

Building Triangles from Sides and Angles

Grade 7 math · Lesson · Standards: 7.G.A.2

Quick answer: A triangle is determined by three measures that lock its shape, such as three sides, two sides with the angle between them, or two angles with a side. Three side lengths work only if each pair adds to more than the third. Three angles alone give infinitely many triangles of different sizes.

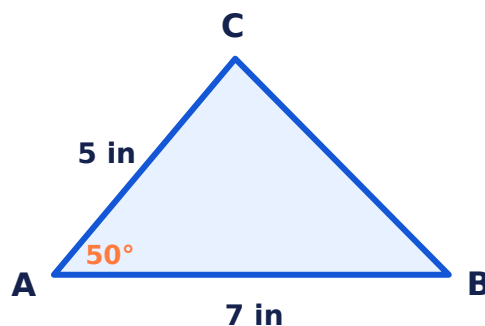
Standards: 7.G.A.2 · **Level:** Grade 7

What do you need to draw a triangle?

To construct a triangle with a ruler and protractor, you need three measures that lock its shape. Common sets are three sides (SSS), two sides and the angle between them (SAS), and two angles and a side (ASA or AAS).

Unique triangle

A set of conditions gives a **unique** triangle when every correct drawing is identical. Some conditions give no triangle, more than one triangle, or infinitely many.



Two sides and the angle between them (SAS) fix one triangle.

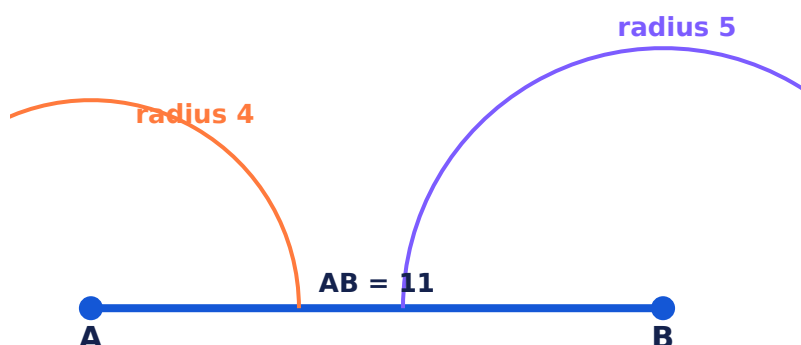
When can three side lengths make a triangle?

Two short sides must be able to reach across the longest side. If they fall short or just touch, the figure never closes.

Triangle inequality

The sum of any two side lengths must be greater than the third side length.

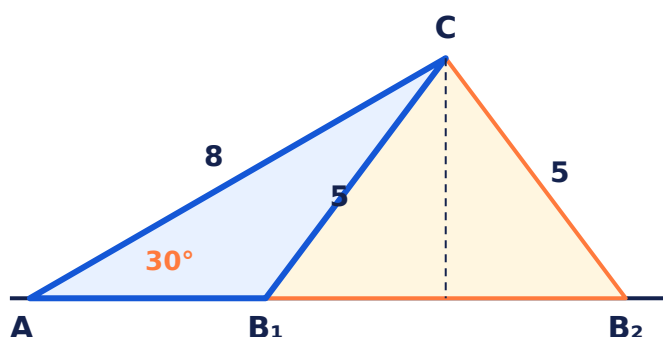
Sides	Check	Triangle?
4, 5, 11	$4 + 5 = 9 < 11$	No
5, 8, 13	$5 + 8 = 13$, not greater	No, it flattens
6, 7, 12	$6 + 7 = 13 > 12$	Yes



Sides 4 and 5 cannot reach across a side of 11: $4 + 5 = 9$ is less than 11.

Which conditions give exactly one triangle?

Given	Result
SSS (triangle inequality holds)	exactly one triangle
SAS (angle between the sides)	exactly one triangle
ASA or AAS	exactly one triangle
AAA (three angles)	infinitely many, all the same shape
SSA (angle not between the sides)	zero, one or two triangles



Side-side-angle can give two triangles: the side of length 5 can swing to B_1 or B_2 .

How do you draw a triangle with a ruler and protractor?

Drawing an ASA triangle

1. Draw the given side AB with the ruler.
2. Place the protractor at A and mark the first angle, then draw a ray.
3. Place the protractor at B, mark the second angle and draw a ray.
4. Label the point C where the rays meet, and check that the three angles add to 180° .

Worked example

Draw $AB = 3$ in with angle $A = 40^\circ$ and angle $B = 65^\circ$. The third angle is $180^\circ - 40^\circ - 65^\circ = 75^\circ$. The rays meet at one point, so the triangle is unique.

Angles alone are not enough

Angles of 40° , 65° and 75° fit a tiny triangle and a giant one. Without a side length, the size is not fixed.

Mathbot's tip

Before drawing, add the angles and test the sides. Impossible conditions are easy to spot on paper and hard to spot with a protractor.

Key points to remember

- The triangle inequality says any two sides must add to more than the third side.
- SSS, SAS, ASA and AAS each give exactly one triangle when the conditions are possible.
- Three angles (AAA) fix the shape but not the size, so many triangles fit.
- Two sides with an angle not between them (SSA) can give no triangle, one or two.

Building Triangles from Sides and Angles: frequently asked questions

What is the triangle inequality?

It states that the sum of the lengths of any two sides of a triangle is greater than the length of the third side. If the sum is equal or smaller, the sides cannot form a closed triangle.

How can I find the third angle of a triangle?

Subtract the two known angles from 180 degrees. For angles of 48° and 67° , the third angle is $180^\circ - 115^\circ = 65^\circ$.

Why do three angles not give a unique triangle?

Angles describe shape, not size. Enlarging or shrinking a triangle keeps all its angles, so there are infinitely many triangles with the same three angles.

What is the ambiguous case?

When two sides and an angle not between them are given (SSA), the second side can swing to two positions, giving two different triangles, or may fail to reach, giving none.

Which side is longest in a triangle?

The side opposite the largest angle. Likewise the shortest side lies opposite the smallest angle, which helps you check a drawing.