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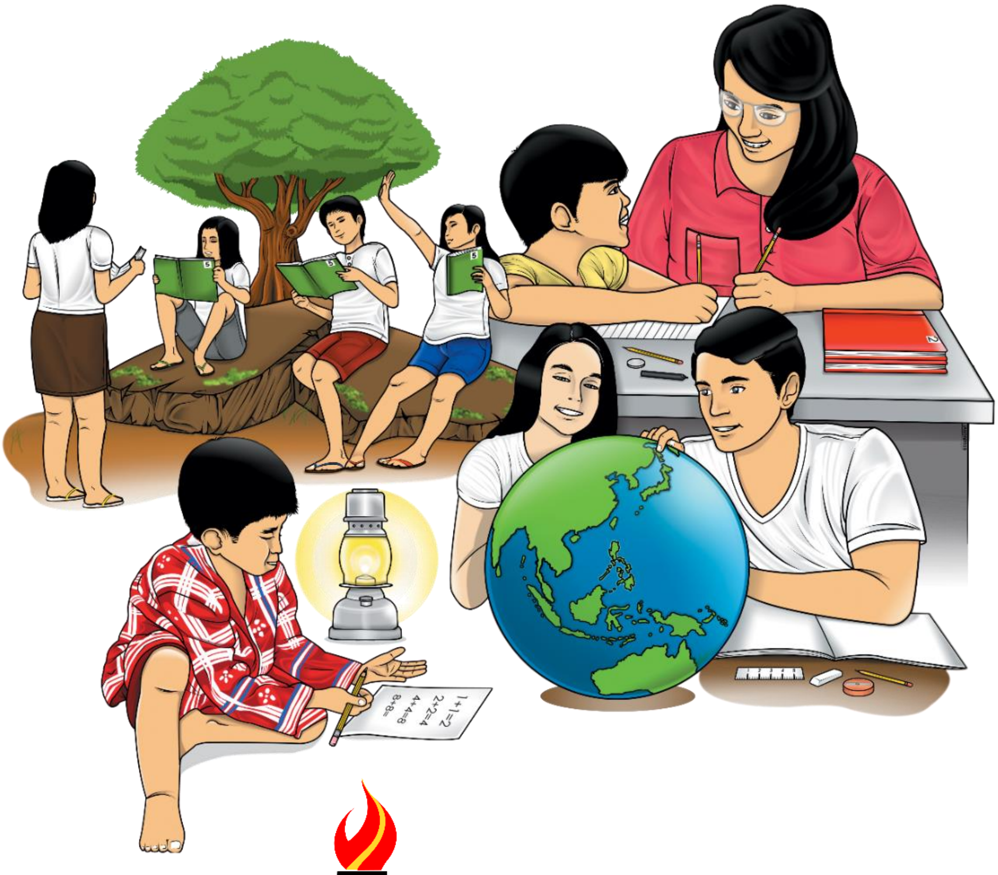
Mathematics

Quarter 3 – Module 6
Proving Two Triangles are Congruent



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Mathematics

Quarter 3 – Module 6
Proving Two Triangles are Congruent

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Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.

What I Need to Know

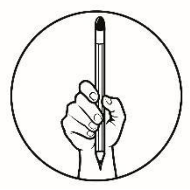
This module is designed for you to understand what it means for two triangles to be congruent and the ways to prove that these triangles are congruent using the theorems and postulates on triangle congruence. This will help you also learn how to prove some theorems of triangle congruence including the right triangles. You will be guided on how to make statements step-by-step and how to make reasons in each corresponding statement. The scope of this module enables you to use it in many different learning situations. The lessons are arranged to follow the standard sequence of the course. But the order in which you read them can be changed to correspond with the textbook you are now using.

This module contains:

Lesson 1: Proving Two Triangles Are Congruent

After going through this module, you are expected to:

1. identify conditions for triangle congruence;
2. use triangle congruence postulates and theorems to prove that two triangles are congruent;
3. use two-column proof in proving that two triangles are congruent; and
4. recognize real-life applications of congruent triangles.



What I Know

Pre- Assessment:

Directions: Choose the letter of the correct answer. Write your answer on a separate sheet of paper.

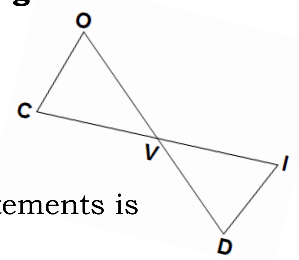
1. "If two angles and the included side of one triangle are congruent to the corresponding two angles and an included side of another triangle, then the triangles are congruent". Which postulate proves this statement?

   A. AAS Congruence
   B. ASA Congruence
   C. SAS Congruence
   D. SSS Congruence

2. Which statement is NOT sufficient to prove the congruence of two triangles?

   A. Three angles of one triangle are congruent respectively to three angles of another triangle.
   B. Three sides of one triangle are congruent respectively to the three sides of another triangle.
   C. Two angles and the included side of one triangle are congruent respectively to the two angles and the included side of another triangle.
   D. Two angles and the non-included side of one triangle are congruent respectively to the two angles and the non-included side of another triangle.

For item numbers 3, 4 and 5 refer to the figure at the right.



3. $\overline{CI}$ bisects $\overline{DO}$ at V. Which of the following is TRUE?

   A. $\overline{OV} \cong \overline{VI}$
   B. $\overline{CV} \cong \overline{VD}$
   C. $\overline{OV} \cong \overline{VD}$
   D. $\angle COV \cong \angle VID$

4. $\overline{OD}$ and $\overline{CI}$ bisect each other. Which set of congruence statements is correct?

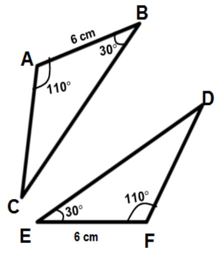
   A. $\overline{VI} \cong \overline{VD}, \overline{CV} \cong \overline{OV}$
   B. $\overline{DV} \cong \overline{OV}, \overline{CV} \cong \overline{IV}$
   C. $\overline{VC} \cong \overline{VO}, \overline{VD} \cong \overline{VI}$
   D. $\overline{VO} \cong \overline{VI}, \overline{VC} \cong \overline{VD}$

5. If $\overline{OD}$ *and* $\overline{CI}$ bisect each other, which set of congruence statements is correct?

   A. $\angle CVO \cong \angle IVD$, $\overline{OV} \cong \overline{VI}$, $\overline{CV} \cong \overline{VD}$
   B. $\angle CVO \cong \angle IVD$, $\overline{OV} \cong \overline{VD}$, $\overline{CV} \cong \overline{VI}$
   C. $\angle CVO \cong \angle IVD$, $\angle VCO \cong \angle VID$, $\overline{CV} \cong \overline{VD}$
   D. $\angle CVO \cong \angle IVD$, $\angle VOC \cong \angle VDI$, $\overline{OV} \cong \overline{VI}$

6. Refer to the figure at the right, $\overline{OV} \perp \overline{DE}$ at V. Which set of congruence statements can be used to prove that $\Delta DVO \cong \Delta EVO$ by HyA Congruence Theorem?
   A. $\overline{OE} \cong \overline{OD}$, $\overline{DV} \cong \overline{EV}$
   B. $\overline{OE} \cong \overline{OD}$, $\overline{OV} \cong \overline{OV}$
   C. $\overline{OD} \cong \overline{OE}$, $\angle ODV \cong \angle OEV$
   D. $\overline{OD} \cong \overline{OE}$, $\angle DVO \cong \angle EVO$

For item numbers 7 and 8, consider the figures at the right.



