Parent Guide to the Standards
9th/10th Grade
Mathematics – Geometry

This guide provides a summary of the geometry skills that your child will learn by the end of tenth grade in mathematics in the state of Kansas. This guide will also give some examples of the ninth/tenth grade mathematics so you can assist your child. To view the standards in their entirety, please go to:

http://community.ksde.org/Default.aspx?tabid=5276

The Mathematics Standards are divided into two sections. The first section is the same for every grade level from Prekindergarten to 12th Grade and is described below. The Standards for Mathematical Practice address *how* mathematics is to be taught and *how* the students are to engage with the mathematics. The second section outlines the content at each grade level.

Standards for Mathematical Practice — 9/10

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision
7. Look for and make use of structure.
8. Look for and express regularity in repeated

Your child will be taught skills that will encourage critical thinking and problem solving. Some examples include:

- Students in 9th/10th grade geometry will integrate the work of algebra and functions to prove geometric theorems algebraically.
- Students justify their conclusions, communicate them to others, and respond to the arguments of others.
- Students solve real-world problems using geometric skills and routinely reflect on whether the results make sense.
- Students make assumptions and approximations to simplify complicated problems, making revisions when necessary.
- Students begin to formalize their mathematical communication skills by using more precise definitions and developing careful proofs.
- Students use geometric reasoning to prove theorems related to lines, angles and triangles.
- Students understand the concepts of congruence, similarity, and symmetry from the perspective of geometric transformation.

Content Standards for Mathematics — 9/10

The specific skills and content your child will be taught come from the content standards. The conceptual categories are listed below with <u>some</u> examples of the geometry at the 9th/10th grade level.

Congruence:

- Understand congruence in terms of rigid motion.
- Construct arguments about geometric theorems using rigid transformations and/or logic.

Similarity, Right Triangles, and Trigonometry:

- Construct arguments about theorems involving similarity.
- Define trigonometric ratios and solve problems involving right triangles.

Circles:

- Understand and apply theorems about circles.

Expressing Geometric Properties with Equations:

- Write the equation of a circle given the center and radius or a graph of the circle.
- Use coordinates to prove simple geometric theorems algebraically.

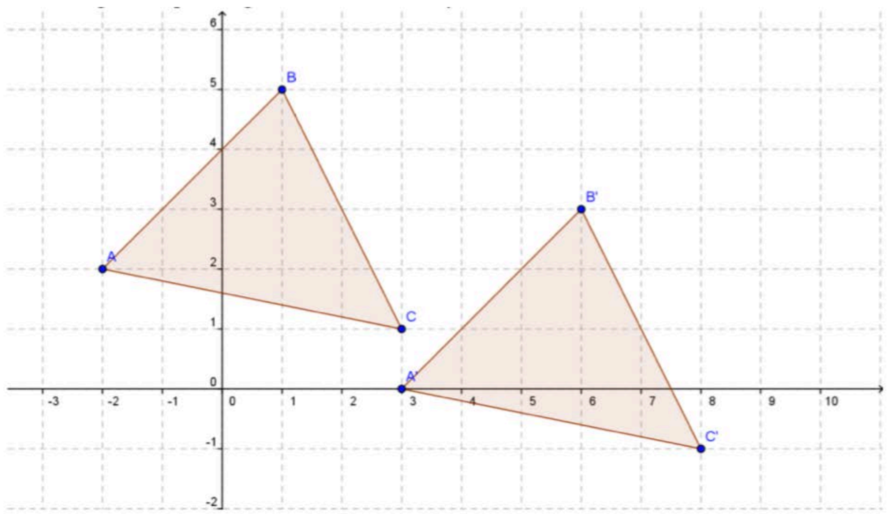
Geometric Measurement and Dimension:

- Apply geometric concepts in modeling situations.

Samples of Math Applications — 9 / 10

9th/10th grade students develop the definition of each transformation in regards to the characteristics between pre-image and image points.

Example: $\triangle A'B'C'$ is a translation of triangle $\triangle ABC$. Write the rule for the translation. Draw line segments connecting corresponding vertices. What do you notice?



Productive Answers:

$(x, y) \rightarrow (x + 5, y - 2)$

$\overline{AA'} \parallel \overline{BB'} \parallel \overline{CC'}$

$\overline{AA'} \cong \overline{BB'} \cong \overline{CC'}$

Applications of Transformations

Careers that utilize transformations include engineers, architects, musicians, choreographers, and of course, mathematicians!

http://teachers.yale.edu/curriculum/viewer/initiative_10.04.01_u

Scale Factor

Students verify that a side length of an image is equal to the scale factor multiplied by the corresponding side length of the pre-image.

