Engineering GatorTRAX

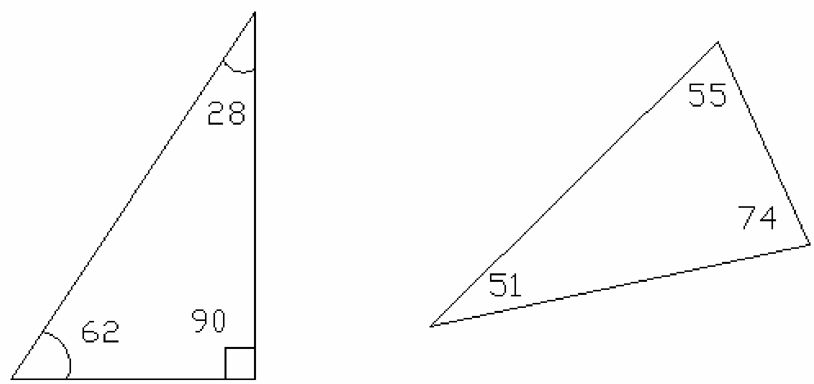
Structural Engineering Module
Introductory Level

Designed in accordance with Tau Beta Pi MindSET standards
*By **American Society of Civil Engineers, University of Florida Chapter, 2009***

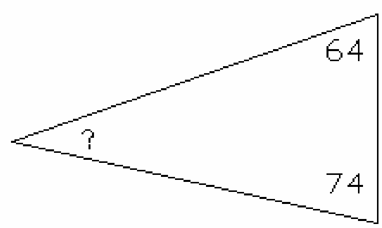
Angles
Definition: A measure of how far one line is rotated off of another line. Angles are measured in degrees or radians. Radians have no units. The conversion between degrees and radians involves a number called pi that is about equal to 3.14. The formula for the conversion is below. We will work in angles during most of this lesson

Radians = Degrees*pi/180

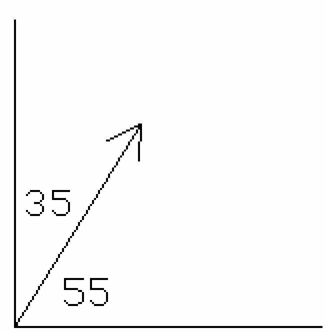
Triangles
Definition: A closed figure with three sides. All triangles have 180° in them when you add up the three angles. The largest angle is always opposite the longest side and the smallest angle is always opposite the smallest side.



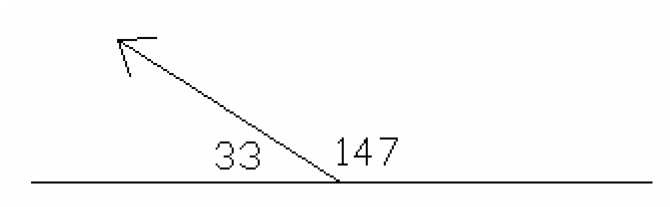
Example: Find the missing angle in the figure below in both radians and degrees.



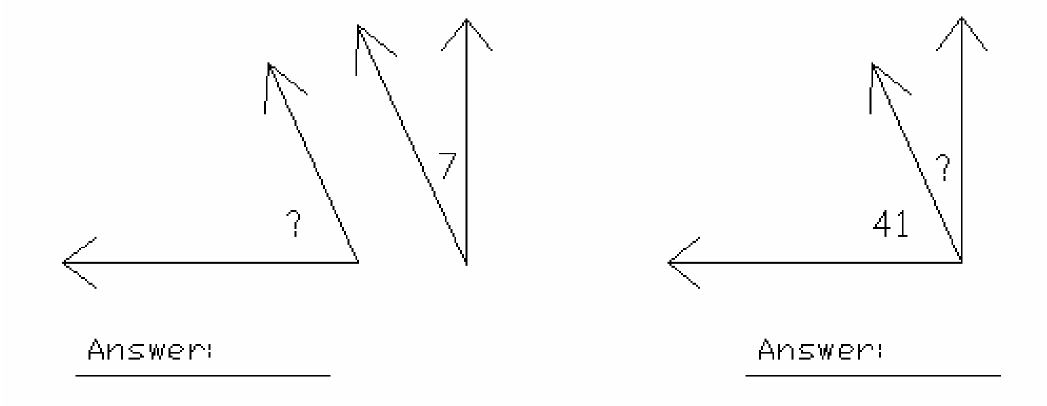
Complimentary Angles: two angles that add up to 90°. These two angles do not have to be touching.