7. Which one states the congruence of the two triangles?
   A. $\Delta ABC \cong \Delta EFD$
   B. $\Delta ABC \cong \Delta EDF$
   C. $\Delta ABC \cong \Delta FED$
   D. $\Delta ABC \cong \Delta FDE$

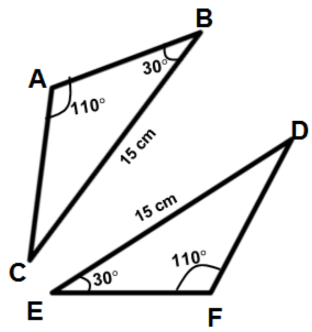
8. Which theorem or postulate can prove the congruence of the two triangles?
   A. AAS Congruence
   B. ASA Congruence
   C. SAS Congruence
   D. SSS Congruence

9. It is given that $\Delta CAN \cong \Delta FED$. Which of the following statement/s is/are true?

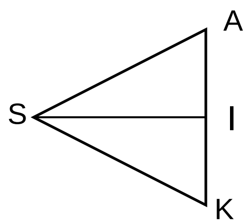
   i. $\angle CAN \cong \angle FED$ ii. $\angle ANC \cong \angle EDF$ iii. $\overline{CA} \cong \overline{FE}$

   A. i and ii
   B. i and iii
   C. ii and iii
   D. i, ii, and iii

10. The figure at the right shows that $\Delta ABC \cong \Delta FED$. Which theorem or postulate supports this statement?
   A. AAS Congruence
   B. ASA Congruence
   C. SAS Congruence
   D. SSS Congruence



For item numbers 11 and 12, use the figure below.

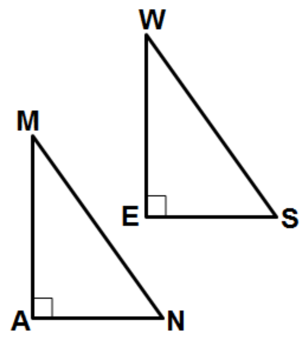


11. Which of the following statements is NOT correct if I is the midpoint of $\overline{AK}$ and $\overline{SI} \perp \overline{AK}$ $at\ I$?
   A. $\angle SAK$ and $\angle SKA$ are right angles
   B. $\angle SIA$ and $\angle SIK$ are right angles
   C. $\overline{SI} \cong \overline{SI}$
   D. $\overline{AI} \cong \overline{KI}$

12. Given: $\overline{SI}$ bisects $\angle ASK$, $\overline{SI} \perp \overline{AK}$ at I, which of the following statements about triangle congruence is true?

A. $\Delta ISA \cong \Delta ISK$ by ASA Congruence
B. $\Delta ISA \cong \Delta IKS$ by SAS Congruence
C. $\Delta SIA \cong \Delta SKI$ by ASA Congruence
D. $\Delta SIA \cong \Delta SKI$ by SAS Congruence

13. Triangles MAN and SEW are right triangles. If $\overline{AN} \cong \overline{ES}$ and $\overline{NM} \cong \overline{SW}$, what special right triangle theorem will prove that $\Delta MAN \cong WES$?

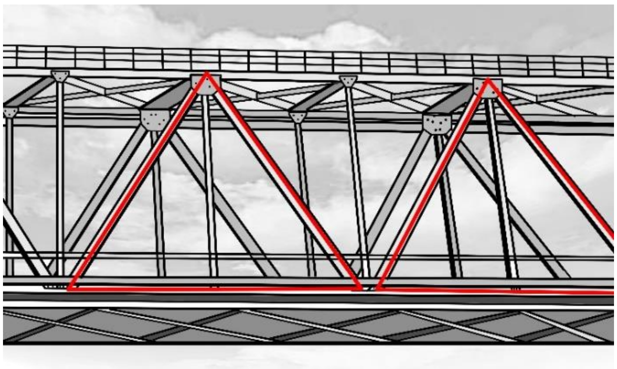


A. HyA Congruence Theorem
B. HyL Congruence Theorem
C. LA Congruence Theorem
D. LL Congruence Theorem

Congruent triangles are commonly seen in buildings and other structures such as bridges, towers and the like. The figure below is a bridge showing congruent triangles.

For items 14 and 15, refer to the image at the right. Complete the proof below by choosing the letter of the correct answer.

A. ASA Congruence Postulate
B. SAS Congruence Postulate
C. SSS Congruence Postulate
D. $\overline{RA} \cong \overline{TA}$
E. $\overline{SA} \cong \overline{SA}$
F. $\overline{ST} \cong \overline{ST}$



Given: $\overline{SR} \cong \overline{ST}$
$\overline{SA}$ bisects $\angle RST$

Prove: $\Delta SRA \cong \Delta STA$

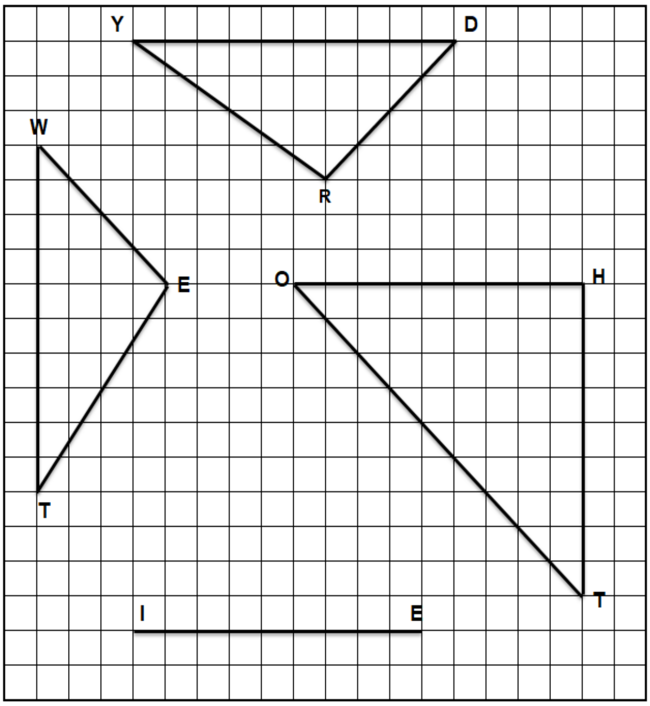
Proof:

Statements	Reasons
1. $\overline{SR} \cong \overline{ST}$	1. Given
2. $\overline{SA}$ bisects $\angle RST$	2. Given
3. $\angle RSA \cong \angle TSA$	3. Definition of Angle Bisector
4. (14)	4. Reflexive Property
5. $\Delta SRA \cong \Delta STA$	5. (15)

Lesson 1

Proving Two Triangles are Congruent

A new tree park site will be built in your school in which it will contain three triangular gardens. The design for the tree park is shown on the graphing paper.



Does garden DRY and WET have the same sizes and shapes? Are they congruent?

If yes, how can we prove that the two triangles are congruent?

How can we apply triangle congruence theorem to prove that the two triangles are congruent?

Let us first review the previous topic by answering the activity in the next page.

Enjoy!

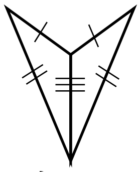
What’s In

Activity: Match Me!

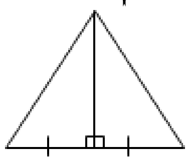
Directions: Math each figure in Column A with the corresponding triangle congruence postulate in column B. Choose the letter of the correct answer. Use a separate sheet of paper.

Column A

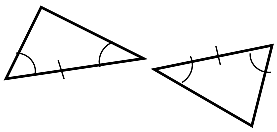
__________ 1.



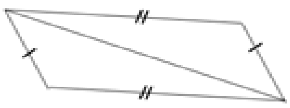
__________ 2.



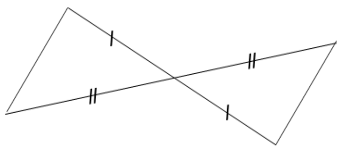
__________ 3.



