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CHAPTER NOTES

Triangles Class 10 Notes | CBSE Maths Chapter 6

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Ask me anything from this chapter. A concept, a numerical, or that one doubt you did not want to raise in class. Pick one to start:

Explain Triangles simply

What can the board exam ask?

Most important formulas

Quiz me on this chapter

Ask Ira anything...



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Triangles Class 10 Notes | CBSE Maths Chapter 6

Triangles is Chapter 6 of CBSE Class 10 Maths. In Class 9 you studied congruent triangles, which have the same shape and the same size. This chapter studies similar figures, which have the same shape but not necessarily the same size. It covers similar polygons, the Basic Proportionality Theorem (Thales theorem) and its converse, and the four ways to prove two triangles similar: AAA, AA, SSS and SAS.

For board exams the chapter asks for two things: short calculations, where you find a missing length from a parallel line or a pair of similar triangles, and written proofs, where every step needs a reason. Most NCERT exercise questions are proofs built on the Basic Proportionality Theorem and the similarity criteria, with a shadow problem on heights, so practise writing them out in full with a reason on every line.

Quick Answer - Triangles in 30 Sec

Two polygons with the same number of sides are similar if their corresponding angles are equal **and** their corresponding sides are in the same ratio. **Theorem** says a line drawn parallel to one side of a triangle divides the other two sides in the same ratio: if $DE \parallel BC$, then $AD/DB = AE/EC$. If a line divides two sides of a triangle in the same ratio, the line is parallel. Two triangles are similar if two angles are equal (AA), three sides are proportional (SSS) or **SAS** (one angle equal and two sides proportional). If you find heights and distances you can use similar triangles.



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All Key Formulas at a Glance

Result	Statement in symbols	When to use it
Similar triangles	$\triangle ABC \sim \triangle DEF \Rightarrow \angle A = \angle D, \angle B = \angle E, \angle C = \angle F$ and $AB/DE = BC/EF = CA/FD$	Reading angles and side ratios from a similarity statement
Basic Proportionality Theorem (Theorem 6.1)	$DE \parallel BC \Rightarrow AD/DB = AE/EC$	A line parallel to one side cuts the other two sides
Part-to-whole form of BPT	$DE \parallel BC \Rightarrow AD/AB = AE/AC$ and $DB/AB = EC/AC$	The whole side is given or asked for
Converse of BPT (Theorem 6.2)	$AD/DB = AE/EC \Rightarrow DE \parallel BC$	Proving or testing that a line is parallel
AAA criterion (Theorem 6.3)	$\angle A = \angle D, \angle B = \angle E$ $\triangle ABC \sim \triangle DEF$	
AA criterion	$\angle A = \angle D, \angle B = \angle E$ $\triangle ABC \sim \triangle DEF$	
SSS criterion (Theorem 6.4)	$AB/DE = BC/EF = CA/FD$ $\triangle ABC \sim \triangle DEF$	
SAS criterion (Theorem 6.5)	$\angle A = \angle D$ and $AB/DE = AC/DF$ $\Rightarrow \triangle ABC \sim \triangle DEF$	
Shadow problems	height of pole = height of shadow of pole / shadow of object	



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Key Concepts

1. Similar Figures: Same Shape, Any Size

In Class 9 you learnt that two figures are **congruent** if they have the same shape and the same size. This chapter widens the idea. Two figures having the **same shape but not necessarily the same size** are called **similar figures**.

Some families of figures are always similar, because every member has the same shape:

- **All circles are similar.** Circles with the same radius are congruent; circles with different radii are still similar.
- **All squares are similar.**
- **All equilateral triangles are similar.**

A circle and a square can never be similar, and neither can a triangle and a square, because their shapes differ.

From this, NCERT draws a key fact: **all corresponding sides are in the same ratio**. **not be congruent.** Congruence is the special case of similarity where the ratio is 1.

Everyday picture. Stamp-size, passport-size, and a large photograph of the Taj Mahal are similar: every length is enlarged by the same factor. Two same-size photographs of one person, one of which has been zoomed, have the same shape but the shape has changed.