Example: Given $\triangle ABC$ with $A(-2,-4), B(1,2),$ and $C(4,-3)$:

a. Perform a dilation from the origin using the following function rule $f(x,y) \longrightarrow (3x,3y)$. What is the scale factor of the dilation?

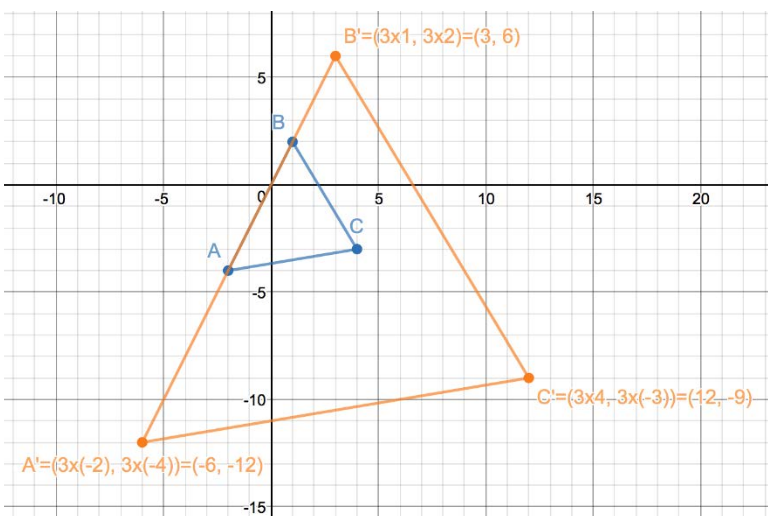
b. Using $\triangle ABC$ and its image $\triangle A'B'C'$, connect the corresponding pre-image and image points. Describe how the corresponding sides are related.

c. Determine the length of each side of the triangle. How do the side lengths compare? How is this comparison related to the scale factor?

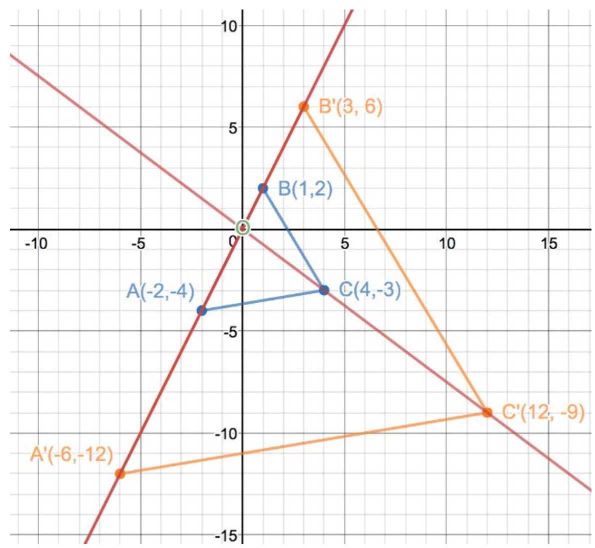
d. Determine the distance between the origin and point A and the distance between the origin and point A'. Do the same for the other two vertices. What do you notice?

Solutions to Scale Factor Examples

a. The scale factor of the dilation is 3.



b. If the lines connecting each preimage and image are extended they will intersect at the origin, which is the center of the dilation.

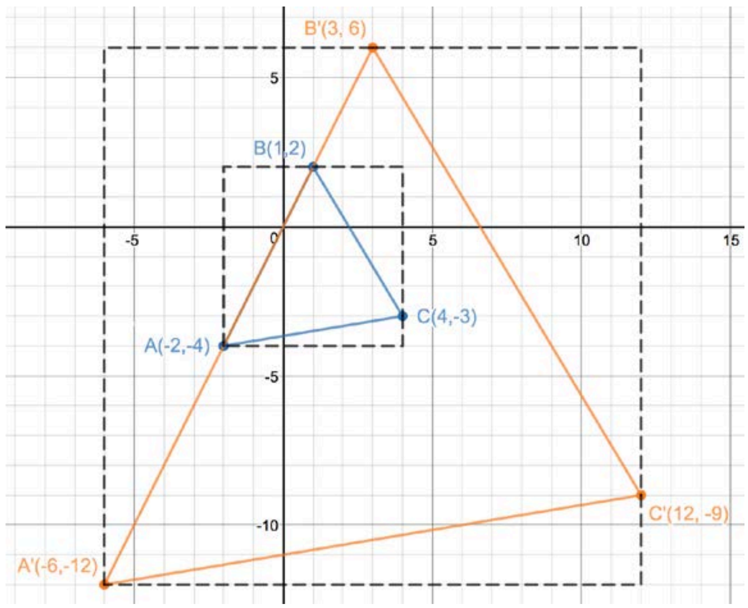


c. $AB = \sqrt{6^2 + 3^2} = \sqrt{36 + 9} = \sqrt{45} \approx 6.71$
$BC = \sqrt{3^2 + 5^2} = \sqrt{9 + 25} = \sqrt{34} \approx 5.83$
$AC = \sqrt{6^2 + 1^2} = \sqrt{36 + 1} = \sqrt{37} \approx 6.08$