__________ 4



__________ 5.



Column B

A. Angle-Side-Angle (ASA)

B. Side-Angle-Side (SAS)

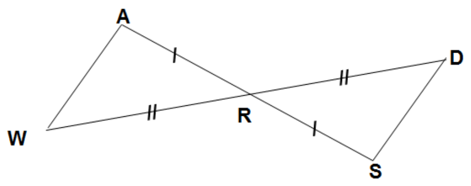
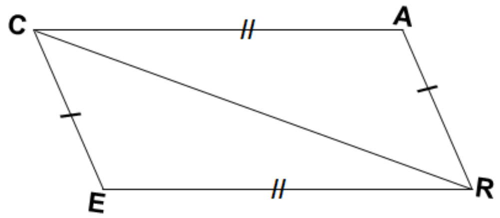
C. Side-Side-Side (SSS)

Questions:

1. How did you find the activity? Do you find it difficult to identify what congruence postulate is illustrated in each figure?
2. What is your basis in determining which congruence postulate is illustrated in each given figure?

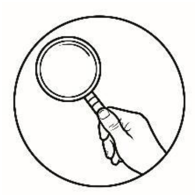
What's New

Directions: List down the corresponding congruent parts of each pair of congruent triangles and answer the questions that follow.

Congruent Triangles	Corresponding Congruent parts
1. 	
2. 	

Questions:

a. Were you able to list down the corresponding congruent parts of each pair of congruent triangles? If yes, what is your basis in identifying the congruent parts?
b. Are the corresponding congruent parts enough to prove that the two triangles are congruent?
c. What congruence postulate can be used to prove the congruence of each pair of triangles?



What is It

In the previous lesson, you learned that triangles are congruent if they have exactly the same shape and size. Specifically, two triangles are congruent if and only if their vertices can be made to coincide so that corresponding sides are congruent and corresponding angles are congruent. However, in certain cases, if the three pairs of corresponding parts are congruent, then it is sufficient to prove that two triangles are congruent.

Let us now recall the conditions under which two triangles are congruent.

1. SAS (Side-Angle-Side) Congruence Postulate

   If two sides and an included angle of one triangle are congruent to the corresponding two sides and the included angle of another triangle, then the triangles are congruent.

2. ASA (Angle-Side-Angle) Congruence Postulate

   If two angles and the included side of one triangle are congruent to the corresponding two angles and an included side of another triangle, then the triangles are congruent.

3. SSS (Side-Side-Side) Congruence Postulate

   If three sides of one triangle are congruent to the corresponding three sides of another triangle, then the triangles are congruent.

From these congruence postulates mentioned above, other theorems can be deduced.

Suppose you are given the measures of two angles and a non-included side, are these information sufficient to prove the congruence of the two triangles?

AAS (Angle-Angle-Side) Congruence Theorem

If two angles and the non-included side of one triangle are congruent respectively to the two angles and the non-included side of another triangle, then the two triangles are congruent.

In Figure 1, given that $\Delta DOG \cong \Delta CAT$, $\angle D \cong \angle C, \angle G \cong \angle T$ as marked, while $\overline{DO} \cong \overline{CA}$ tells the congruence of the non-included sides. The proof of this theorem is presented in Example 3.

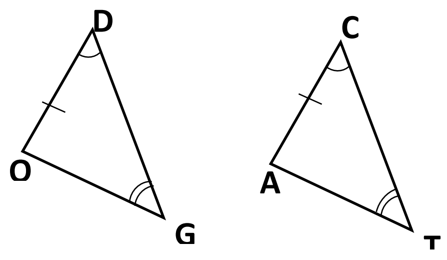


Figure 1

Another theorem that can be deduced from the congruence postulates are the congruence of right triangles. Below are the illustrations and descriptions of each theorem.

HyA (Hypotenuse-Acute angle) Congruence Theorem

If the hypotenuse and an acute angle of one right triangle are congruent to the corresponding hypotenuse and an acute angle of another right triangle, then the triangles are congruent.

This theorem can be applied to right triangles only. Figure 2 at the right shows two right triangles ΔRGA and ΔMSA. The hypotenuses $\overline{AR}$ and $\overline{AM}$ are congruent as marked, $\angle RGA$ and $\angle MSA$ are congruent because they are right angles, $\angle GAR$ and $\angle SAM$ are acute angles and $\angle GAR \cong \angle SAM$ because they are vertical angles. Using these congruent parts, the two triangles are congruent by **HyA Congruence Theorem**. The proof of this theorem is shown in Example 4.

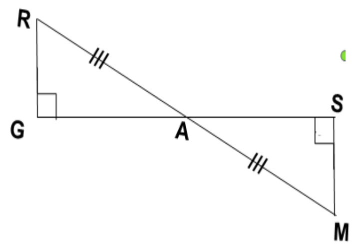


Figure 2

HyL (Hypotenuse-leg) Congruence Theorem

If the hypotenuse and a leg of one right triangle are congruent to the corresponding hypotenuse and a leg of another triangle, then the triangles are congruent.

Again, this theorem can be applied to right triangles only. As shown in Figure 3 at the right, $\Delta USB \cong \Delta ARC$. $\overline{US}$ and $\overline{AR}$ are legs, and $\overline{UB}$ and $\overline{AC}$ are the hypotenuses of the given triangles, $\overline{US} \cong \overline{AR}$ and $\overline{UB} \cong \overline{AC}$ as marked, while $\angle S \cong \angle R$, because both are right angles. The two right triangles are congruent by **HyL Congruence Theorem**. The proof of this is found in Example 5.

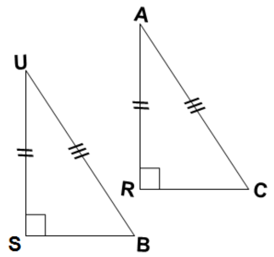


Figure 3

LA (leg-acute angle) Congruence Theorem

If a leg and an acute angle of one right triangle are congruent to a leg and an acute angle of another right triangle, then the triangles are congruent.

In the two right triangles in Figure 4, $\overline{GU}$ and $\overline{RA}$ are the congruent legs as marked, and $\angle M$ and $\angle P$ are congruent acute angles as marked, and $\angle G \cong \angle R$ because both are right angles. Hence, $\overline{GU}$ and $\angle M$ are congruent respectively to $\overline{RA}$ and $\angle P$. The two right triangles are congruent by LA Congruence Theorem. The proof of this theorem is shown in Example 6.

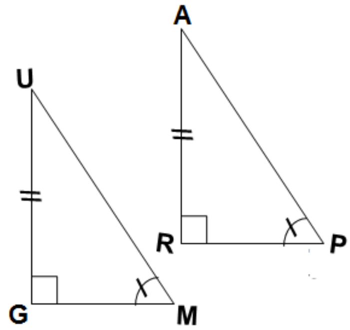


Figure 4

LL (Leg Leg) Congruence Theorem

If the legs of one right triangle are congruent to the legs of another right triangle, then the triangles are congruent.

In the right triangles in Figure 5 at the right, $\overline{AB}$ and $\overline{OC}$ are the longer legs while $\overline{BG}$ and $\overline{CP}$ are the shorter legs of the two triangles. $\overline{AB} \cong \overline{OC}$ and $\overline{BG} \cong \overline{CP}$ as marked. Hence, we can conclude that the two legs of ΔBAG are congruent to the two legs of ΔCOP so, $\Delta BAG \cong \Delta COP$ by LL Congruence Theorem. The proof of this theorem is shown in Example 7.

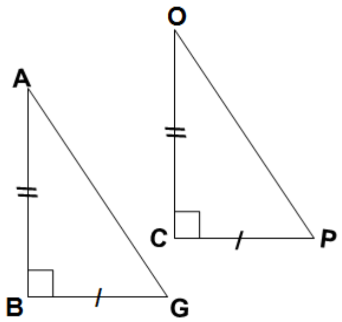


Figure 5

How do we prove that two triangles are congruent? How do we prove the different triangle congruence theorems? Here are the steps in proving that two triangles are congruent.

Steps in Proving Congruence of Two Triangles

Step 1. Identify what the given are, and what is to be proved. Mark the given information on

the diagram.

Step 2. Identify the congruence theorem to be used and the additional information needed

and why.

Now, let us apply the congruence postulates and theorems in proving congruent triangles using the illustrative examples below.