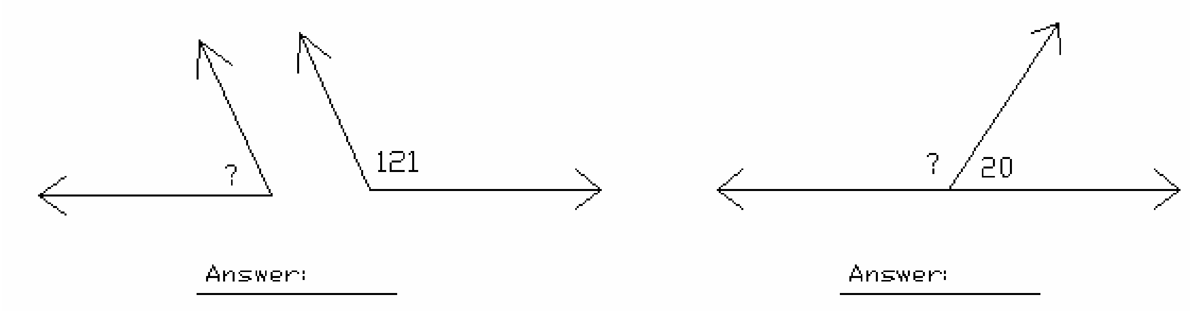
<u>Supplementary Angles</u>: two angles that add up to 180°. These two angles do not have to be touching.



<u>Examples</u>: If the two figures below have complimentary angles, find the missing angle in each figure.



If the two figures below have supplementary angles, find the missing angle in each figure.



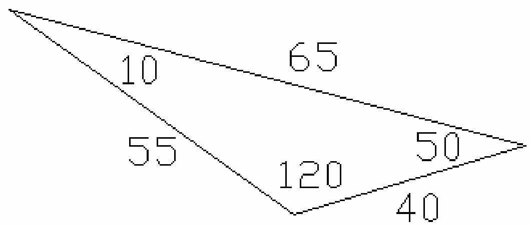
Types of Triangles

<u>Right Triangle</u>: a triangle that has one 90°angle in it.

<u>Acute Triangle</u>: a triangle with every angle less than 90°.

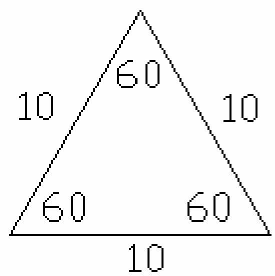
<u>Obtuse Triangle</u>: a triangle that has one angle greater than 90°. The other two angles would then have to be less than 90° when added together.

<u>Scalene Triangle</u>: a triangle that has all three sides not equal to each other in length. They also have three different angles



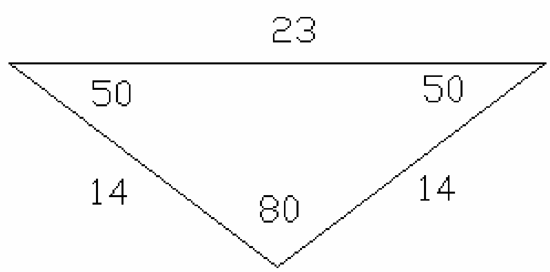
Scalene Triangle
and
Obtuse Triangle

Equilateral Triangle: a triangle with every side equal to the same length which means every angle is also the same.