2. Similar Polygons and the Scale

To decide whether two figures are similar, we check two conditions:

Two polygons of the same number of sides are similar if (i) all their corresponding angles are equal and (ii) their corresponding sides are in the same ratio.

For quadrilaterals ABCD and PQRS, similar if $\frac{AB}{PQ} = \frac{BC}{QR} = \frac{CD}{RS} = \frac{DA}{SP}$.

The common ratio of corresponding sides is called the **scale factor** (or **ratio of similitude**). World maps and blueprints of buildings are similar figures.



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Activity 1. A cardboard quadrilateral ABCD held parallel to the table under a bulb at O casts a shadow A'B'C'D'. Light travels in straight lines, so A' lies on ray OA, B' on ray OB, and so on. The shadow is an enlargement: corresponding angles are equal and corresponding sides are in the same ratio, so the two quadrilaterals are similar.

Why both conditions are needed for polygons

Pair of quadrilaterals	Angles equal?	Sides in the same ratio?	Similar?
A square and a rectangle (non-square)	Yes, all 90°	No	No
A square and a rhombus (non-square)	No	Yes, all sides of each are equal	No
Two squares of sides 3 cm and 5 cm	Yes	Yes	Yes

So for polygons with four or more sides, **both**.

Remark (NCERT): if one polygon is similar to a second, and the second is similar to a third, then the first polygon is similar to the third.

3. Similarity of Triangles and the Criteria

A triangle is a polygon, so the same definition applies. For two triangles to be similar, **(i) corresponding angles are equal and (ii) the corresponding sides are in the same proportion).**

In $\triangle ABC$ and $\triangle DEF$, if $\angle A = \angle D$, $\angle B = \angle E$, $\angle C = \angle F$, then the triangles are similar. We write **$\triangle ABC \sim \triangle DEF$** and read it as "triangle ABC is similar to triangle DEF". The symbol $\sim$ means "is similar to", just as $\cong$ means "is congruent to".

The order of letters carries meaning. Here, the corresponding vertices are A to D, B to E, and C to F. In similar triangles we cannot write $\triangle ABC \sim \triangle EDF$ or $\triangle ACB \sim \triangle DEF$ because the pairs (B, E), (A, D) and (C, F) are not corresponding.



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Once the statement is written correctly, you can read every equal angle and every ratio straight off it: first letter with first letter, first two letters with first two letters, and so on.

Triangles whose corresponding angles are equal are called **equiangular triangles**. The Greek mathematician **Thales** (640 to 546 B.C.) stated that the ratio of any two corresponding sides in two equiangular triangles is always the same. He is believed to have used the result now called the Basic Proportionality Theorem, or Thales Theorem.

4. The Basic Proportionality Theorem (Theorem 6.1)

Activity 2. Draw an angle XAY. On arm AX mark five points P, Q, D, R and B so that $AP = PQ = QD = DR = RB$. Through B draw any line meeting arm AY at C. Through D draw a line parallel to BC meeting AC at E. D is the third of the five equal steps, so $AD/DB = 3/2$. On measuring, AE/EC also comes out as $3/2$. This is the Basic Proportionality Theorem at work.

Theorem 6.1 (Basic Proportionality Theorem) If a line is drawn parallel to one side of a triangle to intersect the other two sides in distinct points, the other two sides are divided in the same ratio.

Proof (write this in full for a long answer)

Given: In $\triangle ABC$, a line parallel to side BC intersects AB at D and AC at E.

To prove: $AD/DB = AE/EC$.

Construction: Join BE and CD. Draw DM $\parallel$ BC meeting BE at M.

Proof:

1. Area of a triangle = $\frac{1}{2} \times \text{base} \times \text{height}$.
EN.
2. Similarly $\text{ar}(\triangle BDE) = \frac{1}{2} DB \times EN$, $\text{ar}(\triangle ADE) = \frac{1}{2} AD \times EN$
3. So $\text{ar}(\triangle ADE)/\text{ar}(\triangle BDE) = (\frac{1}{2} AD \times EN)/(\frac{1}{2} DB \times EN)$
4. And $\text{ar}(\triangle ADE)/\text{ar}(\triangle DEC) = (\frac{1}{2} AE \times DM)/(\frac{1}{2} EC \times DM)$
5. $\triangle BDE$ and $\triangle DEC$ are on the same base DE and between the same parallels BC and DM.
 $\text{ar}(\triangle BDE) = \text{ar}(\triangle DEC) \dots (3)$
6. From (1), (2) and (3): **$AD/DB = AE/EC$** . Hence proved.



