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home / math / triangle calculator Please provide 3 values including at least one side to the following 6 fields, and click the "Calculate" button. When radians are selected as the angle unit, it can take values such as pi/2, pi/4, etc. A triangle is a polygon that has three vertices. A vertex is a point where two or more curves, lines, or edges meet; in the case of a triangle, the three vertices are joined by three line segments called edges. A triangle is usually referred to by its vertices. Hence, a triangle with vertices a, b, and c is typically denoted as Δabc. Furthermore, triangles tend to be described based on the length of their sides, as well as their internal angles. For example, a triangle in which all three sides have equal lengths is called an equilateral triangle while a triangle in which two sides have equal lengths is called isosceles. When none of the sides of a triangle have equal lengths, it is referred to as scalene, as depicted below. Tick marks on the edge of a triangle are a common notation that reflects the length of the side, where the same number of ticks means equal length. Similar notation exists for the internal angles of a triangle, denoted by differing numbers of concentric arcs located at the triangle's vertices. As can be seen from the triangles above, the length and internal angles of a triangle are directly related, so it makes sense that an equilateral triangle has three equal internal angles, and three equal length sides. Note that the triangle provided in the calculator is not shown to scale; while it looks equilateral (and has angle markings that typically would be read as equal), it is not necessarily equilateral and is simply a representation of a triangle. When actual values are entered, the calculator output will reflect what the shape of the input triangle should look like. Triangles classified based on their internal angles fall into two categories: right or oblique. A right triangle is a triangle in which one of the angles is 90°, and is denoted by two line segments forming a square at the vertex constituting the right angle. The longest edge of a right triangle, which is the edge opposite the right angle, is called the hypotenuse. Any triangle that is not a right triangle is classified as an oblique triangle and can either be obtuse or acute. In an obtuse triangle, one of the angles of the triangle is greater than 90°, while in an acute triangle, all of the angles are less than 90°, as shown below. Triangle facts, theorems, and laws It is not possible for a triangle to have more than one vertex with internal angle greater than or equal to 90°, or it would no longer be a triangle. The interior angles of a triangle always add up to 180° while the exterior angles of a triangle are equal to the sum of the two interior angles that are not adjacent to it. Another way to calculate the exterior angle of a triangle is to subtract the angle of the vertex of interest from 180°. The sum of the lengths of any two sides of a triangle is always larger than the length of the third side Pythagorean theorem: The Pythagorean theorem is a theorem specific to right triangles. For any right triangle, the square of the length of the hypotenuse equals the sum of the squares of the lengths of the two other sides. It follows that any triangle in which the sides satisfy this condition is a right triangle. There are also special cases of right triangles, such as the 30° 60° 90, 45° 45° 90°, and 3 4 5 right triangles that facilitate calculations. Where a and b are two sides of a triangle, and c is the hypotenuse, the Pythagorean theorem can be written as: a2 + b2 = c2 EX: Given a = 3, c = 5, find b: 32 + b2 = 52 9 + b2 = 25 b2 = 16 b = 4 Law of sines: the ratio of the length of a side of a triangle to the sine of its opposite angle is constant. Using the law of sines makes it possible to find unknown angles and sides of a triangle given enough information. Where sides a, b, c, and angles A, B, C are as depicted in the above calculator, the law of sines can be written as shown below. Thus, if b, B and C are known, it is possible to find c by relating b/sin(B) and c/sin(C). Note that there exist cases when a triangle meets certain conditions, where two different triangle configurations are possible given the same set of data. = = Given b=2, B=90°, C=45°, find c: Given the lengths of all three sides of any triangle, each angle can be calculated using the following equation. Refer to the triangle above, assuming that a, b, and c are known values. A = arccos( ) B = arccos( ) C = arccos( ) Given a=8, b=6, c=10, find B: B =arccos( ) =arccos(0.8) = 36.87° Area of a Triangle There are multiple different equations for calculating the area of a triangle, dependent on what information is known. Likely the most commonly known equation for calculating the area of a triangle involves its base, b, and height, h. The "base" refers to any side of the triangle where the height is represented by the length of the line segment drawn from the vertex opposite the base, to a point on the base that forms a perpendicular. EX: Given the length of two sides and the angle between them, the following formula can be used to determine the area of the triangle. Note that the variables used are in reference to the triangle shown in the calculator above. Given a = 9, b = 7, and C = 