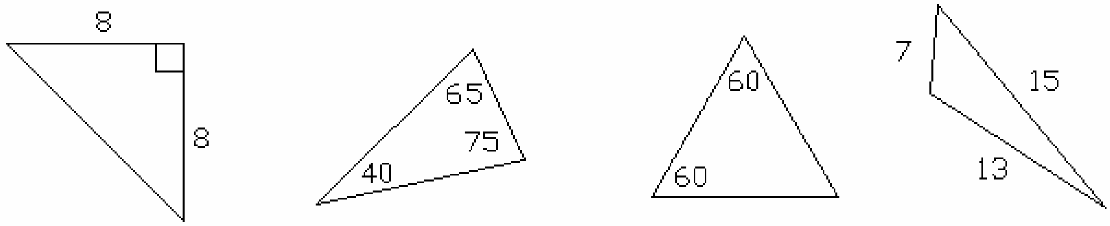
Equilateral Triangle

Isosceles Triangle: a triangle with two sides of the same length which means they also have two angles the same (the ones opposite of the two equal sides).



Isosceles Triangle

Example: Are the triangles below isosceles, scalene, equilateral, obtuse, acute, or right triangles? Hint: there can be more than one answer.



We will now do a few example problems involving fractions, decimals, square roots, and irrational numbers before moving on to special right triangles.

Fractions: a portion of a number. This is simply a division problem. The fraction bar is the same as a division sign. An example of a fraction is 2/3. The top number is called the numerator and the bottom number is called the denominator. In the example 2/3, 2 is the numerator and 3 is the denominator. A fraction in simplest form means the numerator and denominator have no integer number that they can be divided by to give two smaller integer numbers. 4/6 is not in the simplest form because 4 divided by 2 equals 2 and 6 divided by 2 equals 3. 2/3 and 4/6 are the same fraction but 2/3 is in the simplest form. Always report values in the simplest form.

Improper fractions have a numerator that is larger then the denominator. When divided out, improper fractions are larger than 1 and all proper fractions are less than 1. You should never report a value as an improper fraction unless told to do so. You should convert an improper fraction to a mixed number.

A mixed number is an integer and an improper fraction together. 5 ¾ is a mixed number. This would be 23/4 if it were an improper fraction. You convert mixed numbers by multiplying the denominator by the integer and then adding the value you get to the numerator. All of that becomes the numerator for the improper fraction. Keep the same denominator. 4*5=20 and 20+3=23. Put the 23 over the 4 and you have 5 ¾ as an improper fraction of 23/4. To convert 23/4 to the mixed number form, just do 23 divided by 4. 4 goes into 23 5 times so that is the integer value and you have a remainder of 3 so ¾ is the proper fraction in the mixed number.

Decimals: these are a way to write percentages and fractions. It is the fraction divided out. 85% as a decimal is .85. Divide 85 by 100. In fraction form this would be 85/100. Take the decimal number and multiply it by 100 to get the percent.

Fraction form: 4/5 Decimal form: .8 Percent form: 80%

Example: Tell whether or not these fractions are in the simplest form. If they are not, convert them to the simplest form. Also, convert the bottom row to decimals and percentages after you put them in simplest form.

1/2	8/16	5/6	87/87
3/9	2/8	4/10	8/19

Convert all improper fractions to mixed numbers and convert all mixed numbers to improper fractions.

3 4/5	3/2	6 7/9	16/4
9 5/9	45/9	2 1/3	5/1

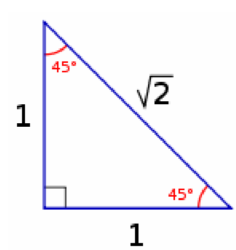
Square Roots: Taking the square root of a number is a way to find what number multiplied by itself equals the number under the radical symbol √. √9=3 because 3*3=9. A square "undoes" an exponent. √16, $16^{.5}$,and $16^{1/2}$ all mean the same thing. The cubed root of 27 which can be written as 27 under a square root sign that has a 3 in the corner is a way to find which number multiplied 3 times equals 27. 3*3*3=27 so 3 is the cubed root of 27. The fourth root of 16 is 2 because 2*2*2*2=16. You can multiply 2 square roots together with different numbers under the radical and it would be the same as taking the square root of the two numbers under the radicals multiplied together. For example, √2*√8=4. since 2*8=16, you can do √16=4. √4*√6=2*√6=√24.