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Other forms of BPT (NCERT Example 1)

If $DE \parallel BC$ in $\triangle ABC$ with D on AB and E on AC, then all of these hold:

Form	Ratio	Type
Basic form	$AD/DB = AE/EC$	part / part
Inverted	$DB/AD = EC/AE$	part / part
Top part to whole side	$AD/AB = AE/AC$	part / whole
Bottom part to whole side	$DB/AB = EC/AC$	part / whole

The rule: use the **same kind of ratio** on both sides. Part over part equals part over part; part over whole equals part over whole. Never set AD/DB equal to AE/AC .

Worked illustration

In $\triangle ABC$, $DE \parallel BC$, $AD = 4\text{ cm}$, $DB = 6\text{ cm}$

Use the part-to-whole form: $AD/AB = AE/AC$
 $\times 4/10 = 6\text{ cm}$. Check: $EC = 9\text{ cm}$, and $AD/DB = EC/AC$

5. The Converse of BPT (Theorem 6.2)

Activity 3. Draw an angle XAY. On ray AX mark points B₁, B₂, B₃, B₄ such that $AB_1/B_1B = AB_2/B_2B = AB_3/B_3B = AB_4/B_4B = 1/4$. On ray AY mark points C₁, C₂, C₃, C₄ such that $AC_1/C_1C = AC_2/C_2C = AC_3/C_3C = AC_4/C_4C = 1/4$. Join B₁C₁, B₂C₂, B₃C₃, B₄C₄. What do you observe? Does this hold for other ratios? Try it.

Theorem 6.2 (Converse of BPT): If a line intersects two sides of a triangle and divides them in the same ratio, then the line is parallel to the third side.

Proof outline (by contradiction)

- Take D on AB and E on AC with $AD/DB = AE/EC$.
- Draw DE' parallel to BC, meeting AC at E'.
- By BPT, $AD/DB = AE'/E'C$. So $AE/EC = AE'/E'C$.
- Add 1 to both sides: $(AE + EC)/EC = (AE' + E'C)/E'C$, that is $AC/EC = AC/E'C$.



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5. So $EC = E'C$, which means E and E' are the same point. Hence DE is the line DE', and $DE \parallel BC$.

How to use the converse

BPT goes from **parallel $\Rightarrow$ equal ratios**. The converse goes from **equal ratios $\Rightarrow$ parallel**. To test whether a line is parallel to the third side, work out both ratios exactly (as fractions). If they are equal, the line is parallel. If they are unequal, the line is not parallel, because a parallel line would force equal ratios by BPT.

The converse also works with the part-to-whole form: if $AD/AB = AE/AC$, then $DE \parallel BC$.

Mid-point theorem as a special case. If D and E are the mid-points of AB and AC, then $AD/DB = 1 = AE/EC$, so $DE \parallel BC$ by the converse (NCERT Exercise 6.2, Q8). In the other direction, a line through the mid-point D of AB parallel to BC gives $AE/EC = AD/DB = 1$, so it bisects AC (Exercise 6.2, Q7).

6. AAA and AA Similarity Criteria

Checking all three angles and all three ratios of corresponding parts are enough.

Activity 4. Draw $BC = 3$ cm and $EF = 5$ cm. Draw two triangles ABC and DEF have equal corresponding angles. Then AB/DE and CA/FD also come out as about 3/5.

Theorem 6.3 (AAA criterion): If in two triangles two corresponding angles are equal, then the triangles are similar.

Proof idea. Cut $DP = AB$ and $DQ = AC$ on line DE (by construction), so $\angle P = \angle B = \angle E$ and $PQ \parallel EF$ (by BPT). In the same way $AB/DE = BC/EF$.