30°: area = ab × sin(C) = bc × sin(A) = ac × sin(B) EX: area = × 7 × 9 × sin(30°) = 15.75 Another method for calculating the area of a triangle uses Heron's formula. Unlike the previous equations, Heron's formula does not require an arbitrary choice of a side as a base, or a vertex as an origin. However, it does require that the lengths of the three sides are known. Again, in reference to the triangle provided in the calculator, if a = 3, b = 4, and c = 5: area = √s(s - a)(s - b)(s - c) area = √6(6 - 3)(6 - 4)(6 - 5) = 6 Median, inradius, and circumradius Median The median of a triangle is defined as the length of a line segment that extends from a vertex of the triangle to the midpoint of the opposing side. A triangle can have three medians, all of which will intersect at the centroid (the arithmetic mean position of all the points in the triangle) of the triangle. Refer to the figure provided below for clarification. The medians of the triangle are represented by the line segments ma, mb, and mc. The length of each median can be calculated as follows: Where a, b, and c represent the length of the side of the triangle as shown in the figure above. As an example, given that a=2, b=3, and c=4, the median ma can be calculated as follows: Inradius The inradius is the radius of the largest circle that will fit inside the given polygon, in this case, a triangle. The inradius is perpendicular to each side of the polygon. In a triangle, the inradius can be determined by constructing two angle bisectors to determine the incenter of the triangle. The inradius is the perpendicular distance between the incenter and one of the sides of the triangle. Any side of the triangle can be used as long as the perpendicular distance between the side and the incenter is determined, since the incenter, by definition, is equidistant from each side of the triangle. For the purposes of this calculator, the inradius is calculated using the area (Area) and semiperimeter (s) of the triangle along with the following formulas: where a, b, and c are the sides of the triangle Circumradius The circumradius is defined as the radius of a circle that passes through all the vertices of a polygon, in this case, a triangle. The center of this circle, where all the perpendicular bisectors of each side of the triangle meet, is the circumcenter of the triangle, and is the point from which the circumradius is measured. The circumcenter of the triangle does not necessarily have to be within the triangle. It is worth noting that all triangles have a circumcircle (circle that passes through each vertex), and therefore a circumradius. For the purposes of this calculator, the circumradius is calculated using the following formula: Where a is a side of the triangle, and A is the angle opposite of side a Although side a and angle A are being used, any of the sides and their respective opposite angles can be used in the formula. Trig without Tears Part 4: Copyright © 1997–2025 by Stan Brown, BrownMath.com See also: How to Solve Triangles on TI-83/84 includes a TI-83/84 program to automate the computations mentioned in this chapter. There's an online triangle solver, by Jesús SD, for checking your answers. Click through the prompt about Chrome; it seems to work fine in the other browsers that I tried. Contents: Let's look at a specific example to start with. Suppose you have a triangle where one side has a length of 180, an adjacent angle is 42°, and the opposite angle is 31°. You're asked to find the other angle and the other two sides. It's always a good idea to draw a rough sketch, like this one. Not only does it help you organize your solution process better, but it can help you check your work. For instance, since the 31° angle is the smallest, you know that the opposite side must also be the shortest. If you were to come up with an answer of, say, 110 for one of the other sides, you'd know at once that you had made a mistake somewhere because 110 is 180. How would you go about solving this problem? It's not immediately obvious, I agree. But maybe we can get some help from some useful general techniques in problem solving: Can you draw a diagram? Can you use what you already know to solve a piece of this problem, or a related problem? If you have a specific case, can you solve a more general problem? (Sometimes it works the other way, too, where taking a specific example points out a good technique for solving a general problem.) We've already got the diagram, but let's see if those other techniques will be helpful. (By the way, they're not original with me, but are from a terrific book on problem-solving techniques that I think you should know about.) "Can you use what you already know to solve a piece of this problem?" For example, if this were a right triangle you'd know right away how to write down the lengths of sides in terms of sines or cosines. But it's not a right triangle, alas. Is there any way to turn it into a right triangle? Not exactly, but if you construct a line at right angles to one side and passing through the opposite vertex, you'll have two right triangles. Maybe solving those right triangles will show how to solve the original triangle. This diagram shows the same triangle after I drew that perpendicular. I've also used another principle ("Can you solve a more general problem?") and replaced the specific numbers with the usual letters for sides and