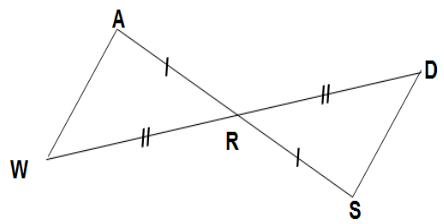


Figure 6

Example 1. Prove that $\Delta RAW \cong \Delta RSD$ in Figure 6 at the right.

Step 1. *Identify what the given are and what is to be proved.*

Given: $\overline{AR} \cong \overline{SR}$, $\overline{WR} \cong \overline{DR}$

Prove: $\Delta RAW \cong \Delta RSD$

Step 2. *Identify the congruence theorem to be used and the additional information needed and why.*

$\angle WRA$ and $\angle DRS$ are vertical angles so they are congruent by Vertical Angle Theorem, hence **SAS congruence postulate can be used to prove** $\Delta RAW \cong \Delta RSD$.

Step 3. *Write down the statements and the reasons in a two-column proof. Make sure the last statement contains what should be proved.*

Two-column proof:

Statements	Reasons
1). $\overline{AR} \cong \overline{SR}$, $\overline{WR} \cong \overline{DR}$	1). Given
2). $\angle WRA$ and $\angle DRS$ are vertical angles	2). Definition of vertical angles
3). $\angle WRA \cong \angle DRS$	3). Vertical Angle Theorem
4). $\Delta RAW \cong \Delta RSD$	4). SAS Congruence Postulate

We were able to show the congruence of the two triangles using **SAS congruence postulate.**

Example 2. Based on Figure 7 at the right, prove that $\Delta REC \cong \Delta CAR$.

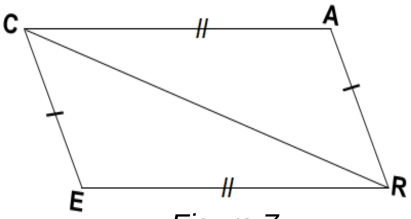


Figure 7

Step 1. *Identify what the given are and what is to be proved.*

Given: $\overline{RE} \cong \overline{CA}$, $\overline{EC} \cong \overline{AR}$

Prove: $\Delta REC \cong \Delta CAR$

Step 2. *Identify the congruence theorem to be used and the additional information needed and why.*

$\overline{CR}$ is the common side of ΔREC *and* ΔCAR, so by reflexive property. Hence, **SSS postulate can be used to prove** $\Delta REC \cong \Delta CAR$ because each of the three sides of ΔREC is congruent respectively to the three sides of ΔCAR.

Step 3. *Write down the statements and the reasons in a two-column proof. Make sure the last statement contains what should be proved.*

Two-column proof:

Statements	Reasons
1). $\overline{RE} \cong \overline{CA}$, $\overline{EC} \cong \overline{AR}$	1). Given
2). $\overline{CR} \cong \overline{CR}$	2). Reflexive Property
3). $\Delta REC \cong \Delta CAR$	3). SSS Congruence Postulate

Example 3. In the Figure 8 at the right, prove that

$\Delta DOG \cong \Delta CAT$

Step 1. *Identify what the given are and what is to be proved*

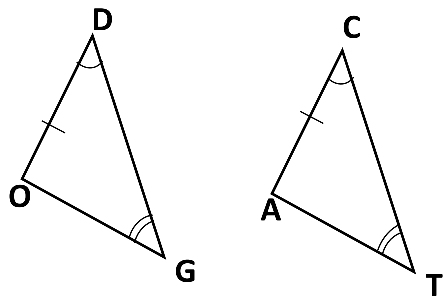


Figure 8

Given: $\overline{DO} \cong \overline{CA}$, $\angle D \cong \angle C$, $\angle G \cong \angle T$

Prove: $\Delta DOG \cong \Delta CAT$

Step 2. *Identify the congruence theorem to be used and the additional information needed and why.*

Since it is given that $\angle D \cong \angle C$, $\angle G \cong \angle T$, then by Angle Sum Theorem, $\angle O \cong \angle A$.

Angle Sum Theorem states that the sum of the measures of the angles of a triangle is 180°. Because the two corresponding pairs of angles are already congruent, so the third pair of angles are also congruent.

Thus, the two triangles can be proven either by **ASA congruence postulate** or by **AAS congruence theorem.**

Step 3. *Write down the statements and the reasons in a two-column proof. Make sure the last statement contains what should be proved.*

Two-column proof:

Statements	Reasons
1). $\overline{DO} \cong \overline{CA}$, $\angle D \cong \angle C$, $\angle G \cong \angle T$	1). Given
2). $\Delta DOG \cong \Delta CAT$	2). AAS Congruence Theorem

or

1). $\overline{DO} \cong \overline{CA}$, $\angle D \cong \angle C$, $\angle G \cong \angle T$	1). Given
2). $m\angle D = m\angle C$; $m\angle G = m\angle T$	2). Definition of Congruent Angles
3). $m\angle D + m\angle O + m\angle G = 180^o$ $m\angle C + m\angle A + m\angle T = 180^o$	3). Angle Sum Theorem In a triangle
4a). $m\angle O = 180^o - m\angle D - m\angle G$ 4b). $m\angle A = 180^o - m\angle C - m\angle T$	4). Addition Property of Equality
5). $m\angle A = 180^o - m\angle D - m\angle G$	5). Substitution Property (2)
6). $m\angle O = m\angle A$	6). Transitive Property of Equality (4a & 5)
7). $\angle O \cong \angle A$	7). Converse of the Definition of Congruent Angles
8). $\Delta DOG \cong \Delta CAT$	8). ASA Congruence Postulate

You have noticed that in this example, we were able to prove the congruence of the given triangles by ASA postulate and at the same time by **AAS theorem**.

Let us try to use AAS congruence theorem in proving triangle congruence in the next example.

Example 4. In the right triangles in Figure 9 at the right, prove that $\Delta ARG \cong \Delta AMS$.

Step 1. *Identify what the given are and what is to be proved.*

Given: $\overline{RA} \cong \overline{MA}$, $\angle G$ and $\angle S$ are right angles

Prove: $\Delta ARG \cong \Delta AMS$

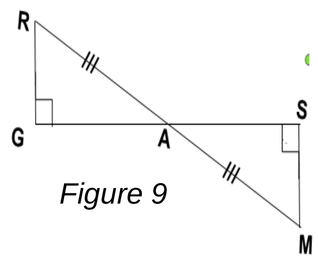


Figure 9

Step 2. *Identify the congruence theorem to be used and the additional information needed and why.*

Since $\overline{RM}$ intersects $\overline{GS}$, vertical angles are formed, and vertical angles are congruent. Thus, AAS congruence theorem can be used to prove $\Delta ARG \cong \Delta AMS$.

Step 3. *Write down the statements and the reasons in a two-column proof. Make sure the last statement contains what should be proved.*

Two-column proof:

Statements	Reasons
1). $\overline{RA} \cong \overline{MA}$	1). Given
2). $\angle G$ and $\angle S$ are right angles	2). Given
3). $\angle G \cong \angle S$	3). Right Angle Theorem
4). $\angle RAG$ and $\angle MAS$ are vertical angles	4). Definition of Vertical Angles
5). $\angle RAG \cong \angle MAS$	5). Vertical Angles Theorem
6). $\Delta ARG \cong \Delta AMS$	6). AAS Congruence Theorem

Hence, the two triangles are congruent by **AAS theorem.**

Example 5. Figure 10 at the right shows that the hypotenuses and legs of the two right triangles are given to be congruent respectively. Prove that $\Delta BUS \cong \Delta CAR$.

