Hinge theorem proof worksheet

8. From the park, Dave rides his horse due north for 3 miles and then turns N 120º W for 1.5 miles. Ellen leaves the park and rides her horse 3 miles due south and then turns due east for 1.5 miles. a) Which rider is now farther from the park? Choose: b) Your choice is supported by: Choose: An indirect proof is a proof in which we prove that a statement is true by first assuming that its opposite is true. If this assumption leads to an impossibility, then we have proved that the original statement is true. Guidelines for Writing an Indirect Proof 1. Identify the statement that you want to prove.2. Begin by assuming the statement is false; assume its opposite is true.3. Obtain statements that logically follow from your assumption.4. If you obtain a contradiction, then the original statement must be true. Hinge Theorem If two sides of one triangle are congruent to two sides of another triangle, and the included angle of the first is larger than the included angle of the second, then the third side of the first is longer than the third side of the second.It has been illustrated in the diagram given below. Converse of the Hinge Theorem If two sides of one triangle are congruent to two sides of another triangle, and the third side of the first is longer than the third side of the second, then the included angle of the first is larger than the included angle of the second.It has been illustrated in the diagram given below. Example 1 :Use an indirect proof to prove that a triangle cannot have more than one obtuse angle.Solution : Given : Triangle ABCTo Prove : Triangle ABC does not have more than one obtuse angle.Begin by assuming that triangle ABC does have more than one obtuse angle. m∠A > 90°m∠B > 90° Assume triangle ABC has two obtuse angles. m∠A + m∠B > 180° Add the two inequalities. We know, however, that the sum of the measures of all three angles is 180°. m∠A + m∠B + m∠C = 180° Triangle Sum Theorem m∠A + m∠B = 180° - m∠C Subtraction property of equality. So, we can plug 180° - m∠C for m∠A + m∠B inm∠A + m∠B > 180° 180° - m∠C > 180° Substitution property of equality. The last statement is not possible.Because angle measures in any triangle cannot be negative.So, we can conclude that the original assumption must be false. That is, triangle ABC cannot have more than one obtuse angle.Example 2 :Use an indirect proof to prove the Converse of the Hinge Theorem.Solution :Converse of the Hinge Theorem :If two sides of one triangle are congruent to two sides of another triangle, and the third side of the first is longer than the third side of the second, then the included angle of the first is larger than the included angle of the second. Given : AB ≅ DEBC ≅ EFAC > DFTo Prove : m∠B > m∠EBegin by assuming that m∠B is not greater than m∠E.Then, it follows that either m∠B = m∠E or m∠B < m∠E.Case 1 :If m∠B = m∠E, then m∠B ≅ m∠E. So, ΔABC ≅ ΔDEF by the SAS Congruence Postulate and AC = DF.Case 2 :If m∠B m∠EExample 3 :In triangles ABC and DEF, we have AB ≅ DEBC ≅ EFAC = 12 inches m∠B = 36°m∠E = 80°Which of the following is a possible length for DF?8 inches, 10 inches, 12 inches, 23 inchesSolution :From the given information, let us draw the two triangles ABC and DEF. Because the included angle in triangle DEF is larger than the included angle in triangle ABC, the third side DF must be longer than AC.So, of the four choices, the only possible length for DF is 23 inches. The diagram of the two triangles ABC and DEF above shows that this is possible.Example 4 :In triangles RST and XYZ, we haveRT ≅ XZST ≅ YZRS = 3.7 centimetersXY = 4.5 centimetersm∠Z = 75°Which of the following is a possible measure for m∠T?60°, 75°, 90°, 105°Solution :Because the third side in triangle RST is shorter than the third side in triangle XYZ, the included angle m∠T must be smaller than m∠Z.So, of the four choices, the only possible measure for m∠T is 60°. Kindly mail your feedback to v4formath@gmail.comWe always appreciate your feedback. ©All rights reserved. onlinemath4all.com What is the Hinge Theorem? Let's say you have a pair of triangles with two congruent sides but a different angle between those sides. Think of it as a hinge, with fixed sides, that can be opened to different angles: The Hinge Theorem states that in the triangle where the included angle is larger, the side opposite this angle will be larger. It is also sometimes called the "Alligator Theorem" because you can think of the sides as the (fixed length) jaws of an alligator- the wider it opens its mouth, the bigger the prey it can fit. We'll prove this theorem two ways. Problem Two triangles, △ABC and △DEF, have two pairs of congruent sides: |AB|=|DE|; |BC|=|EF|. θ2=∠DEF>∠ABC=θ1. Show that |DF|>|AC| Strategy To prove the Hinge Theorem, we need to