angles. Dropping perpendicular CD in the diagram divides the big triangle (which you don't know how to solve) into two right triangles ACD and BCD, with a common side CD. And you can solve those right triangles. We're going to use this simple diagram to develop two important tools for solving triangles: the Law of Sines and the Law of Cosines. Just drawing this one perpendicular line will show you how to solve not just the triangle we started with, but any triangle. (Some trig courses teach other laws like the Law of Tangents and the Law of Segments. I'm ignoring them because you can solve triangles just fine without them.) Law of Sines The Law of Sines is simple and beautiful and easy to derive. It's useful when you know two angles and any side of a triangle, or two angles and the area, or (sometimes) two sides and one angle. Let's start by writing down things we know that relate the sides and angles of the two right triangles in the diagram above. You remember how to write down the lengths of the legs of a right triangle? The leg is always equal to the hypotenuse times either the cosine of the adjacent angle or the sine of the opposite angle. (If that looks like just empty words to you, or even if you're not 100% confident about it, please go back and review that section until you feel confident.) In the diagram, look at triangle ADC at the left: the right angle is at D and the hypotenuse is b. We don't know how much of original angle C is in this triangle, so we can't use C to find the lengths of any sides. What can we write down using angle A? By using its cosine and sine we can write the lengths of both legs of the triangle: AD = b cos A and CD = b sin A By the same reasoning, in the other triangle you have DB = a cos B and CD = a sin B This is striking: you see two different expressions for the length CD. But things that are equal to the same thing are equal to each other. That means that b sin A = a sin B Divide through by sin A and you have the solution for the general case: b = a sin B / sin A How does that apply to the triangle we started with? Well, plug in the values and you get the length of the side next to the 31° angle (or opposite the 42° angle): b = 180 × sin 42° / sin 31° ≈ 234 What about the third angle, C, and the third side, c? Well, when you have two angles of a triangle you can find the third one easily: A + B + C = 180° C = 180° − A − B In this case, C = 180° − 31° − 42° = 107°. For the third side, there are a couple of ways to go. You wrote expressions above for AD and DB, and you know that c = AD+DB, so you could compute c = b cos A + a cos B. But that's two multiplies and an add, a bit more complicated than the one multiply and one divide to find side b. I'm lazy, and I like to reduce the amount of tapping I do on my calculator. Is there an easier way, even if just slightly easier? Yes, there is. Go back a step, to a sin B = b sin A Divide left and right by (sin A)(sin B) to get a/sin A = b/sin B But there's nothing special about the two angles A and B. You could just as well have dropped a perpendicular from A to BC or from B to AC. Shown at right is the result of dropping a perpendicular from B to line CD. Because C > 90°, this perpendicular happens to be outside the triangle and the two right triangles ABD and CBD overlap. But this won't affect the algebra. By the way, the angle in triangle CBD is not C but 180° − C, the supplement of C. Angle C belongs to the original triangle ABC. You can write the length of the common side BD as BD = c sin A (in triangle ABD) and BD = a sin(180° − C) (in triangle CBD) But sin(180° − C) = sin C, so you have BD = a sin C (in triangle CBD) Set the two computed lengths of BD equal to each other, and divide by (sin A)(sin C): a sin C = c sin A a/sin A = c/sin C But we already figured out earlier that a/sin A = b/sin B Combining these two equations you have the Law of Sines: (28) Law of Sines—First Form: a/sin A = b/sin B = c/sin C This is very simple and beautiful: for any triangle, if you divide any side by the sine of the opposite angle, you'll get the same result. This law is valid for any triangle. You can derive the Law of Sines at need, so I don't specifically recommend memorizing it. But it's so simple and beautiful that it's pretty hard not to memorize if you use it at all. It's also pretty hard to remember it wrong: there are no alternating plus and minus signs or combinations of different functions. Coming back to our original triangle, we can compute the length of the third side: a/sin A = c/sin C a (sin C)/(sin A) = c c = 180 × (sin 107°)/(sin 31°) ≈ 334 The Law of Sines is sometimes given upside down: (29) Law of Sines—Second Form: (sin A)/a = (sin B)/b = (sin C)/c Of course that's the same law, just as 2/3 = 6/9 and 3/2 = 9/6 are the same statement. Work with it either way, and you'll come up with the same answers. In most cases where you use the Law of Sines, you get a unique solution. But sometimes you get two solutions (or none) in the side-side-angle case, where you know two sides and an angle that's not between them. Please see the Special Note below, after the table. Law of Cosines The Law of Sines is fine when you can relate sides and angles. But suppose you know three sides of the triangle—for instance a = 180, b = 238, c = 340—and you have to find the three angles. The Law of Sines is no good for that, because it relates two sides and