Step 1. *Identify what the given are and what is to be proved*

Given: $\overline{US} \cong \overline{AR}$, $\overline{BU} \cong \overline{CA}$, $\angle S$ and $\angle R$ are right angles

Prove: $\Delta BUS \cong \Delta CAR$

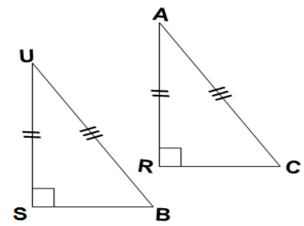


Figure 10

Step 2. *Identify the congruence theorem to be used and the additional information needed and why.*

The congruence of the ΔBUS and ΔCAR can be proven using SSS congruence postulate and HyL congruence theorem.

Case 1): In using the SSS congruence postulate, there is a need to show the congruence of $\overline{SB}$ and $\overline{RC}$ using the Pythagorean equation since the given triangles are right triangles.

Case 2); $\Delta BUS \cong \Delta CAR$ can also be proven using the HyL congruence theorem because the given triangles are right triangles.

Step 3. *Write down the statements and the reasons in a two-column proof. Make sure the last statement contains what should be proved.*

Two-column proof:

Case 1:

Statements	Reasons
1). $\overline{US} \cong \overline{AR}$, $\overline{BU} \cong \overline{CA}$	1). Given
2). $\lvert US\rvert = \lvert AR\rvert$, $\lvert BU\rvert = \lvert CA\rvert$	2) Definition of congruent segments
3) $\angle S$ and $\angle R$ are right angles.	3). Given
4). ΔBUS *and* ΔCAR are right triangles.	4). Definition of right triangle.
5a). $\lvert BU\rvert^2 = \lvert US\rvert^2 + \lvert SB\rvert^2$ 5b). $\lvert CA\rvert^2 = \lvert AR\rvert^2 + \lvert RC\rvert^2$	5). Pythagorean Theorem
6a). $\lvert BU\rvert^2 - \lvert US\rvert^2 = \lvert SB\rvert^2$ 6b). $\lvert CA\rvert^2 - \lvert AR\rvert^2 = \lvert RC\rvert^2$	6). Addition Property of Equality

7). $\lvert BU\rvert^2 - \lvert US\rvert^2 = \lvert RC\rvert^2$	7). Substitution Property (2)
8a). $\lvert SB\rvert = \sqrt{\lvert BU\rvert^2 - \lvert US\rvert^2}$ 8b). $\lvert RC\rvert = \sqrt{\lvert BU\rvert^2 - \lvert US\rvert^2}$	8). Raising Each Side to a Power Property
9). $\lvert SB\rvert = \lvert RC\rvert$	9). Transitive Property
10). $\overline{SB} \cong \overline{RC}$	10). Converse of the Definition of Congruent segments
11). $\Delta BUS \cong \Delta CAR$	11). SSS Congruence Postulate

Case 2:

Statements	Reasons
1). $\overline{US} \cong \overline{AR}$, $\overline{BU} \cong \overline{CA}$	1). Given
2) $\angle S$ and $\angle R$ are right angles.	2). Given
3). $\angle S \cong \angle R$	3). Right Angle Theorem
4). ΔBUS *and* ΔCAR are right triangles.	4). Definition of right triangle.
5). $\overline{US}$ *and* $\overline{AR}$ are legs of the right triangles	5). Definition of leg of a right triangle. (A side of a right triangle opposite an acute angle is called leg.)
6). $\overline{BU}$ *and* $\overline{CA}$ are the hypotenuses of the right triangles.	6). Definition of hypotenuse.
7). $\Delta BUS \cong \Delta CAR$	7).) HyL Congruence Theorem

Example 6. In Figure 11 at the right, corresponding congruent parts of the right triangles are similarly marked. Prove that $\Delta GUM \cong \Delta RAP$.

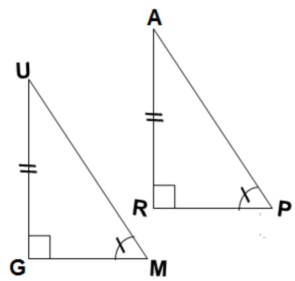


Figure 11

Step 1. *Identify what the given are and what is to be proved,*

Given: $\overline{GU} \cong \overline{RA}$, $\angle M \cong \angle P$, $\angle G$ *and* $\angle R$ are right angles

Prove: $\Delta GUM \cong \Delta RAP$

Step 2. *Identify the congruence theorem to be used and the additional information needed and why.*

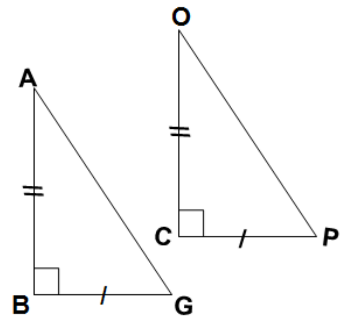
By the Right-Angle theorem, $\angle G \cong \angle R$, plus the given above, we can prove that $\Delta GUM \cong \Delta RAP$ by **AAS congruent theorem**. And since the given triangles are right triangles, $\Delta GUM \cong \Delta RAP$ can be proven by **LA congruence theorem.**

Step 3. *Write down the statements and the reasons in a two-column proof. Make sure the last statement contains what should be proved.*

Two-column proof:

Statements	Reasons
1). $\overline{GU} \cong \overline{RA}$, $\angle M \cong \angle P$	1). Given
2). $\angle G$ *and* $\angle R$ are right angles	2). Given
3). $\angle G \cong \angle R$	3). Right Angle Theorem
4). $\overline{GU}$ *and* $\overline{RA}$ are legs of the right triangles.	4). Definition of leg of a right triangle Leg is a side of a right triangle opposite an acute angle.
5). $\angle M$ *and* $\angle P$ are acute angles in the right triangles	5). Acute angle in a right triangle is opposite to a leg.
6). $\Delta GUM \cong \Delta RAP$	6). AAS Congruence Theorem
7). $\Delta GUM \cong \Delta RAP$	7) LA Congruence Theorem

Example 7. The two legs of ΔBAG are congruent respectively to the two legs of ΔCOP. The two triangles are right. Prove that $\Delta BAG \cong \Delta COP$



Step 1. *Identify what the given are and what is to be proved*

Given: $\overline{BA} \cong \overline{CO}$, $\overline{BG} \cong \overline{CP}$, ΔABG *and* ΔOCP are right triangles

Prove: $\Delta BAG \cong \Delta COP$

Step 2. *Identify the congruence theorem to be used and the additional information needed and why.*

Since the two triangles, ΔABG *and* ΔOCP are right, hence $\angle B \cong \angle C$. Based on the given congruent parts, $\Delta BAG \cong \Delta COP$ by **SAS congruence postulate.**

The congruence of the corresponding legs of the two triangles will lead us to show that $\overline{AG} \cong \overline{OP}$ through the use of Pythagorean Theorem. So, $\Delta BAG \cong \Delta COP$ can also be proven using SSS Congruence Postulate.

And since the corresponding legs of the right triangles are congruent, it can also be proven by **LL congruence theorem, as shown in step 3 below**

Step 3. *Write down the statements and the reasons in a two-column proof. Make sure the last statement contains what should be proved.*

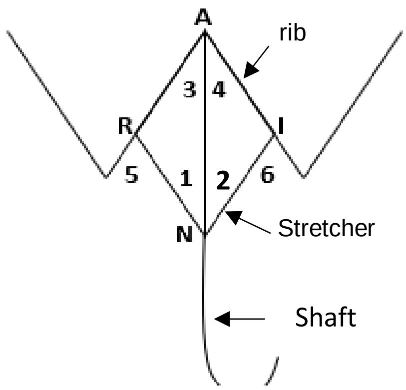
Two-column proof:

Statements	Reasons
1). $\overline{BA} \cong \overline{CO}$, $\overline{BG} \cong \overline{CP}$	1). Given
2). ΔABG *and* ΔOCP are right triangles	2). Given
3). $\angle B$ *and* $\angle C$ are right angles	3). Given in the figure. Definition of right triangle.
4). $\angle B \cong \angle C$	4). Right-Angle Theorem

5). $\overline{BA}$ *and* $\overline{CO}$, $\overline{BG}$ *and* $\overline{CP}$ are pairs of corresponding legs of the right triangles	5). Legs are sides of a right triangle opposite the acute angles.
6). $\Delta BAG \cong \Delta COP$	6). LL Congruence Theorem

Now let us try to explore examples of triangle congruence in the real-world and prove that these triangles are congruent.

