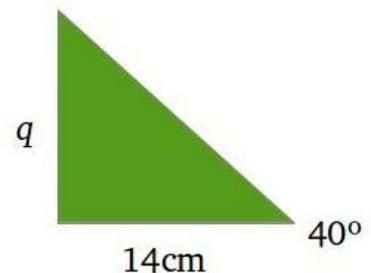
Looking at our [trigonometric table](#) shows us that 0.6428 corresponds to an angle measure of 50° , so $\angle w = 50^\circ$

Tangent problems work on the same principle as sin and cosine, you're just using different inputs, so you have to look at a different column in your trigonometric table.

In the example at the right: since tangent equals the ratio of the opposite side over the adjacent side, we know that:

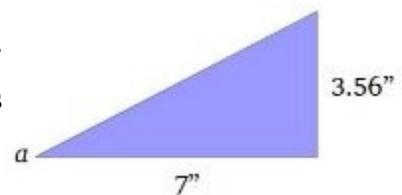
$\frac{q}{14} = \text{tangent } 40^\circ$, and looking at our [trig table](#) tells us that the tangent of $40^\circ = 0.8391$, we know that $\frac{q}{14} = 0.8391$.

Multiplying both sides of the equation by 14 gives us $q = 11.75$.



To use tangents to find an unknown angle, we find the ratio of the opposite side length over the adjacent side length, then compare that value to our trig table to recognize the value of the unknown angle.

In the example at the right we know that $\tan \angle a = \frac{3.56}{7}$ or .509, looking at our table of trig values shows us that value corresponds to an angle of roughly 27° . Since the difference between the value we get, and the value shown in the trig table only varies by 1/1000th of a degree, we can just round the answer and say that $\angle a = 27^\circ$.



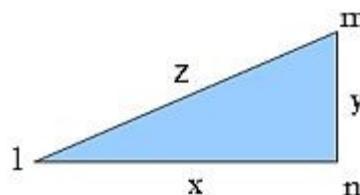
Online resources related to this standard:

- **CK12.org: Sin, cosine and tangent**
<http://www.ck12.org/geometry/Sine-Cosine-Tangent/lesson/Sine-Cosine-Tangent---Intermediate/>
- **Khan Academy: Basic trigonometry**
https://www.khanacademy.org/math/trigonometry/basic-trigonometry/basic_trig_ratios/v/basic-trigonometry

G-SRT.7: Explain and use the relationship between the sine and cosine of complementary angles.

Complementary angles are two angles that have a sum of 90° .

$$\text{Sin} = \frac{\textit{opposite}}{\textit{hypotenuse}} \quad \text{and} \quad \text{Cosine} = \frac{\textit{adjacent}}{\textit{hypotenuse}}$$

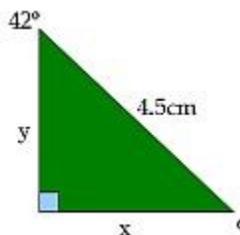


Using the example at the right, notice that the

sin of $\angle l$ equals $\frac{y}{z}$ while the cosine of $\angle m$ also equals $\frac{y}{z}$. The two values are equal, because they are comparing the same two sides against each other.

Also notice that because $\angle n$ is a right angle - which measures 90° , and because the measure of the three interior angles of a triangle must always have a sum of 180° , that means that $\angle l + \angle m = 90^\circ$. To put this in more general terms, you could say that if $\angle x$ is an angle with a measure of less than 90° , then anytime you are discussing two complementary angles:

$$\text{The sin of } \angle x = \text{the cosine of } \angle 90-x$$



You can use this principle to find the measure of unknown side lengths in a triangle.

In the example at the left, we have three pieces of information about this triangle, and using our knowledge of trigonometric ratios, we can find all other information about this triangle. We know that one angle equals 90° ,

and a second equals 42° , which means $\angle a$ must equal 48° . From looking at our [trigonometric table](#), we see that the sin of 42° and the cosine of $48^\circ = 0.6691$.