their opposite angles. If you don't know any angles, you have an equation with two unknowns and you can't solve it. But a triangle can be solved when you know all three sides; you just need a different tool. And knowing me, you can be sure I'm going to help you develop one! It's called the Law of Cosines. Let's look back at that generic triangle with a perpendicular dropped from vertex C. You may remember that when we first looked at this picture, we pulled out information using both the sine and the cosine of the two angles. We used the sine information to develop the Law of Sines, but we never went anywhere with the cosine information, which was AD = b cos A and DB or BD = a cos B Let's see where that can lead us. You remember that the way we came up with the Law of Sines was to write two equations that featured the length of the construction line CD, and then combine the equations to eliminate CD. Can we do anything like that here? Well, we know the other two sides of those right triangles, so we can write an expression for the height CD using the Pythagorean theorem—actually, two expressions, one for each triangle. a² = (CD)² + (BD)² ⇒ (CD)² = a² − (BD)² b² = (CD)² + (AD)² ⇒ (CD)² = b² − (AD)² and therefore a² − (BD)² = b² − (AD)² Substitute the known values BD = a cos B and AD = b cos A, and you have a² − a² cos² B = b² − b² cos² A Bzzt! No good! That uses two sides and two angles, but we need an equation in three sides and one angle, so that we can solve for that angle. Let's back up a step, to a² − (BD)² = b² − (AD)², and see if we can go in a different direction. Maybe the problem is in treating BD and AD as separate entities when actually they're parts of the same line. Since BD + AD = c, we can write BD = c − AD BD = c − b cos A. Notice that this brings in the third side, c, and angle B drops out. Substituting, we now have a² − (BD)² = b² − (AD)² a² − (c − b cos A)² = b² − (b cos A)² This looks worse than the other one, but actually it's better because it's what we're looking for: an equation for the three sides and one angle. We can solve it with a little algebra: a² − c² + 2bc cos A − b²cos² A = b² − b²cos² A a² − c² + 2bc cos A = b² 2bc cos A = b² + c² − a² cos A = (b² + c² − a²) / 2bc We were a long time getting there, but finally we made it. Now we can plug in the lengths of the sides that I mentioned in the first paragraph, and come up with a value for cos A, which in turn will tell us angle A: cos A = (238² + 340² − 180²) / (2 × 238 × 340) cos A ≈ 0.864088 A ≈ 30.2° Do the same thing to find the second angle (or use the Law of Sines, since it's less work), then subtract the two known angles from 180° to find the third angle. You can find the Law of Cosines for the other angles by following the same process using the other two perpendiculars. (30) Law of Cosines—First Form: cos A = (b² + c² − a²) / 2bc cos B = (a² + c² − b²) / 2ac cos C = (a² + b² − c²) / 2ab Just for fun, let's use the Law of Cosines to find the other two angles of that triangle: cos C = (a² + b² − c²) / 2ab cos C = (180² + 238² − 340²) / (2 × 180 × 238) cos C ≈ −0.309944 C ≈ 108.1° To find the third angle, remember that the sum of the three angles of a triangle is always 180°, so all you have to do is subtract the two angles you now know from 180°: A + B + C = 180° B = 180° − A − C B = 180° − 30.2° − 108.1° B = 41.7° Because this textbook helps you,please click to donate!Because this textbook helps you,please donate atBrownMath.com/donate. The Law of Cosines automatically handles acute and obtuse angles, because a positive cosine means an acute angle and a negative cosine means an obtuse angle. More about that in the next chapter, in Signs of Function Values, but for now it's enough to know that you never have to worry about multiple solutions of a triangle when you use the Law of Cosines. There's another well-known form of the Law of Cosines, which may be a bit easier to remember. Start with the above form, multiply through by 2ab, and isolate c on one side: cos C = (a² + b² − c²) / 2ab 2ab cos C = a² + b² − c² c² = a² + b² − 2ab cos C You can play the same game to solve for the other two sides: (31) Law of Cosines—Second Form: a² = b² + c² − 2bc × cos A b² = a² + c² − 2ac × cos B c² = a² + b² − 2ab × cos C Typically you'll use the Law of Cosines in the first form for finding an angle and the second form for finding a side. Probably you don't want to try to remember that, but it's not as hard as it looks. I think of it this way: the square of one side is the sum of the squares of the other two, like Pythagoras, but with a "correction factor" of 2 times those same sides times the cosine of the opposite angle. Detective Work: Solving All Types of Triangles With just the definitions of sine, cosine, and tangent, you can solve any right triangle. If you've got the Law of Sines and the Law of Cosines under your belt, you can solve any triangle that exists. (Some sets of givens lead to an impossible situation, like a "triangle" with sides 3-4-9.) Really, it's pretty straightforward. Whenever you have to solve a triangle, think about what you have and then think about which formula you can use to get what you need. (When you have two angles, you can always find the third by A + B + C = 180°.) The Cases Many people find it easier to think about the known elements of a triangle as a "case". For instance, if you know two angles and the side