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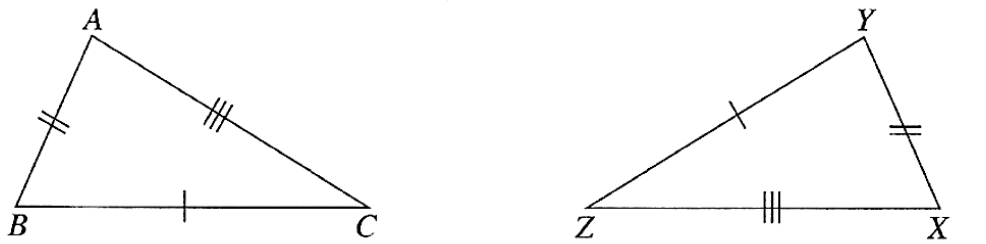
Secondary 3 Mathematics: Similarity and Congruency

1. Congruency

- Congruent objects have the exact same shape and size.
- When two objects/figures are congruent, then their
  (a) corresponding sides are equal (**same size**) and
  (b) corresponding angles are equal (**same size**).
- We use ≡ to represent congruent.

Example: If $\triangle ABC$ is congruent to $\triangle XYZ$, then



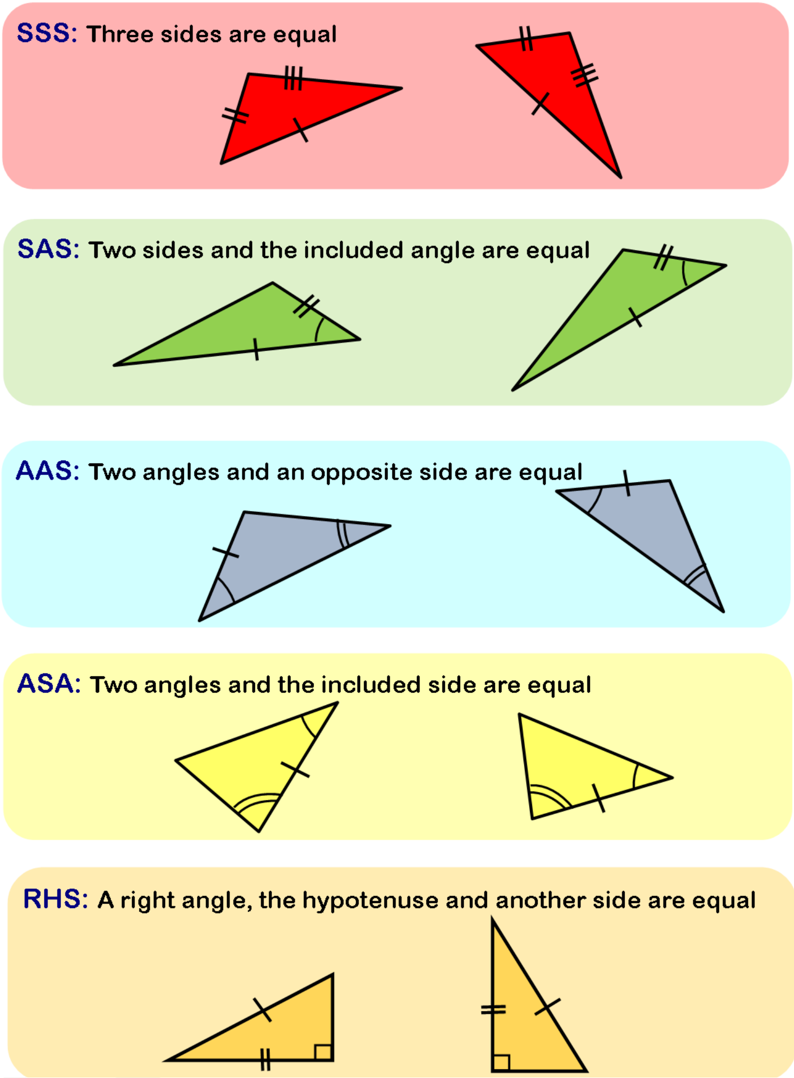
Corresponding sides	Corresponding angles
$AB = XY$	$\angle A = \angle X$
$BC = YZ$	$\angle B = \angle Y$
$AC = XZ$	$\angle C = \angle Z$

We write $\triangle ABC \equiv \triangle XYZ$

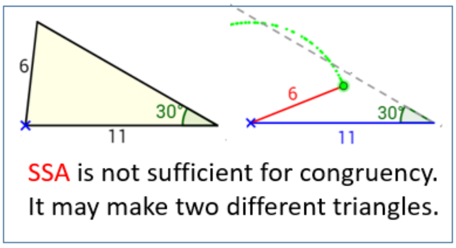
Important note: The order of the vertices (alphabets) of one triangle must correspond or match to the vertices (alphabets) of the other triangle.

