

# The Laws of Sines and Cosines Made Simple!

## Summary

This activity is designed to expand the students' knowledge of trigonometry using the Law of Sines and Law of Cosines. This lesson comes in three parts.

Part One: The students will construct a Triangle Trigonometry Tool to help them visualize the trigonometry laws.

Part Two: Students will examine the use of these laws by working in pairs using the attached worksheets.

Part Three: Students will reconstruct triangles of their own, trade those constructions with other student groups, then find the solutions. Students will check their solutions using a protractor and centimeter ruler as their measuring tools.

## Time Frame

1 class periods of 90 minutes each

## Group Size

Pairs

## Life Skills

Thinking & Reasoning, Communication

## Materials

The teacher should provide one piece of cardstock per student. Scissors should also be available for students to make several cuts.

Students will need to bring 3 markers of different colors. (For example: one red marker, one blue marker and one black marker.) Students will also need a protractor and a centimeter ruler.

## Background for Teachers

Students should already have knowledge of right triangles, and right triangle trigonometry. This is an activity that gives students a tool for introducing and understanding the Law of Sines and Law of Cosines.

## Student Prior Knowledge

Students should know the Pythagorean Theorem, and the trigonometric relationships of sine, cosine and tangent with respect to a right triangle.

## Intended Learning Outcomes

Students will expand their knowledge of trigonometry by learning non-right triangle trigonometry. In this activity, students will learn and practice, through a hands on activity, the Law of Sines and the Law of Cosines.

## Instructional Procedures

This activity has students make their own non-right triangle, complete with color coding, and written trigonometry ratios on their triangle. This helps as an instructional tool for students to use when first learning the Law of Sines, and the Law of Cosines.

Once the students have made their Triangle Trigonometry Tool, they can practice using this tool with

two attached worksheets. This activity can be extended by having students draw their own triangles, trade papers with other students and calculate the missing parts of these triangles. This can be done in partnerships or small groups.

#### PART ONE: Making the Triangle Trig Tool

Provide each student with a piece of white or buff colored card stock.

Using a straight edge, have each student draw a line across the diagonal. This makes two congruent, right triangles. Cut along the diagonal line. Put one triangle aside for later use.

Using a straight edge, draw a line through the right angle to the opposite side, slicing off part of the right angle, so that the angle is no longer 90 degrees. The student should now have a non-right triangle.

Using a red marker, have students label one angle, Angle A. Then have the student color Angle A's opposite side with the matching red marker. Follow this same procedure to label Angle B, and the opposite side with a blue marker. Next, label Angle C and the opposite side with a Black marker.

Label each angle with a capitol letter, and the opposite side of that angle with the same letter and color, but in lower case.

Have students turn their triangle over, and duplicate their markings on the other side.

In the center of one side of the triangle, have students write the Law of Sines formula. On the other side of the triangle, have students write the 3 formulas for the Law of Cosines.

#### PART TWO: Practice Worksheets

Attached are two worksheets with four triangles on each worksheet. You may wish to use actual measurements or estimation measurements on these worksheets. For ease in measurement, measurements of sides should be represented in centimeters. (I like using actual angle and side measurements, so that students can check their solutions by actually measuring their results with measuring tools.)

You will need to print and prepare the Law of Sines Worksheet in advance. As the teacher, you will need to give the measurements to one angle and its opposite side, and then one other measurement of your choosing. (Such as one of the remaining sides or angles.)

The Law of Cosines Worksheet will need to be printed and prepared in advance. For each triangle, the Teacher will need to put in the measurements for 3 of the 6 parts of the triangle.

(Hint: I always try to put a trick question in with the given information. An example of this might be giving the students two angles and one of their opposite sides. This is not so easily solved under the Law of Cosines as the first step.)

#### PART THREE: Small Group Activity

Have students work in pairs or in small groups.

Have each student draw about 6 triangles; big enough that all 6 fill up the whole page. Instruct your students to draw these triangles carefully, and accurately, using a straight edge.

Ask each student to measure 3 out of the 6 parts of each triangle, and record those measurements right on the drawing. (Note: Tell the students not to think about which trigonometric law they would use to solve these problems. It is better if they just randomly choose 3 different parts to measure. This gives some groups problems that are quite difficult and require higher level thinking to solve.)

Have students trade papers with each other, or with other groups. With their new paper, students must find the missing parts of each triangle, using whatever trigonometry knowledge they have.

Have students show their work, and don't let them use their measuring tools as a short cut.

After the group has finished their work, give the papers back to the original owners.

Using a protractor and a centimeter ruler, have the original owner grade the answers for accuracy.

This lesson can be modified to fit the needs of the students in your class. For the struggling students, you may wish to give an introduction on how Trigonometry would be used in a job situation. Some examples in building construction, or surveying could be helpful.

This lesson can be expanded to challenge gifted students by having them create story problems. Using real life situations, students can develop and sketch applied problems which have real life application. The emphasis should be placed on the aspects of "Why trigonometry is the best way to solve this problem?" and "Which method did you choose and why?"

### Extensions

I found a lesson from the Web which may be useful after teaching this lesson. The link is found below:

### Assessment Plan

The assessment for this activity is quite simple. This activity should be graded on a mastery vs. non mastery criteria. The student will need to have mastered these trigonometric laws in order to go forward with more trigonometry concepts.

The worksheets may be corrected with the class as a whole, or individually as students use their measuring tools to correct their calculations.

For the group activity, students can check each other's work, or students may check their own.

### Bibliography

Website <http://illuminations.nctm.org>

### Authors

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