show that one line segment is larger than another. Both lines are also sides in a triangle. This guides us to use one of the triangle inequalities which provide a relationship between sides of a triangle. One of these is the converse of the scalene triangle Inequality. This tells us that the side facing the larger angle is larger than the side facing the smaller angle. The other is the triangle inequality theorem, which tells us the sum of any two sides of a triangle is larger than the third side. We'll use each one of these in the two different ways we prove the Theorem. But one hurdle first: both these theorems deal with sides (or angles) of a single triangle. Here we have two separate triangles. So the first order of business is to get these sides into one triangle. Let's place triangle △ABC over △DEF so that one of the congruent edges overlaps, and since θ2>θ1, the other congruent edge will be outside △ABC: The above description was a colloquial, layman's description of what we are doing. In practice, we will use a compass and straight edge to construct a new triangle, △GBC, by copying angle θ2 into a new angle ∠GBC, and copying the length of DE onto the ray BG so that |DE=|GB|=|AB|. We'll now compare the newly constructed triangle △GBC to △DEF. We have |DE=|GB| by construction, θ2=∠DEF=∠GBC by construction, and |BC|=|EF| (given). So the two triangles are congruent by the Side-Angle-Side postulate, and as a result |GC|=|DF|. First method - using the converse scalene triangle inequality Let's look at the first method for proving the Hinge Theorem. To put the edges that we want to compare in a single triangle, we'll draw a line from G to A. This forms a new triangle, △GAC. This triangle has side AC, and from the above congruent triangles, side |GC|=|DF|. Now let's look at △GBA. |GB|=|AB| by construction, so △GBA is isosceles. From the Base Angles theorem, we have ∠BGA= ∠BAG. From the angle addition postulate, ∠BGA>∠CGA, and also ∠CAG>∠BAG. So ∠CAG>∠BAG=∠BGA>∠CGA, and so ∠CAG>∠CGA. And now, from the converse of the scalene triangle Inequality, the side opposite the large angle (GC) is larger than the one opposite the smaller angle (AC). |GC|>|AC|, and since |GC|=|DF|, |DF|>|AC| Second method - using the triangle inequality For the second method of proving the Hinge Theorem, we'll construct the same new triangle, △GBC, as before. But now, instead of connecting G to A, we'll draw the angle bisector of ∠GBA, and extend it until it intersects CG at point H: Triangles △BHG and △BHA are congruent by the Side-Angle-Side postulate: AH is a common side, |GB|=|AB| by construction and ∠HBG≅∠HBA, since BH is the angle bisector. This means that |GH|=|HA| as corresponding sides in congruent triangles. Now consider triangle △AHC. From the triangle inequality theorem, we have |CH|+|HA|>|AC|. But as |GH|=|HA|, we can substitute and get |CH|+|GH|>|AC|. But |CH|+|GH| is simply |CG|, so |CG|>|AC|, and as |GC|=|DF|, we get |DF|>|AC| And so we were able to prove the Hinge Theorem (also known as the Alligator theorem) in two ways, relying on the triangle inequality theorem or its converse. In order to continue enjoying our site, we ask that you confirm your identity as a human. Thank you very much for your cooperation. This lesson includes 2 additional questions for subscribers. The Hinge Theorem can be understood by exploring real hinges. If the two hinges are of the same size and the angle of the first hinge is opened wider than the second, then the distance between the edges of the first hinge, is farther than that of the second. If a string is placed connecting the hinges, then a triangle is formed. As we shall see, hinges are connected to theorems about triangles. Theorem The Hinge Theorem states if two sides of one triangle is congruent, respectively, to two sides of another triangle, and the included angle of the first angle is larger than the included angle of the second, then the third side o f the first triangle is longer than the third side of the second. The Hinge Theorem is illustrated in the first figure. Given triangle ABC and triangle DEF, with AB = DE, and AC = DF. If angle A > angle D, then BC > EF. Proof First we construct AGC, with G in the interior of angle BAC such that triangle AGC is congruent to triangle DEF. This can be done using compass and straightedge construction. First copy angle EDC to angle BAC, then locate AG = DE Now, bisect angle BAG and let M be the intersection of the bisector and BC. By SAS Congruence, triangle AMB is congruent to triangle AMG. Therefore, MB = MG. Now, by the Triangle Inequality Theorem, CG < CM + MG Therefore, CG < CM + MB because MB = MG. Since CG = EF, and CM + MB = BC, We have EF < BC which is what we want to show.

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