For example, it is wrong to express $\triangle ABC \equiv \triangle YXZ$ for the above example.

- To prove that a pair of triangles are the same, use the following set of rules:



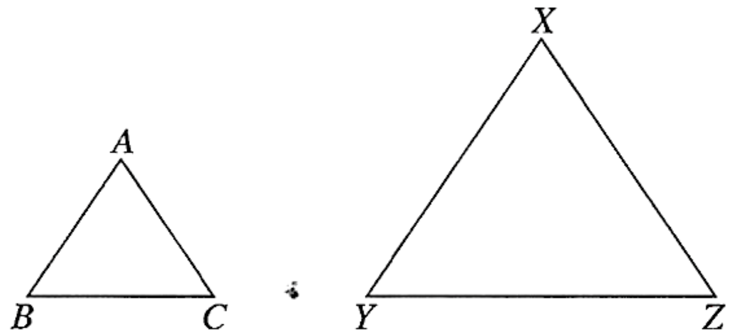
  - For SAS, the **<u>Angle</u>** must be between two **<u>Sides</u>**
  - For ASA/AAS → knowing two **<u>A</u>**ngles would mean that third **<u>A</u>**ngle can also be found. S must be present otherwise cannot prove that triangles are congruent
- SSA is not sufficient to prove congruency.



2. <u>Similar Objects</u>

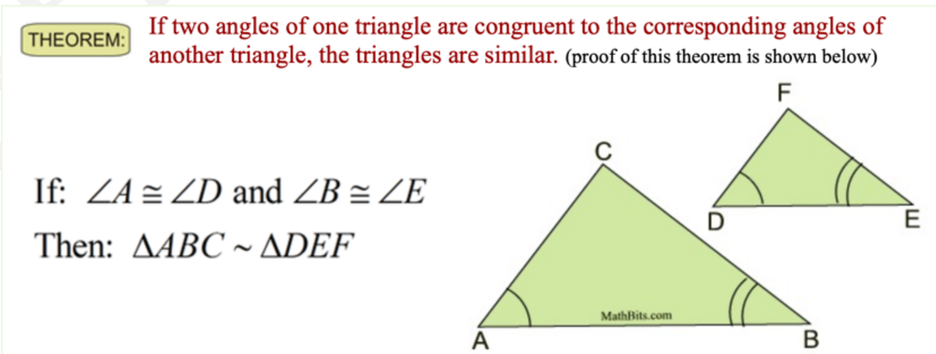
- Similarity is the study of figures that have the same shape but different sizes.
- When two figures are similar, their lengths, areas, volumes and masses should be in a certain ratio.
- If two figures are similar, then all the
  (a) corresponding angles are equal and
  (b) ratios of their corresponding sides are equal.

Example: If $\triangle ABC$ is similar to $\triangle XYZ$, then



Corresponding sides (ratio = constant)	Corresponding angles
$\frac{AB}{XY} = \frac{BC}{YZ} = \frac{AC}{XZ}$	$\angle A = \angle X$
	$\angle B = \angle Y$
	$\angle C = \angle Z$

- Similar objects can be proven by
  - (1) matching at least two angles. **(AA)**

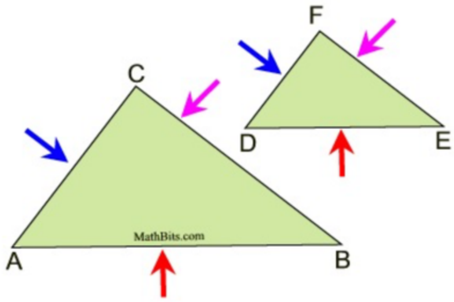


- (2) if ratios of all three sets of corresponding sides are in proportion. **(SSS)**

THEOREM: If the three sets of corresponding sides of two triangles are in proportion, the triangles are similar.

If: $\dfrac{AB}{DE} = \dfrac{BC}{EF} = \dfrac{AC}{DF}$

Then: $\Delta ABC \sim \Delta DEF$



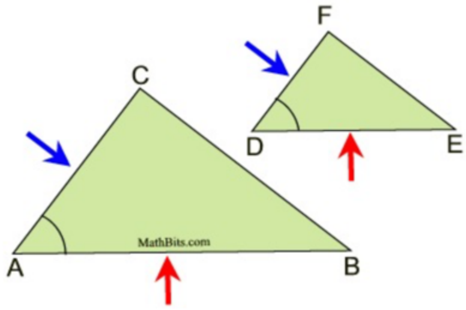
- (3) when two sets of corresponding sides are in proportion and one angle in between the sides are equal. **(SAS)**

THEOREM: If an angle of one triangle is congruent to the corresponding angle of another triangle and the lengths of the sides including these angles are in proportion, the triangles are similar.