between them, that's case ASA; if you know two angles and a side that's not between them, that's case AAS, and so on. I'm not presenting the following table for you to memorize. Instead, what I hope to do is show you that between the Law of Sines and the Law of Cosines you can solve any triangle, and that you simply pick which law to use based on which one has just one unknown and otherwise uses information you already have. Most cases can be solved with the Law of Sines. But if you have three sides (SSS), or two sides and the angle between them (SAS), you must begin with the Law of Cosines. If you know this … You can solve the triangle this way … three angles, AAA There's not enough information. Without at least one side you have the shape of the triangle, but no way to scale it correctly. For example, the same angles could give you a triangle with sides 7-12-13, 35-60-65, or any other multiple. two angles and a side, AAS or ASA Find the third angle by subtracting from 180°. Then use the Law of Sines (28)★ twice to find the second and third sides. two sides and … the included angle, SAS Use the Law of Cosines (31)★ to find the third side. Then use either the Law of Sines (29)★ or the Law of Cosines (30)★ to find the second angle. a non-included angle, SSA Use the Law of Sines (29)★ to get the second angle, and the Law of Sines (28)★ to get the third side. But … This case may have no solutions, one solution, or two solutions. See more details in the Special Note, below. three sides, SSS Find one angle with the Law of Cosines (30). Use that angle and its opposite side in the Law of Sines (29) to find the second angle, then subtract to find the third angle. two angles and the area See Given: Area and Two Angles, below. Find the third angle. Next, find a side using a = √2 × area × sin A/(sin B sin C) Then, proceed as in the ASA case, above. two sides and the area See Given: Area and Two Sides, below. Find the included angle with sin A = 2 × area/(b c) Then, proceed as in the SAS case, above. ★ If a 90° angle is given, the Law of Sines and the Law of Cosines are overkill. Just apply the definitions of the sine and cosine (equation 1) and the tangent (equation 4) to find the other sides and angles. Special Note: Side-Side-Angle For most sets of facts, either there's a unique solution or they're obviously absurd. (If you don't see why a "triangle" with sides 50-60-200 is absurd, try to sketch it.) But the SSA case can be tricky. Suppose you know acute angle B and sides a and b. Given those facts, there are two different ways you could draw the triangle, as shown in the picture. How can this be? Well, you use the Law of Sines to find angle A. Let's say you find sin A = 0.95. That means A could be either about 72° or the supplement, about 108°. Remember that the sine of any angle and the sine of its supplement are the same. This is the infamous ambiguous case. You can see the problem from the picture: the known opposite side b can take either of two positions that satisfy the given the lengths of a and b. Those two positions give rise to two different values for angle A, two different values for angle C, and two different values for side c. Think about it for a while, maybe sketch some pictures, and you'll see that this ambiguity can arise only when the known angle is acute, the known adjacent side to that angle is longer than the opposite side, and the opposite side is greater than the height. (Once you know the size or sizes of angle A, you can find angle C by subtracting 180° − B − A.) Here's a complete rundown of all the possibilities with the SSA case: Possibilities within the SSA Case known angle opposite side Compute the triangle height h (adjacent side times sine of known angle). Opposite side < h? no solution Opposite side = h? one solution (a right triangle) Opposite side > h? two solutions no solution(The conditions violate the theorem that the longest side is always opposite the largest angle.) For heaven's sake, don't try to memorize that table! Instead, always draw a picture. If you can draw two pictures that both fit all the available facts, you have two legitimate solutions. If only one picture fits all the facts, it will show you which angle (if any) is > 90°. And if you can't make any picture that fits the facts, the triangle has no solution. If you do have two solutions, what do you do? If you have no other information to go on, of course you report both solutions. But check the situation carefully. Maybe you're told explicitly which is the largest angle, or it's implied by other facts you know. In that case your solution is constrained, and you reject the solution that doesn't meet the constraints. Example: Suppose you are asked to solve a triangle with B = 36.9° a = 75.3, and b = 51.3. How do you proceed? Solution: Start with a sketch, like the one shown at right. This helps you assign the numbers to the right elements of the triangle. This is the side-side-angle case: you know two sides a and b, and a non-included angle B. The adjacent side to angle B, a = 75.3, is larger than the opposite side, b = 51.3, so you have to compute the height, h = 75.3 sin 36.9° ≈ 45.2. The opposite side, b = 51.3, is larger than this, so there are two solutions. Use the Law of Sines, equation 29, to get the second angle: (sin A)/a = (sin B)/b sin A = (a/b) sin B sin A = (75.3 / 51.3) sin 36.9° ≈ 0.8813 A = 61.8° or 180° − 61.8° = 