The AA criterion

By the angle sum property, if two angles of one triangle are equal to two angles of another triangle, then the third angles are also equal (each is 180° minus the sum of the other two). **Two triangles are similar if two angles of one triangle are respectively equal to two angles of another triangle.** This is the **AA similarity criterion**.

Where equal angles come from in a figure:



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- **A common angle** shared by both triangles (a vertex that belongs to both).
- **Vertically opposite angles** where two lines cross.
- **Alternate or corresponding angles** formed by parallel lines.
- **Right angles**, for example at the foot of an altitude or where a pole stands on the ground.
- Angles given equal in the question.

Illustration. $\triangle ABC$ has $\angle A = 50^\circ$ and $\angle B = 70^\circ$. $\triangle PQR$ has $\angle Q = 70^\circ$ and $\angle R = 60^\circ$. Is $\triangle ABC \sim \triangle PQR$? $\angle C = 180^\circ - 50^\circ - 70^\circ = 60^\circ$ and $\angle P = 180^\circ - 70^\circ - 60^\circ = 50^\circ$. So $\angle A = \angle P$, $\angle B = \angle Q$, $\angle C = \angle R$ and **$\triangle ABC \sim \triangle PQR$** by AA.

7. SSS and SAS Similarity Criteria (Theorems 6.4 and 6.5)

SSS criterion

Activity 5. Draw $\triangle ABC$ with $AB = 3$ cm, $BC = 4$ cm, $AC = 5$ cm. Draw $\triangle DEF$ with $DE = 6$ cm, $EF = 8$ cm, $FD = 12$ cm. Every ratio AB/DE , BC/EF , AC/FD is $1/2$. Hence $\triangle ABC \sim \triangle DEF$ and $\angle C = \angle F$.

Theorem 6.4 (SSS criterion): If in two triangles the corresponding sides are in the same ratio (or if the sides of one triangle are proportional to the sides of the other triangle), then the triangles are similar. Hence the two triangles are similar.

Proof idea. Cut $DP = AB$ and $DQ = AC$ and complete $\triangle DEF$ such that $DE/AB = DF/AC$. Then $\triangle DEF \sim \triangle ABC$ (by SAS) and $PQ/EF = DP/DE = BC/EF$, which implies $PQ = BC$ (by congruence), and the angles match.

Matching sides correctly. Sort each triangle's sides in increasing order. Example: $\triangle ABC$ has $AB = 2$ cm, $BC = 3$ cm, $AC = 4$ cm. $\triangle PQR$ has $QR = 4$ cm, $RP = 5$ cm, $PQ = 6$ cm. Sorted pairs: $AB \leftrightarrow QR$, $BC \leftrightarrow RP$, $AC \leftrightarrow PQ$. Every ratio $1/2$. $AB \leftrightarrow QR$ and $BC \leftrightarrow RP$ share the same ratio $1/2$. Hence **$\triangle ABC \sim \triangle QRP$** , and so $\angle A = \angle Q$, $\angle B = \angle R$, $\angle C = \angle P$.

Key remark. For triangles, Theorems 6.3 and 6.4 are equivalent. Equal angles force proportional sides, and equal sides force equal angles. With four or more sides you must check both.

SAS criterion



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Activity 6. Draw $\triangle ABC$ with $AB = 2\text{ cm}$, $\angle A = 50^\circ$, $AC = 4\text{ cm}$ and $\triangle DEF$ with $DE = 3\text{ cm}$, $\angle D = 50^\circ$, $DF = 6\text{ cm}$. Then $AB/DE = AC/DF = 2/3$, and $\angle A$ (between AB and AC) equals $\angle D$ (between DE and DF). On measuring, $\angle B = \angle E$ and $\angle C = \angle F$, so $\triangle ABC \sim \triangle DEF$.

Theorem 6.5 (SAS criterion): If one angle of a triangle is equal to one angle of the other triangle and the sides including these angles are proportional, then the two triangles are similar.

Proof idea. Cut $DP = AB$ and $DQ = AC$ and join PQ . Then $PQ \parallel EF$ (converse of BPT) and $\triangle ABC \cong \triangle DPQ$ (SAS congruence), so all three pairs of angles are equal and AAA applies.