Example 8. Shapes formed by the ribs, stretchers, and shaft are congruent whether an umbrella is open or closed. Prove that the triangles formed by the shaft and the ribs are congruent.



Step 1. *Identify what the given are and what is to be proved*

Given: Quadrilateral RAIN is a parallelogram, and $\overline{AN}$ is a diagonal.

Prove: $\Delta ARN \cong \Delta NIA$

Step 2. *Identify the congruence theorem to be used and the additional information needed and why.*

The congruence between ΔARN *and* ΔNIA can be proven by SSS, ASA, and SAS congruence postulates.

Step 3. *Write down the statements and the reasons in a two-column proof. Make sure the last statement contains what should be proved.*

Proof: Case 1:

Statements	Reasons
1). Quadrilateral RAIN is a parallelogram.	1). Given
2). $\overline{AN}$ is a diagonal.	2). Given
3). $\overline{AR} \cong \overline{NI}$ *and* $\overline{RN} \cong \overline{IA}$	Opposite sides of a parallelogram are congruent.
4). $\overline{AN} \cong \overline{AN}$	4). Reflexive Property
5). $\Delta ARN \cong \Delta NIA$	5). SSS Congruence Postulate

Proof: Case 2:

Statements	Reasons
1). Quadrilateral RAIN is a parallelogram.	1). Given
2). $\overline{AN}$ is a diagonal.	2). Given
3). $\angle R \cong \angle I$	Opposite angles of a parallelogram are congruent.
4). $\overline{AR} \cong \overline{NI}$ *and* $\overline{RN} \cong \overline{IA}$	Opposite sides of a parallelogram are congruent.
5). $\Delta ARN \cong \Delta NIA$	5). SAS Congruence Postulate

Proof: Case 3:

1). Quadrilateral RAIN is a parallelogram.	1). Given
2). $\overline{AN}$ is a diagonal.	2). Given
3). $\overline{AR} \parallel \overline{NI}$ *and* $\overline{RN} \parallel \overline{IA}$	Opposite sides of a parallelogram are parallel.
3). $\angle 1 \cong \angle 4$ and $\angle 2 \cong \angle 3$	Alternate interior angles are congruent if parallel lines are cut by a transversal
4). $\overline{AN} \cong \overline{AN}$	4). Reflexive Property
5). $\Delta ARN \cong \Delta NIA$	5). ASA Congruence Postulate

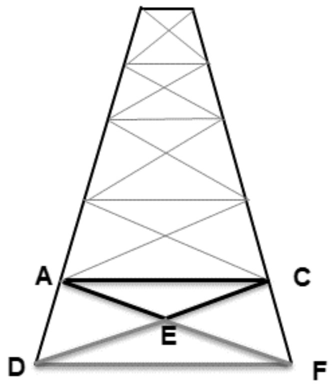
Example 9. Determine if triangles are congruent. Consider the figure at the right. The diagonals of the tower form triangles. Consider ΔAEC and ΔFED as illustrated.

Step 1. *Identify what the given are and what is to be proved.*

Given: Quadrilateral ADFC is an isosceles trapezoid, and $\angle EAC \cong \angle EFD$.

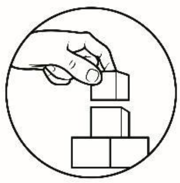
Prove: $\Delta AEC \cong \Delta FED$

Step 2. *Identify the congruence theorem to be used and the additional information needed and why.*



$\angle EAC \cong \angle EFD$	given congruent angles
$\angle ECA \cong \angle EDF$	congruent because Alternate Interior Angles
$\angle AEC \cong \angle FED$	congruent by Vertical Angle Theorem
$\overline{AC}$ *and* $\overline{DF}$ *are not congruent*	Parallel sides of a trapezoid are not congruent.
$\overline{AE}$ *and* $\overline{EF}$ *are not congruent* $\overline{CE}$ *and* $\overline{ED}$ *are not congruent*	Diagonals of an isosceles trapezoid do not bisect each other.
ΔAEC *and* ΔDEF are not congruent.	Notice that the three pairs corresponding angles of the two triangles are congruent. However, this fact will not be sufficient to prove triangle congruence

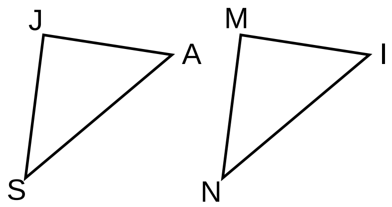
The Angle-Angle-Angle (AAA) combination shows that the two triangles may have the same shape but different sizes. In the figure, ΔAEC *and* ΔFED have corresponding angles congruent but their sizes are not the same, hence their corresponding sides are not congruent. Therefore, ΔAEC *and* ΔFED are not congruent.



What's More

Activity 1: Give Me!

I. Using the given congruent parts, state the postulate or theorem that proves $\Delta JAS \cong \Delta MIN$



1. $\overline{JS} \cong \overline{MN}$, $\angle J \cong \angle M$, $\overline{JA} \cong \overline{MI}$
2. $\angle S \cong \angle N$, $\angle A \cong \angle I$, $\overline{SA} \cong \overline{NI}$
3. $\angle J \cong \angle M$, $\angle A \cong \angle I$, $\overline{SA} \cong \overline{NI}$

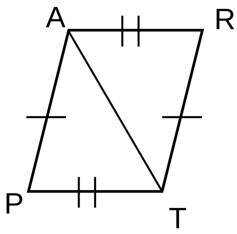
II. Give additional congruent parts needed to prove that $\Delta CAR \cong \Delta TOY$ by the indicated postulate.

1. $\boldsymbol{\overline{AR} \cong \overline{OY}, \angle R \cong \angle Y}$; SAS
2. $\angle C \cong \angle T$, $\overline{AC} \cong \overline{OT}$; ASA
3. $\overline{TO} \cong \overline{CA}$, $\overline{TY} \cong \overline{CR}$; SSS

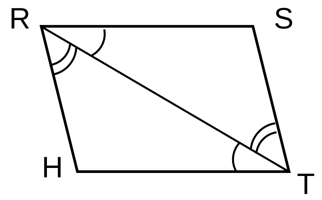
III.

In each figure, congruent parts are marked. Give additional parts to prove that the triangles are congruent and name the postulate or theorem that justifies the congruence.

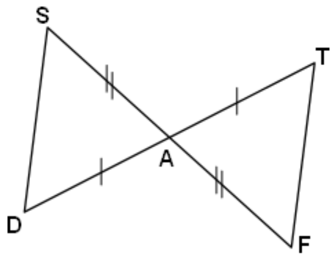
1.



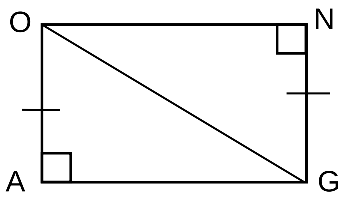
2.



3.



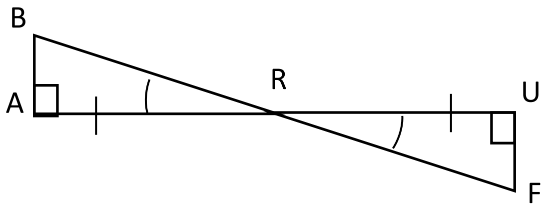
4.



Questions:

1. How did you identify the postulate or theorem in part I?
2. How did you identify the additional part to prove that the two triangles are congruent in Part II?
3. Were you able to give an additional congruent part in Part III to prove that the two triangles are congruent? If yes, how?