$A'B' = \sqrt{18^2 + 9^2} = \sqrt{324 + 81} = \sqrt{405} \approx 20.12$
$B'C' = \sqrt{9^2 + 15^2} = \sqrt{81 + 225} = \sqrt{306} \approx 17.49$
$A'C' = \sqrt{18^2 + 3^2} = \sqrt{324 + 9} = \sqrt{333} \approx 18.25$

$$A'B' = 3AB$$
$$B'C' = 3BC$$
$$A'C' = 3AC$$

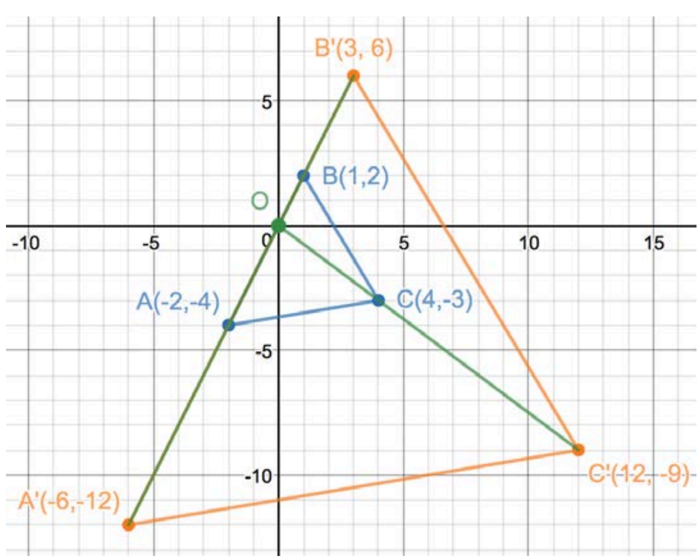
The length of each side of the image is 3 times as long as each side of the preimage. This factor is the same as the scale factor.



d. $OA = \sqrt{2^2 + 4^2} = \sqrt{4 + 16} = \sqrt{20} \approx 4.47$
$OC = \sqrt{4^2 + 3^2} = \sqrt{16 + 9} = \sqrt{25} = 5$
$OB = \sqrt{1^2 + 2^2} = \sqrt{1 + 4} = \sqrt{5} \approx 2.24$

$OA' = \sqrt{6^2 + 12^2} = \sqrt{36 + 144} = \sqrt{180} \approx 13.42$
$OC' = \sqrt{12^2 + 9^2} = \sqrt{144 + 81} = \sqrt{225} = 15$
$OB' = \sqrt{3^2 + 6^2} = \sqrt{9 + 36} = \sqrt{45} \approx 6.71$

The distance from the origin to each image is 3 times the distance from the origin to each preimage. This factor is the same as the scale factor.

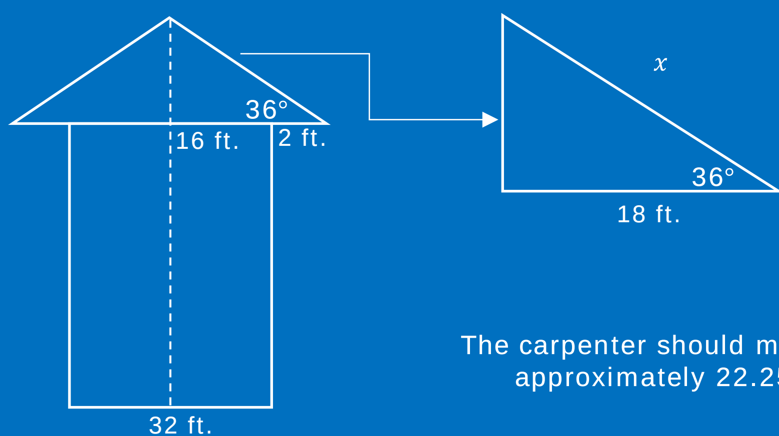


Real-Life Application

Students can use trigonometric ratios and the Pythagorean Theorem to find side lengths and angle measures in right triangles.

Example: 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?

Solution:



$$\cos 36 = \frac{18}{x}$$

$$x \cos 36 = 18$$

$$x = \frac{18}{\cos 36}$$

$$x \approx 22.25$$

The carpenter should make each rafter approximately 22.25 feet long.