118.2° If A = 61.8° … If A = 118.2° … Angle C = 180° − A − B C = 180° − 61.8° − 36.9° = 81.3° Use the Law of Sines, equation 28, for the third side: c/(sin C) = b/(sin B) c = b sin C / sin B c = 51.3 sin 81.3° / sin 36.9° ≈ 84.5 All six elements of the triangle, in order, are A=61.8°, c=84.5, B=36.9°, a=75.3, C=81.3°, b=51.3. Angle C = 180° − A − B C = 180° − 118.2° − 36.9° = 24.9°Use the Law of Sines, equation 28, for the third side: c / sin C = b / sin B c = b sin C / sin B c = 51.3 sin 24.9° / sin 36.9° ≈ 36.0 All six elements of the triangle, in order, are A=118.2°, c=36.0, B=36.9°, a=75.3, C=24.9°, b=51.3. Solving Triangles from Area Given: Area and Two Angles In April 2016, Caroline McKnoe asked me how to solve a triangle if you have two angles and the area. I hadn't run across that one before, but it's doable with the standard ploy of dropping a perpendicular. Recall that the area of a triangle is base × height/2. Here the base is c and the height (CD) is b sin A. (CD also equals a sin B, but for this solution it doesn't matter which expression you use.) That gives you area = (c b sin A)/2 We know angle A—even if A isn't one of the two givens we can easily find it by subtracting the other two from 180°—but there are two unknown sides in that equation. How can we eliminate one of them? We need some second equation that involves b and c but no other unknowns. The answer is in the Law of Sines: b/sin B = c/sin C ⇒ b = c sin B/sin C Substitute that in the equation for area: area = (c b sin A)/2 area = (c² sin B sin A)/(2 sin C) Solve for side c: c² = 2 area sin C/(sin A sin B) (32) c = √2 × area × sin C/(sin A sin B) Finally, use the Law of Sines to find sides a and b. After solving a triangle given the area and two angles, it's natural to wonder if you can do it given the area and two sides. The answer is yes, and it's even a bit easier than the case where you know the area and two angles. In the previous section, we found a formula for area in terms of two sides and the included angle: area = (c b sin A)/2 We couldn't use that directly when we knew two angles and the area, but if we know two sides and the area then this formula is exactly what we want. Just solve for sin A: (33) sin A = 2 × area/(b c) Next, use the Law of Cosines to find side a. Finally, use the Law of Sines or Law of Cosines to find a second angle, and subtract those angles from 180° to find the third angle. Practice Problems To get the most benefit from these problems, work them without first looking at the solutions. Refer back to the chapter text if you need to refresh your memory. Recommendation: Work them on paper — it's harder to fool yourself about whether you really understand a problem completely. You'll find full solutions for all problems. Don't just check your answers, but check your method too. 1 You have a right triangle (C = 90°) with short sides a = 88 and b = 37. Solve the triangle. 2(Sketch this problem as you read through it.) In a state park, a river flows virtually straight for 1800 m. You want to build a monorail from A, one end of this stretch, to a point C on the far shore. You also want to build a foot bridge from B, at the other end of this stretch of the river, to the same point C on the far shore. At A, the angle between your sight lines to B and C is 67°. At B, the angle between your sight lines to A and C is 38°. How long must the monorail and the foot bridge be? Bonus question: If the river has the same width all along the stretch from A to B, how wide is it? 3 Find the other elements of a triangle with B = 117°, a = 16 cm, and b = 25 cm. 4 A very modern-looking trivet is a triangular shape with sides of 6″, 9″, and 12″. What are the three angles? 5After you've painted your bedroom, you have enough paint left to cover 25 ft². You decide to paint a triangle on the wall of another room, as an accent. Two of the angles should be 30° and 40°. Find the third angle, and the lengths of the three sides. 6 You drive 6.0 miles along a straight highway, then take an exit. It's a right turn, but you don't notice the angle. You're now driving along a straight side road. At the end of 9.8 miles on the side road, you turn 135° to the right, on a third road. (If you're visualizing this from above, the 135° change of direction corresponds to an angle of 180° − 135° = 45° in the triangle.) Assuming that road continues in the same direction, how far must you drive to reach your starting point? 7You're laying out a triangular bed for your garden. Two sides are 40 m and 60 m, and the angle between them is 22°. How long is the third side, and what are the other two angles? I have to recommend a terrific little book, How To Solve It by G. Polya. Most teachers aren't very good at teaching you how to solve problems and do proofs. They show you how they do them, and expect you to pick up their techniques by a sort of osmosis. But most of them aren't very good at explaining the thought process that goes into doing a geometrical proof, or solving a dreaded "story problem". Polya's book does a great job of teaching you how to solve problems. He shows you the kinds of questions you should ask yourself when you see a problem. In other words, he teaches you how to get yourself over the hum, past the floundering that most people do when they see an unfamiliar problem. And he does it with lots of examples, so that you can develop confidence in your