The angle must be the **included angle**, the one between the two proportional sides. An equal angle somewhere else does not satisfy SAS.

RHS similarity (NCERT note to the reader)

If in two right triangles, the hypotenuse and one side of one triangle are proportional to the hypotenuse and one side of the other triangle, then the two triangles are similar. This is called the **RHS similarity criterion**.

Choosing the right criterion

What the question gives you	Criterion
Two pairs of equal angles	AA
Three side lengths of each triangle	SSS
One equal angle and the two sides around it	SAS
Two right triangles with hypotenuse and a side	RHS

8. Using Similarity: Heights, Shadows

Heights of mountains such as Mount Everest were measured with a tape. They were found to be very high. The height of the mountain was not measured with a tape. They were found to be very high.



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similarity: a small triangle that you can measure is similar to a large triangle that you cannot, so the unknown length follows from equal ratios.

Shadows at the same moment

At a given moment the sun's rays fall on nearby objects at the same angle. A vertical pole and a vertical tower both make 90° with the ground. So the triangle formed by the pole, its shadow and the sun's ray is similar (AA) to the triangle formed by the tower, its shadow and the ray:

height of pole / length of its shadow = height of tower / length of its shadow

The lamp-post problem

A person of height h stands at distance d from a lamp-post of height H , and the shadow has length x . The lamp, the top of the person's head and the tip of the shadow lie on one straight line. Both triangles share the angle at the tip of the shadow and have a right angle at the ground, so they are similar by AA:

$(d + x)/x = H/h$

Notice that the big triangle's base is the width of the shadow, which is $d + x$, and the small triangle's base is x .

Other lengths. In similar triangles, corresponding sides are proportional. For example, $AB/BC = DE/CD$ (Exercise 6.3, Q10 and Solved Example 11).



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Formula and Theorem Sheet

Result	Statement	Symbols
Theorem 6.1 (BPT)	A line parallel to one side of a triangle divides the other two sides in the same ratio	$DE \parallel BC \Rightarrow AD/DB = AE/EC$
Theorem 6.2 (Converse of BPT)	A line dividing two sides of a triangle in the same ratio is parallel to the third side	$AD/DB = AE/EC \Rightarrow DE \parallel BC$
Theorem 6.3 (AAA) and AA criterion	Equal corresponding angles $\Rightarrow$ similar; two pairs of equal angles are enough	$\angle A = \angle D, \angle B = \angle E$
Theorem 6.4 (SSS)	Sides proportional $\Rightarrow$ angles equal $\Rightarrow$ similar	$AB/DE = BC/EF = CA/FD$
Theorem 6.5 (SAS)	One angle equal and sides proportional	
RHS similarity	Right triangles with one side proportional	
Diagonals of a trapezium	Exercise 6.2 C	
Point D on BC with $\angle ADC = \angle BAC$	Exercise 6.3 C	
Shadows	AA similarity	



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Important Definitions

- **Congruent figures:** figures that have the same shape and size
- **Similar figures:** figures that have the same shape but not necessarily the same size
- **Similar polygons:** two polygons of the same shape whose corresponding angles are equal and whose corresponding sides are in the same ratio
- **Scale factor (Representative Fraction):** the ratio of the corresponding sides of two similar polygons.

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- **Similar triangles:** two triangles whose corresponding angles are equal and whose corresponding sides are in the same ratio. Written $\triangle ABC \sim \triangle DEF$ with the vertices in corresponding order.
- **Equiangular triangles:** two triangles whose corresponding angles are equal.
- **RHS similarity criterion:** if in two right triangles the hypotenuse and one side of one triangle are proportional to the hypotenuse and one side of the other, the triangles are similar.
- **Indirect measurement:** finding a height or distance that cannot be measured directly, by using similar figures.

Solved Examples (NCERT-Based)

Example 1: The part-to-whole form of BPT (NCERT Example 1)

If a line intersects sides AB and AC of a $\triangle ABC$ at D and E respectively, such that $AD/AB = AE/AC$.