$0.6691 = \frac{x}{4.5}$ which can be manipulated to form or $x = 0.6691 \times 4.5 = 3.01$ (which we'll round to zero) so $x = 3$

The cosine of $42^\circ = 0.7431$, so $\frac{y}{4.5} = 0.7431$ or $y = 0.7431 \times 4.5 = 3.34$ so $y = 3.34$.

Online resources related to this standard

- **CK12.org: Sin and cosine of complementary angles**
<http://www.ck12.org/book/CK-12-Geometry-Honors-Concepts/section/7.3/>
 - Khan Academy: Showing relationship between cosine and sin of complements
https://www.khanacademy.org/math/geometry/right_triangles_topic/cc-geometry-trig-similarity/v/sine-and-cosine-of-complements-example
-

G-SRT.8: Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

This last Geometry standard is essentially a "persistence standard", that asks you to take all of the principles described in the preceding SRT standards, and use them in the practice of solving problems. Therefore this last section will be a pair of online resources where you can find an abundance of practice problems. Apply the material you have covered in these standards, to solving the problems given in the following chapters.

- **Archive.org: Wentworth's plane trigonometry: Chapters I and II**
<https://archive.org/stream/planetrigonometr00wentrich#page/n111/mode/2up>
- **CK12.org Flexbook: Chapter 8: Right triangle trigonometry**
<http://www.ck12.org/book/CK-12-Basic-Geometry-Concepts/>

Appendix: Resources

Users Left versus Screen Left: When referring to navigation of web-pages, you'll see references to *Users Left or Right*. This is similar to Stage directions for an ac *Read Online* tor. Users Left refers to your left as you're facing the screen.

<http://www.experienceproject.com/>

Archive.org textbooks: All of the Archive.org links in this booklet will refer you to the Archive.org catalog page for that title. Clicking on the *Read Online* link will open the book in your browser window. Right clicking on the PDF link will open a drop-down menu with a *Save As* option, so you can keep a copy of the book for your own use. The EPUB, Kindle, Daisy and DjVu links are for use with assorted e-reader devices. It is important to note the difference between the printed page number, and the file page number with these documents. In this handout, the page number that's given will always refer to the printed page number that appears at the bottom of the scanned page, rather than the file page number. This is because the file paghttp://www.experienceproject.com/e number can vary depending upon the format of the file.



7 — 5 denotes that 5 is to be subtracted from 7. In like manner, $a + b$ denotes that the number represented by b is to be added to the number represented by a , and $a - b$ denotes that the

7

The printed page number appears at the bottom of the scanned page. The file page number can vary by formats. This example was taken from the *Read Online* version of the file, the printed page 7 is on file page 13.

<http://www.experienceproject.com/>

CK12.org links

On the CK12.org pages you'll see headings for each standard, over tables that are labeled with various sub-topics within that standard. On some of the pages clicking on the sub-topic will open up a practice test. Other times you'll get print reference materials or instructional videos. In cases where multiple standards are referenced on a single page, it's best to help avoid confusion by not skipping ahead, and reviewing videos, texts and quizzes related to prior standards when you feel you need a review.

Khan Academy Videos

On the Khan Academy pages you'll find a navigation bar to the Users left of the video screen. Links to instructional videos are marked by an icon that looks like a VCR play button, along with the video title. Khan Academy groups videos by subject, so all of the videos in a set are usually related to the standard being addressed. In some cases there will be a note telling you to focus on particular videos and to skip over others. On some of the pages you'll see videos that relate to more than one standard. It's recommended that you only concern yourself with the videos related to the standard you're currently working on, and go back to earlier videos if you feel you need to review those concepts.

Many of the Khan Academy links will take you to a quiz page. If you look in the lower right hand of the quiz window you'll see a link that's marked "*Stuck? Watch a Video*", which will provide additional instruction on the topic.



This work is licensed under a [Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License](https://creativecommons.org/licenses/by-nc-sa/4.0/).