If: $\dfrac{AB}{DE} = \dfrac{AC}{DF}$

and $\angle A \cong \angle D$

Then: $\Delta ABC \sim \Delta DEF$



- Ratios of areas and volumes of similar objects can also be found:
  - $\frac{Areaof\ A}{Area\ of\ B} = \left(\frac{length\ object\ A}{length\ object\ B}\right)^2$
    - Examples: surface areas, area of triangles and area of spheres
  - $\frac{Volume\ of\ A}{Volume\ of\ B} = \left(\frac{length\ object\ A}{length\ object\ B}\right)^3$
    - Examples: volume of cylinders, spheres and even mass
  - $\frac{Mass\ of\ A}{Mass\ of\ B} = \left(\frac{length\ object\ A}{length\ object\ B}\right)^3$
    - $since\ density = \frac{mass}{volume} \rightarrow \boldsymbol{volume} \times density\ = \boldsymbol{mass}$
    - therefore, $\boldsymbol{mass}$ is directly proportional to $\boldsymbol{volume}$

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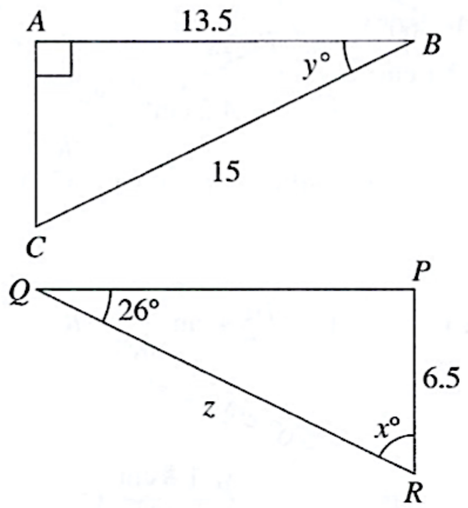
Similarity and Congruency (Worksheet 1a)

1. It is given that $\triangle ABC$ is congruent to $\triangle PQR$. Find the values of x, y and z.

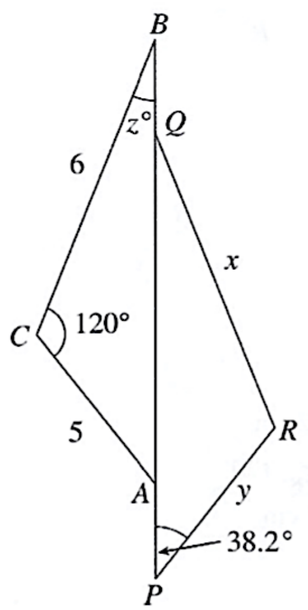


Answer : x = ______________

y = ______________

z = ______________

2. It is given that $\triangle ABC$ is congruent to $\triangle PQR$. Find the values of x, y and z.



Answer : x = ______________

y = ______________

z = ______________

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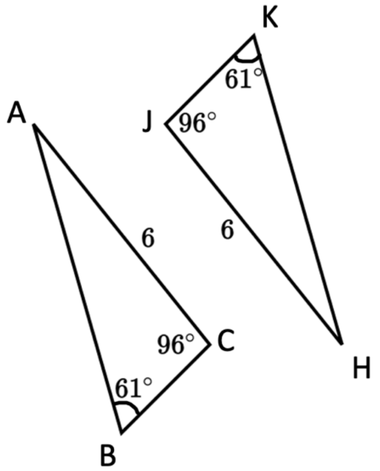
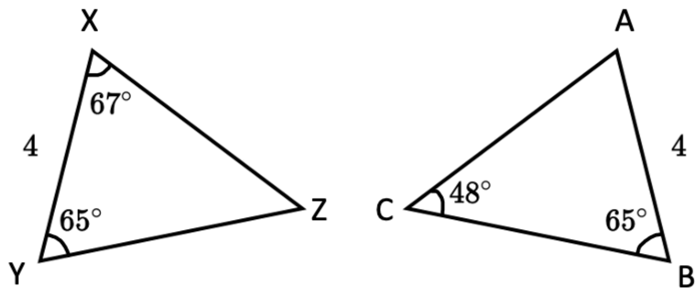
Similarity and Congruency (Worksheet 1c)