Irrational Numbers: These are numbers that go on forever and are often rounded. Pi is an irrational number. It is a constant used frequently in trig calculations. The number is 3.14159265358979323846… and it goes on forever. It is often expressed at 3.14. The square root of 2 is also an irrational number. It is often rounded to 1.414. repeating decimals are also irrational.

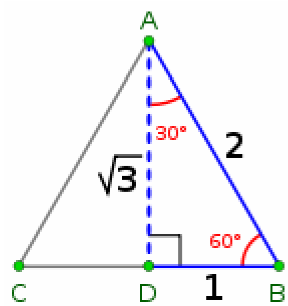
Example: Tell whether or not these number are irrational

√3	√4	√5	33/100

Special Right Triangles
Angle Based
45-45-90 triangle: has its three angles in a ratio of 1:1:2. 90 is twice as big as 45. A ratio is an expression that compares terms. It can be written as a fraction or a decimal as well. 1:1:2 is read as 1 to 1 to 2 and can be written also as 1/1/2. The lengths are in a ratio of 1 to 1 to the square root of 2. The square root of 2 can also be written as $2^{.5}$ or $2^{1/2}$.

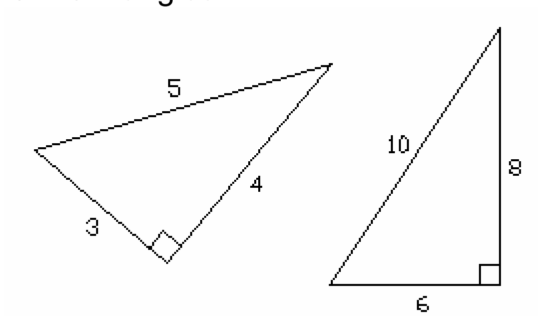


30-60-90 triangle: has its three angles in a ratio of 1:2:3. 60 is twice as big as 30 and 90 is three times as big as 30. The lengths are in a ratio of 1 to 2 to the square root of 3. The square root of 3 can also be written as $2^{.333}$ or $2^{1/3}$.

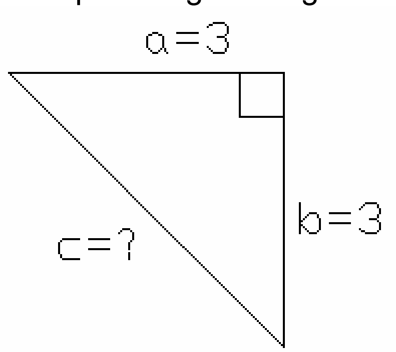


Side Based

3-4-5 triangles: these are right triangles that have their three side lengths in a ratio of 3:4:5. The sides can be multiples of 3:4:5 as well to fall under this category. 6:8:10 and 9:12:15 (which are 3, 4, and 5 multiplied by 2 and 3 respectively) are also 3-4-5 triangles.



Example: If the Pythagorean Theorem is a2 + b2 = c2 where c is the longest side of a triangle (called the hypotenuse). Find c and leave it as a multiple of a square root such as 4√8 or 7√7. Which special right triangle rule did you just use?



Triangles are important in structural engineering because they have more resistance to rotation. Trusses are made up triangles because of their structural stability. The next time you are in Walmart, Home Depot, or the O'Dome, look up at the ceiling and notice all of the triangles. You will now do a project that involves everything you learned today. Remember: Triangles make structures more stable.