techniques and compare your methods with his. The techniques I've mentioned above are just three out of the many in his book. There's even a handy checklist of questions you can ask yourself whenever you're stuck on a problem. How To Solve It was first published in 1945, and it's periodically in and out of print. If you can't get it from your bookstore, go to the library and borrow a copy. You won't be sorry. What's New 29 Jan 2025: 15/16 Feb 2024: In the Special Note about the side-side-angle case, reader Alex Pinchuk questioned how you could find angles A and C with the Law of Sines, since side c was unknown. I clarified the text to indicate that angle A is found by the Law of Sines and then angle C = 180° − B − A. My thanks also to Alex for pointing out in the SSA example where I twice wrote side a where I meant b. 19 Nov 2021: Updated a link here. (intervening changes suppressed) 19 Feb 1997: New document. next: 5/Functions of Any Angle "SSS" means "Side, Side, Side" "SSS" is when we know three sides of the triangle, and want to find the missing angles. To solve an SSS triangle: We use the "angle" version of the Law of Cosines: cos(C) = a2 + b2 − c2 2ab cos(A) = b2 + c2 − a2 2bc cos(B) = c2 + a2 − b2 2ca (they are all the same formula, just different labels) In this triangle we know the three sides: Use the Law of Cosines first to find one of the angles. It doesn't matter which one. Let's find angle A first: cos(A) = (b2 + c2 − a2) / 2bc cos(A) = (62 + 72 − 82) / (2×6×7) cos(A) = (36 + 49 − 64) / 84 cos(A) = 0.25 A = cos-1(0.25) A = 75.5224...° A = 75.5° to one decimal place. Next we find another angle. We use the Law of Cosines again, this time for angle B: cos(B) = (c2 + a2 − b2)/2ca cos(B) = (72 + 82 − 62)/(2×7×8) cos(B) = (49 + 64 − 36) / 112 cos(B) = 0.6875 B = cos-1(0.6875) B = 46.5674...° B = 46.6° to one decimal place Finally, we can find angle C by using "angles of a triangle add to 180°": C = 180° − 75.5224...° − 46.5674...° C = 57.9° to one decimal place Now we have completely solved the triangle ... we have found all its angles. The triangle can have letters other than ABC: This is also an SSS triangle: In this triangle we know the three sides x = 5.1, y = 7.9 and z = 3.5. Use the Law of Cosines to find angle X first: cos(X) = (y2 + z2 − x2)/2yz cos(X) = ((7.9)2 + (3.5)2 − (5.1)2)/(2×7.9×3.5) cos(X) = (62.41 + 12.25 − 26.01)/55.3 cos(X) = 48.65/55.3 = 0.8797... X = cos-1(0.8797...) X = 28.3881...° X = 28.4° to one decimal place Next we will use The Law of Cosines again to find angle Y: cos(Y) = (z2 + x2 − y2)/2zx cos(Y) = −24.15/35.7 = −0.6764... cos(Y) = (12.25 + 26.01 − 62.41)/35.7 cos(Y) = −24.15/35.7 = −0.6764... Y = cos-1(−0.6764...) Y = 132.5684...° Y = 132.6° to one decimal place. Finally, we can find angle Z by using "angles of a triangle add to 180°": Z = 180° − 28.3881...° − 132.5684...° Z = 19.0° to one decimal place Another Method Here is another (slightly faster) way to solve an SSS triangle: Largest Angle? Why do we try to find the largest angle first? That way the other two angles must be acute (less than 90°) and the Law of Sines will give correct answers. The Law of Sines is difficult to use with angles above 90°. There can be two answers either side of 90° (example: 95° and 85°), but a calculator will only give you the smaller one. So by calculating the largest angle first using the Law of Cosines, the other angles are less than 90° and the Law of Sines can be used on either of them without difficulty. B is the largest angle, so find B first using the Law of Cosines: cos(B) = (a2 + c2 − b2) / 2ac cos(B) = (11.62 + 7.42 − 15.22) / (2×11.6×7.4) cos(B) = (134.56 + 54.76 − 231.04) / 171.68 cos(B) = −41.72 / 171.68 cos(B) = −0.2430... B = 104.1° to one decimal place Use the Law of Sines, sinC/c = sinB/b, to find angle A: sin(C) / 7.4 = sin(104.1°) / 15.2 sin(C) = 7.4 × sin(104.1°) / 15.2 sin(C) = 0.4722... C = 28.2° to one decimal place Find angle A using "angles of a triangle add to 180": A = 180° − (104.1° + 28.2°) A = 180° − 132.3° A = 47.7° to one decimal place So A = 47.7°, B = 104.1°, and C = 28.2° All done! And just a little easier. 269, 3963, 270, 1551, 1552, 1553, 1564, 2378, 2379, 3964 Copyright © 2025 Rod Pierce Hanna Pamuła, PhDHanna (Hania) Pamuła holds a Ph.D. in Bioacoustics / Mechanical Engineering, obtained at AGH University of Science and Technology. She has participated in research work in labs in France and the UK and presented papers at several international conferences. Hania has a penchant for photography and graphic design. When not in the office, she's probably traveling, hiking, or out in the field, watching birds and recording their calls. See full profileCheck our editorial policyBogna Szyk and Adena BennAdena Benn is a Guyanese teacher with a degree in computer science who is always reading and learning. She loves problem-solving, everything tech, and working with teenagers. She has a passion for education and is especially interested in how children learn and the teaching methods that best suit their learning styles. She grew up on a farm in Pomeroon, Guyana, where she worked alongside her parents and siblings. As such, she is just as comfortable growing plants as teaching in the classroom. In her early life, she also gained expertise as a seamstress, which she learned from her mother. By grade 9, she had already acquired her dressmaker's certificate. Today