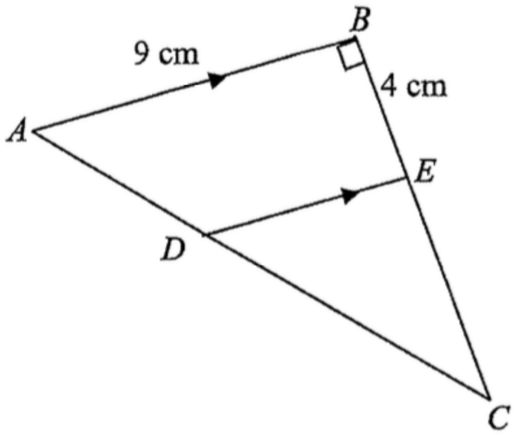
1. Consider the two triangles, ΔACB and ΔHKJ, shown below, prove that ΔACB is congruent to ΔHJK. State your reasons clearly.



2. Consider the two triangles, ΔABC and ΔXYZ, shown below, prove that ΔABC is congruent to ΔXYZ. State your reasons clearly.



11. In the diagram, AB is parallel to DE and $BC = \frac{3}{2}EC$. AB = 9 cm and BE = 4cm.



(a) Show that triangle *ABC* is similar to triangle *DEC*.

(b) Calculate the length of *CE*.

Answer : *EC* = _________________ cm

(c) Find the ratio of the area of triangle *ABC* to triangle *DEC*.

Answer : _________________

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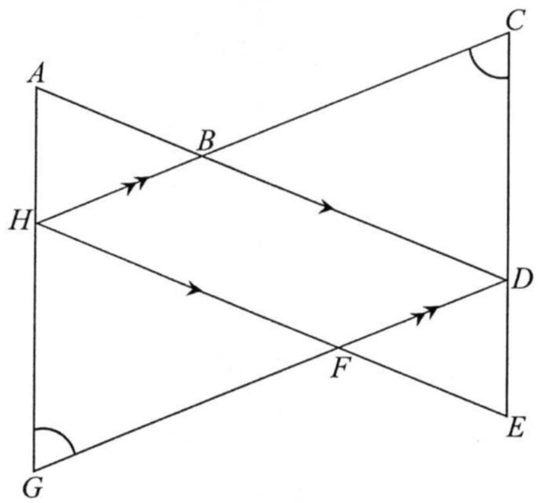
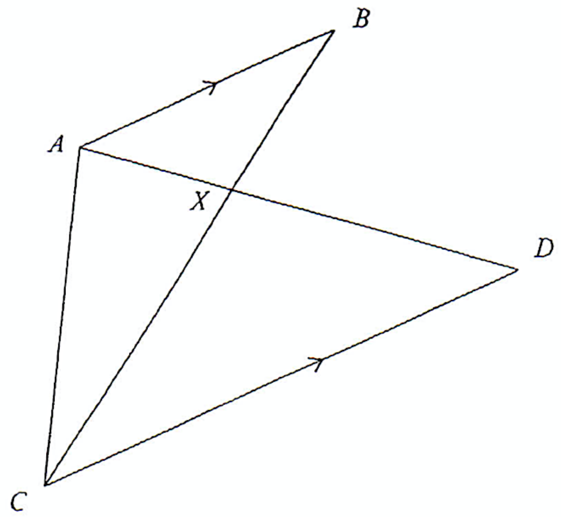
Similarity and Congruency (Worksheet 2)

1. Consider the two triangles, ΔADG and ΔEHC, shown In the diagram below, ΔADG and ΔEHC overlap to form a parallelogram *BDFH.* Given further that $AG = EC$ and $\angle HCE = \angle DGA$, prove that ΔADG is congruent to ΔEHC. State your reasons clearly.



11. In the diagram, *AB* is parallel to *CD*. *AD* and *BC* meet at *X*.



(a) Prove that triangles *ABX* and *DCX* are similar.

(b) Given that $\frac{BX}{BC} = \frac{3}{8}$ and *AB* = 15 cm, find *CD*.

Answer: ________________

(c) Given that the area of triangle *ABX* is 81 cm^2. Find

(i) the area of triangle *DCX*

(ii) the area of triangle *ACX*

Answer: (c) (i) ________________

(ii) ________________

12. The areas of the two similar octagons are 25 cm^2 and 576 cm^2.

The length of the sides of the octagons are x cm and 7 cm.

Find the two possible values of x.

Answer: x = ___________ or ___________