Activity 2: Fill Me Up



Given: R is the midpoint of $\overline{AU}$

$\angle A$ and $\angle U$ are right angles

Prove: $\Delta BAR \cong \Delta FUR$

Proof: (Complete the table)

Statements	Reasons
1. R is the midpoint of $\overline{AU}$	1.
2.	2. Definition of Midpoint
3.	3. Given
4. $\angle A \cong \angle U$	4.
5. $\angle BRA$ and $\angle FRU$ are vertical angles	5. Definition of Vertical Angles
6.	6. Vertical Angle Theorem
7. $\Delta BAR \cong \Delta FUR$	7.

Questions:

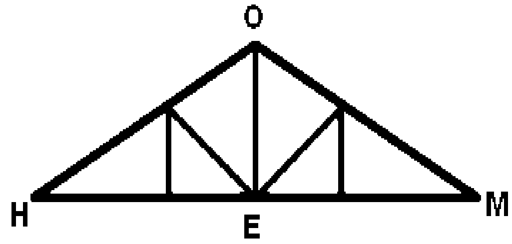
1). What are the identified congruent corresponding parts?

2). What congruence postulate and congruence theorem can be used to prove that

$\Delta BAR \cong \Delta FUR$?

Activity 3. My Home

Trusses in our houses form congruent triangles similar to the picture at the right.



Given: $\overline{HO} \cong \overline{MO}$, $\overline{HE} \cong \overline{ME}$

Prove: $\Delta HOE \cong \Delta MOE$

Proof:

Statements	**Reasons**
1. $\overline{HO} \cong \overline{MO}$, $\overline{HE} \cong \overline{ME}$	1.
2.	2. Reflexive Property
3. $\Delta HOE \cong \Delta MOE$	3.

Questions:

1. How do you find the activity? Did you find it difficult to prove the congruence of two triangles?
2. Why do you think the trusses in our houses form congruent triangles?
3. List down at least five things in your house, buildings or other structures found in your community where congruent triangles are used. Explain the importance of congruent triangles in these structures.

What I Have Learned

PROVING CONGRUENT TRIANGLES

Name and describe the triangle congruence postulates and theorems by filling up the blanks with the correct answer

Fill each blank with correct answer.

Two triangles are congruent if and only if their ______________ can be made to coincide such that corresponding ______________ are congruent and corresponding ______________ are congruent.

Instead of showing the six corresponding congruent parts, the congruence postulates and theorems reduce these into three. The Congruence Postulates are ______________ , ______________ , and ______________ .

The Congruence Theorems are ______________ , ______________ , ______________ , ______________ , and ______________ . The AAS Congruence Triangle Theorem is deduced from ______________ Congruence Postulate. ______________ and ______________ are theorems which can be proved using the AAS Congruence Theorems while ______________ and are theorems which can be proved

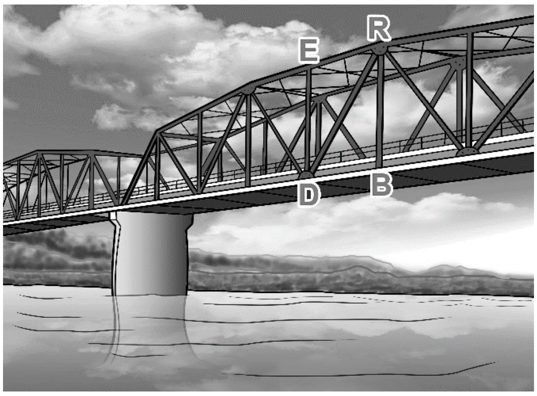
Illustrate the three triangle congruence postulates

Answer this!

Why do congruent triangles appear in many structures such as buildings and towers?

What I Can Do

The **Buntun bridge** spans the Cagayan River. It is 1,369 m long and said to be the longest river **bridge** in the country. It was opened in 1947 and has been known as the gateway to the City of Tuguegarao. The **bridge** has never been flooded by the river but it almost did when typhoons Ondoy and Juan hit the city. One of the reasons why it still stands magnificently until today because of its structures that are made of congruent triangles.



Buntun Bridge

In the figure at the right, it is given that

$\overline{\boldsymbol{ED}} \cong \overline{\boldsymbol{RB}}$ and $\overline{\boldsymbol{ED}} \,//\, \overline{\boldsymbol{RB}}$.

Prove that $\Delta\boldsymbol{RED} \cong \Delta\boldsymbol{DBR}$ by completing the two-column proof below.

Proof:

Statements	**Reasons**
1. $\overline{ED} \cong \overline{RB}$ $\overline{ED} \,//\, \overline{RB}$	1.
2. $\angle BRD$ & $\angle EDR$ are alternate interior angles	2.
3. $\angle BRD \cong \angle EDR$	3.
4. $\overline{RD} \cong \overline{RD}$	4.
5. $\Delta RED \cong \Delta DBR$	5.

Assessment

Directions: Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

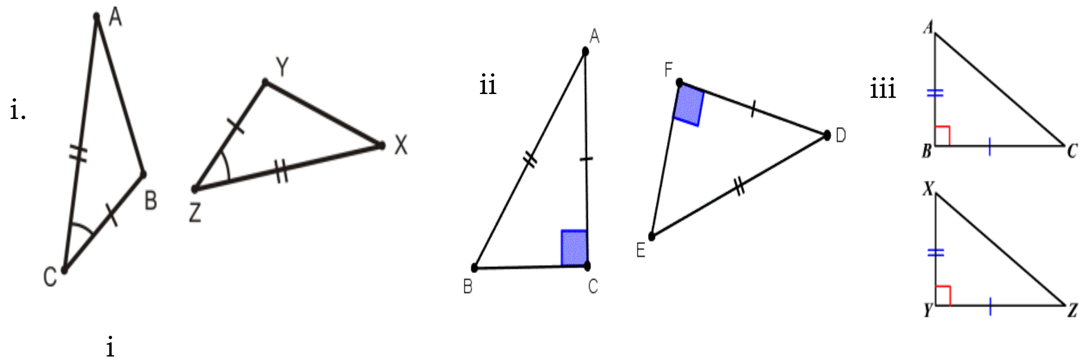
1. Which of the theorems below states that: "If two angles and a non-included side of one triangle are congruent to the corresponding two angles and a non-included side of another triangle, then the triangles are congruent."?

   A. HyA Congruence Theorem
   B. HyL Congruence Theorem
   C. LL Congruence Theorem
   D. AAS Congruence Theorem

2. Which of the following theorems states that: "If the hypotenuse and an acute angle of one right triangle are congruent to the corresponding hypotenuse and an acute angle of another right triangle, then the triangles are congruent."?

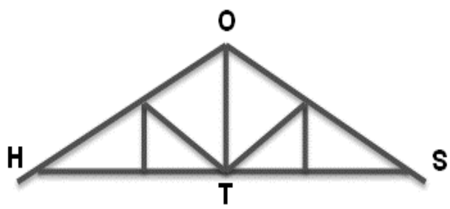
   A. HyA Congruence Theorem
   B. HyL Congruence Theorem
   C. LA Congruence Theorem
   D. LL Congruence Theorem

3. Which of the following pairs of triangles below are congruent and can be proved by SAS Congruence?



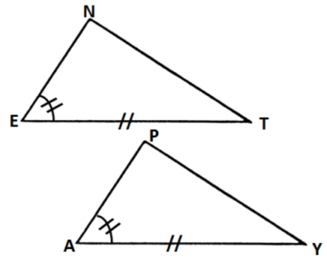
   A. i and ii
   B. ii and iii
   C. iii
   D. i, ii, and iii

4. In the figure at the right, $\overline{OT}$ is a perpendicular bisector of $\overline{HS}$ at T. What triangle congruence theorem can be used to prove that $\Delta HOT \cong \Delta SOT$?



   A. LL Congruence Theorem
   B. HyA Congruence Theorem
   C. HyL Congruence Theorem
   D. AAS Congruence Theorem

5. In the figures at the right, $\angle E \cong \angle A$, $\overline{ET} \cong \overline{AY}$. What additional data is needed to prove that $\Delta NET \cong \Delta PAY$ by SAS Congruence?