she uses her skills to design many items for her family. In her free time, Adena loves to read, take long walks, write children's stories and poetry, travel, or spend time with her family. See full profileCheck our editorial policy676 people find this calculator helpfulTriangle angle calculator is a safe bet if you want to know how to find the angle of a triangle. Whether you have three sides of a triangle given, two sides and an angle or just two angles, this tool is a solution to your geometry problems. Below you'll also find the explanation of fundamental laws concerning triangle angles: triangle angle sum theorem, triangle exterior angle theorem, and angle bisector theorem. Read on to understand how the calculator works, and give it a go - finding missing angles in triangles has never been easier!There are several ways to find the angles in a triangle, depending on what is given: Given three triangle sides Use the formulas transformed from the law of cosines:cos(α)=b2+c2−a22bc\cos(\alpha)=\frac{b^2+c^2-a^2}{2bc}cos(α)=2bcb2+c2−a2α=arccos(b2+c2−a22bc)\alpha= \mathrm{arccos}\left(\frac{b^2+c^2-a^2}{2bc}\right)α=arccos(2bcb2+c2−a2)For the second angle we have:cos(β)=a2+c2−b22ac\cos(\beta)=\frac{a^2+c^2-b^2}{2ac}cos(β)=2aca2+c2−b2β=arccos(a2+c2−b22ac)\beta = \mathrm{arccos}\left(\frac{a^2+c^2-b^2}{2ac}\right)β=arccos(2aca2+c2−b2)And eventually, for the third angle:cos(γ)=a2+b2−c22ab\cos(\gamma)=\frac{a^2+b^2-c^2}{2ab}cos(γ)=2aba2+b2−c2γ=arccos(a2+b2−c22ab)\gamma = \mathrm{arccos}\left(\frac{a^2+b^2-c^2}{2ab}\right)γ=arccos(2aba2+b2−c2) Given two triangle sides and one angle If the angle is between the given sides, you can directly use the law of cosines to find the unknown third side, and then use the formulas above to find the missing angles, e.g. given a,b,γ: calculate c=a2+b2−2ab×cos(γ)c = \sqrt{a^2 + b^2 - 2ab \times \cos(\gamma)}c=a2+b2−2ab×cos(γ); substitute ccc in α=arccos((b2+c2−a2)/(2bc))\alpha = \mathrm{arccos}\left((b^2 + c^2- a^2)/(2bc)\right)α=arccos((b2+c2−a2)/(2bc)); then find β\betaβ from triangle angle sum theorem: β=180°−α−γ\beta = 180\degree- \alpha - \gammaβ=180°−α−γ If the angle isn't between the given sides, you can use the law of sines. For example, assume that we know aaa, bbb, and α\alphaα:asin(α)=bsin(β)\frac{a}{\sin(\alpha)}=\frac{b}{\sin(\beta)}sin(α)a=sin(β)bβ=arcsin(b×sin(α)a)\beta = \mathrm{arcsin}\left(b\times\frac{\sin(\alpha)}{a}\right)β=arcsin(b×asin(α)) As you know, the sum of angles in a triangle is equal to 180°180\degree180°. From this theorem we can find the missing angle: γ=180°−α−β\gamma = 180\degree- \alpha - \betaγ=180°−α−β. That's the easiest option. Simply use the triangle angle sum theorem to find the missing angle: α=180°−β−γ\alpha = 180\degree- \beta - \gammaα=180°−β−γ; β=180°−α−γ\beta= 180\degree- \alpha - \gammaβ=180°−α−γ; and γ=180°−α−β\gamma = 180\degree- \alpha- \betaγ=180°−α−β In all three cases, you can use our triangle angle calculator - you won't be disappointed.The theorem states that interior angles of a triangle add to 180°180\degree180°:α+β+γ=180°\alpha + \beta+\gamma = 180 \degreeα+β+γ=180°How do we know that? Look at the picture: the angles denoted with the same Greek letters are congruent because they are alternate interior angles. Sum of three angles α\alphaα β\betaβ, γ\gammaγ is equal to 180°180\degree180°, as they form a straight line. But hey, these are three interior angles in a triangle! That's why α+β+γ=180°\alpha + \beta+ \gamma = 180\degreeα+β+γ=180°.An exterior angle of a triangle is equal to the sum of the opposite interior angles. Every triangle has six exterior angles (two at each vertex are equal in measure). The exterior angles, taken one at each vertex, always sum up to 360°360\degree360°. An exterior angle is supplementary to its adjacent triangle interior angle. Angle bisector theorem states that: An angle bisector of a triangle angle divides the opposite side into two segments that are proportional to the other two triangle sides. Or, in other words: The ratio of the BD¯\overline{BD}BD length to the DC¯\overline{DC}DC length is equal to the ratio of the length of side AB¯\overline{AB}AB to the length of side AC¯\overline{AC}AC:|BD¯||DC¯|=|AB¯||AC¯|\frac{\left|\overline{BD}\right|}{\left|\overline{DC}\right|}=\frac{\left|\overline{AB}\right|}{\left|\overline{AC}\right|}||DC||||BD||=||AC||||AB||OK, so let's practice what we just read. Assume we want to find the missing angles in our triangle. How to do that? Find out which formulas you need to use. In our example, we have two sides and one angle given. Choose angle and 2 sides option. Type in the given values. For example, we know that a=9 ina = 9\ \mathrm{in}a=9 in, b=14 inb = 14\ \mathrm{in}b=14 in, and α=30°\alpha = 30\degreeα=30°. If you want to calculate it manually, use law of sines: asin(α)=bsin(β)\frac{a}{\sin(\alpha)} = \frac{b}{\sin(\beta)}sin(α)a=sin(β)bβ=arcsin(b×sin(α)a)=arcsin(14 in×sin(30°)9 in)=arcsin(79)=51.06°\begin{split} \beta&=\mathrm{arcsin}\left(b\times\frac{\sin(\alpha)}{a}\right)\\ &=\mathrm{arcsin}\left(14\ \mathrm{in}\times\frac{\sin(30\degree)}{9\ \mathrm{in}}\right)\\ &=\mathrm{arcsin}\left(\frac{7}{9}\right)=51.06\degree \end{split}β =arcsin(b×asin(α))=arcsin(14 in×9 insin(30°))=arcsin(97)=51.06° From the theorem about sum of angles in a triangle, we calculate that γ=180°−α−β=180°−30°−51.06°=98.94°\gamma = 180\degree- \alpha - \beta = 180\degree- 30\degree - 51.