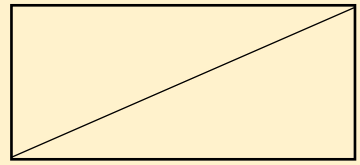
Why Must I Learn Math?

Here's a Math Guide!
http://www.mathguide.com/issues/whymath.html#6

Parallel Lines Cut By Transversals

Students can prove theorems about parallel lines cut by a transversal and the angles formed by the lines.

Example: A carpenter is framing a wall and wants to make sure the edges of his wall are parallel. He is using a cross-brace as shown in the diagram.



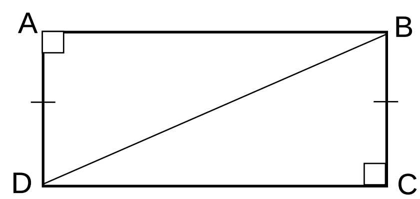
a. What are some different ways that he could verify that the edges are parallel?
b. Write a formal argument to show that the walls are parallel.
c. Pair up with another student who created a different argument than yours and critique their reasoning. Did you modify your diagram as a result of the collaboration? How? Why?

Solutions to Parallel Lines Cut By Transversals Examples

a. Answers may vary, but could include the following:

The carpenter could make sure that each of the corner angles are right angles. As long as the sides are the same lengths, then the triangles formed by the cross-brace would be congruent. Because of this, corresponding angles would be congruent, ensuring the walls are parallel by the Converse of the Alternate Interior Angles Theorem.

b. A formal argument for example (a) could be:



Given: $\angle A$ and $\angle C$ are right angles
$\overline{AD} \cong \overline{CB}$

Prove: $\overline{AD} \parallel \overline{BC}$ and $\overline{AB} \parallel \overline{DC}$

Statements	**Reasons**
$\angle A$ and $\angle C$ are right angles	Given
$\overline{AD} \cong \overline{CB}$	Given
$\overline{BD} \cong \overline{BD}$	Reflexive Property
$\triangle ABD \cong \triangle CDB$	HL Congruence Theorem
$\angle ADB \cong \angle \mathrm{CBD}$	Corresponding parts of $\cong$ $\triangle$'s are $\cong$
$\overline{AD} \parallel \overline{BC}$	Converse of the Alt Int $\angle$'s Theorem
$\angle ABD \cong \angle \mathrm{CDB}$	Corresponding parts of $\cong$ $\triangle$'s are $\cong$
$\overline{AB} \parallel \overline{DC}$	Converse of the Alt Int $\angle$'s Theorem

*Note: Two-column proofs <u>are not</u> the only way students can write formal arguments. Other examples might include flow proofs or paragraph proofs.

c. Answers will depend upon student pairings and individual responses.

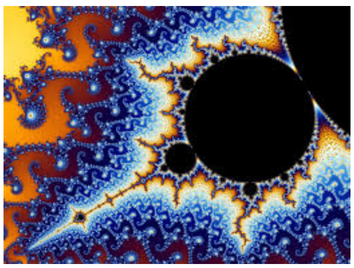
Fractals

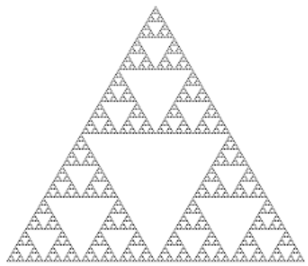
A fractal is a complex pattern that repeats itself infinitely (a process called recursion) at different scales.

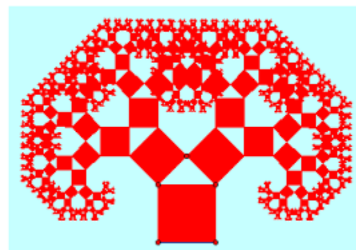
Studying fractals aids in understanding important scientific concepts such as the way things grow in nature (bacteria, trees, broccoli), snowflake patterns, and brain waves. Wireless cell phone antennas that use fractal patterns to pick up signals are more effective than a simple antenna.

Check out the following famous fractals:

Mandelbrot Set   Sierpinski Triangle   Pythagoras Tree







Fractals in Nature

Mother Nature Network
https://www.mnn.com/earth-matters/wilderness-resources/blogs/14-amazing-fractals-found-in-nature

Helpful Websites:

- ✓ Kansas Math Standards – http://bit.ly/KS-Math-Standards
- ✓ Illustrative Mathematics – https://www.illustrativemathematics.org/content-standards/tasks/
- ✓ Khan Academy Algebra Help – https://www.khanacademy.org/math/geometry
- ✓ Desmos Online Graphing Calculator – https://www.desmos.com/calculator