A. $\angle N \cong \angle P$
B. $\angle T \cong \angle Y$
C. $\overline{NE} \cong \overline{PA}$
D. $\overline{NT} \cong \overline{PY}$

6. Which statement is NOT sufficient to prove the congruence of two triangles?

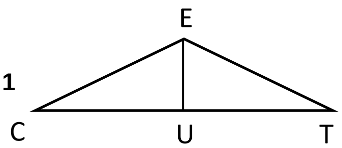
A. Two angles and the included side of one triangle are congruent respectively to the two angles and the included side of another triangle.
B. Two sides of one triangle are congruent respectively to the two sides of another triangle
C. Two angles and the non-included side of one triangle are congruent respectively to the two angles and the non-included side of another triangle.
D. Three sides of one triangle are congruent respectively to the three sides of another triangle.

For items 7 to 9, complete the table below. Choose the letter of the correct answer from the choices provided.

A. $\angle CUE$ and $\angle TUE$ are right angles
B. Given
C. $\overline{\text{EU}} \cong \overline{\text{EU}}$
D. SAS Congruence Postulate
E. Right Angle Theorem

Given: $\overline{EU}$ is the $\perp$ bisector of $\overline{CT}$
Prove: $\Delta CUE \cong \Delta TUE$

Figure No. 1



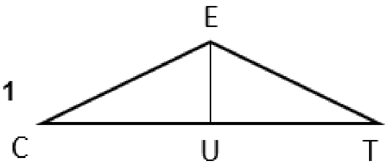
Proof:

Statements	Reasons
1. $\overline{EU}$ is the $\perp$ bisector of $\overline{CT}$	(7)
2. $\angle CUE$ and $\angle TUE$ are right angles	Definition of Perpendicular Line Segments
3. $\angle CUE \cong \angle TUE$	Right Angle Theorem
4. $\overline{CU} \cong \overline{UT}$	Definition of $\perp$ bisector
5. (8)	Reflexive Property
6. $\Delta CUE \cong \Delta TUE$	(9)

For items 10 to 12, use figure no. 1 and its given data to complete the table below by choosing the letter of the correct answer below.

Given: $\overline{EU}$ is the $\perp$ bisector of $\overline{CT}$
Prove: $\Delta CUE \cong \Delta TUE$

Figure No. 1



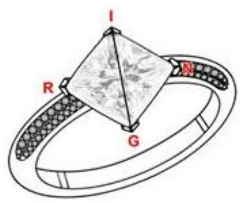
A. LA Congruence Theorem
B. Definition of perpendicular bisector
C. LL Congruence Theorem
D. HyL Congruence Theorem
E. HyA Congruence Theorem
F. $\Delta CUE \cong \Delta TUE$
G. $\overline{CU} \cong \overline{UT}$
H. $\overline{CU} \cong \overline{EU}$
I. $\overline{EU} \cong \overline{EU}$
J. $\angle C \cong \angle T$

Statements	Reasons
1. $\overline{EU}$ is the $\perp$ bisector of $\overline{CT}$	1. Given
2. U is the midpoint of $\overline{CT}$	2. (10)
3. (11)	3. Definition of Midpoint
4. $\angle CUE$ and $\angle TUE$ are right angles	4. Definition of perpendicular bisector
5. $\angle CUE \cong \angle TUE$	5. Right Angle Theorem
6. $\overline{EU} \cong \overline{EU}$	6. Reflexive Property
7. $\Delta CUE \cong \Delta TUE$	7. (12)

13. You are tasked to make a design of the flooring of your barangay hall using triangles. The available materials are square tiles. How are you going to make the design?

A. Apply triangle congruence by SSS
B. Apply triangle congruence by SAS.
F. Apply triangle congruence by ASA.
G. Apply triangle congruence by AAS.

14. The figure at the right shows a ring with a rhombus-shaped diamond. $\overline{IG}$ divides the diamond into two congruent triangles. What reason will justify that $\angle IRG \cong \angle ING$?



A. Adjacent angles congruent
B. Vertical angles are congruent
C. Alternate interior angle congruent
D. Opposite angles of a rhombus are congruent

15. Using the same figure in no. 14, what triangle congruence postulate/theorem may NOT be used to prove that $\Delta RIG \cong \Delta NIG$?
   A. SSS B. SAS C. SAA D. H

Additional Activities

During a storm, a man supported his hut by using three wires of equal length. The wires are staked to the ground at different points R, S, T which are of the same distance from the base of the hut. Explain and illustrate how you can prove that the angles formed by the wires attached to the ground are all congruent.

Your output will be rated using the following rubrics

10	8	6	4	2
Able to provide correct, logical, explanation and illustration of the hut completely and clearly	Able to provide an explanation and illustration of the hut but not complete and clear	Able to provide explanation and illustration of the hut but the hut being illustrated is not strong enough to survive the storm.	Able to provide a brief explanation without illustration.	Was not able to provide an explanation and illustration.

Answer Key

What I Know

1. B
2. A
3. C
4. B
5. B
6. C
7. C
8. B
9. D
10. A
11. A
12. A
13. B
14. E
15. B

What's In

1. C	2. B	3. A	4. C	5. B

What's New

1. $\overline{AR} \cong \overline{SR}$ $\overline{WR} \cong \overline{DR}$ $\angle ARW \cong \angle SRD$	2. $\overline{CE} \cong \overline{RA}$ $\overline{ER} \cong \overline{AC}$ $\overline{CR} \cong \overline{CR}$

What's More! Activity 1

I.
1. SAS Congruence Postulate
2. ASA Congruence Postulate
3. AAS Congruence Theorem

II.
1. $\overline{CR} \cong \overline{TY}$
2. $\angle A \cong \angle O$
3. $\overline{OY} \cong \overline{AR}$

III.
1. $\overline{AT\cancel{R}} \cong \overline{AT}$; SSS Congruence
2. $\overline{RT} \cong \overline{RT}$; ASA Congruence
3. $\angle SAD \cong \angle FAT$; SAS Congruence
4. $\overline{OG} \cong \overline{OG}$; HyL Congruence

What's More
Activity 2

Statements	Reasons
1.	1. Given
2. $\overline{AR} \cong \overline{RU}$	2.
3. $\angle A$ and $\angle U$ are right angles	*3.*
4.	*4. Right Angle Theorem*
5.	5.
6. $\angle BRA \cong \angle FRU$	6.
7.	7. ASA Congruence Postulate

What's More
Activity 3

Statements	Reasons
1.	1. Given
2. $\overline{OE} \cong \overline{OE}$	2.
3.	*3. SSS Congruence Postulate*

What I Have Learned

Two triangles are congruent if and only if their **vertices** can be paired such that corresponding **angles** are congruent and corresponding **sides** are congruent.

Instead of showing the six corresponding congruent parts, the congruence postulates and theorems reduce these into three. The Congruence Postulates are **SSS**, **SAS**, and **ASA**.

The Congruence Theorems are **AAS**, **LA**, **LL**, **HyA**, and **HyL**. The AAS Triangle Theorem is deduced from **ASA** Congruence Postulate. **LA** and **HyA** are theorems which can be proved using the AAS Congruence Theorems while **LL** and **HyL** are theorems which are proved using the SSS Postulates.

What I Can Do

Statements	Reasons
1. $\overline{ED} \cong \overline{RB}$ and $\overline{ED} \parallel \overline{RB}$	Given
2. $\angle BRD$ & $\angle EDR$ are alternate interior angles	Definition of alternate interior angles
3. $\angle BRD \cong \angle EDR$	When parallel lines are cut by a transversal, alternate interior angles are congruent
4. $\overline{RD} \cong \overline{RD}$	Reflexive property
5. $\Delta RED \cong \Delta DBR$	SAS Congruence

Assessment

1. D
2. A
3. D
4. A
5. C
6. B
7. B
8. C
9. D
10. B
11. G
12. C
13. A
14. D
15. D

Additional Activities

(Students' answers vary.)

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A. Book

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