Solution: $DE \parallel BC$ (given). So $AD/DB = AE/EC$

Inverting both sides, $DB/AD = EC/AE$. Adding 1 to both sides, $(DB + AD)/AD = (EC + AE)/AE$.

Since $DB + AD = AB$ and $EC + AE = AC$, then $AB/AD = AC/AE$. Hence proved.

Example 2: Is EF parallel to QR? (NCERT Example 2)

E and F are points on the sides PQ and PR respectively. In the following cases, state whether $EF \parallel QR$: (i) $PE = 3.9$ cm, $QE = 4.5$ cm, $PF = 8$ cm and $RF = 9$ cm. (ii) $PE = 3.9$ cm, $QE = 4.5$ cm, $PF = 0.36$ cm and $RF = 0.45$ cm.

Solution:

(i) $PE/EQ = 3.9/4.5 = 13/15$ and $PF/FR = 8/9$. Since $13/15 \neq 8/9$, EF is not parallel to QR .

(ii) $PE/EQ = 3.9/4.5 = 13/15$ and $PF/FR = 0.36/0.45 = 4/5$. Since $13/15 \neq 4/5$, EF is not parallel to QR . Hence, BPT is not applicable.



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(iii) Here whole sides are given, so use part-to-whole ratios. $PE/PQ = 0.18/1.28 = 18/128 = 9/64$ and $PF/PR = 0.36/2.56 = 36/256 = 9/64$. Equal, so **EF || QR**.

Example 3: A line parallel to the sides of a trapezium (NCERT Example 2)

ABCD is a trapezium with $AB \parallel DC$. E and F are points on non-parallel sides AD and BC respectively such that EF is parallel to AB. Show that $AE/ED = BF/FC$.

Solution: Join AC, meeting EF at G.

$AB \parallel DC$ and $EF \parallel AB$ (given), so $EF \parallel DC$ (lines parallel to the same line are parallel to each other).

In $\triangle ADC$, $EG \parallel DC$, so $AE/ED = AG/GC$ (Theorem 6.1) ... (1)

In $\triangle CAB$, $GF \parallel AB$, so $CG/AG = CF/BF$ (Theorem 6.1). Inverting, $AG/GC = BF/FC$... (2)

From (1) and (2), **$AE/ED = BF/FC$** .

Example 4: Converse of BPT gives

S and T are points on sides PQ and PR of $\triangle PQR$. Prove that PQR is an isosceles triangle.

Solution: $PS/SQ = PT/TR$ (given), so $ST \parallel QR$

Therefore $\angle PST = \angle PQR$ (corresponding angles)

Also $\angle PST = \angle PRQ$ (given) ... (2)

From (1) and (2), $\angle PRQ = \angle PQR$. So $PQ = PR$.
isosceles.

Example 5: Diagonals of a trapezium

ABCD is a trapezium in which $AB \parallel DC$ and diagonals AC and BD intersect at O. Show that $AO/BO = CO/DO$.

Solution: Through O draw $OE \parallel DC$, meeting AD and BC at E and F respectively.

In $\triangle ADC$, $OE \parallel DC$, so $AE/ED = AO/OC$ (BPT)



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In $\triangle DAB$, $OE \parallel AB$, so $DE/EA = DO/OB$ (BPT). Inverting, $AE/ED = BO/OD$... (2)

From (1) and (2), $AO/OC = BO/OD$. Rearranging, **$AO/BO = CO/DO$** .

Example 6: Parallel lines and crossing segments (NCERT Example 4)

Segments PS and QR intersect at O, and $PQ \parallel RS$. Prove that $\triangle POQ \sim \triangle SOR$.

Solution: $PQ \parallel RS$ (given).

So $\angle P = \angle S$ (alternate angles, transversal PS) and $\angle Q = \angle R$ (alternate angles, transversal QR).

Also $\angle POQ = \angle SOR$ (vertically opposite angles).

Therefore **$\triangle POQ \sim \triangle SOR$** (AAA similarity criterion). Note the order: $P \leftrightarrow S$, $O \leftrightarrow O$, $Q \leftrightarrow R$.

Example 7: A product of lengths of segments

Segments AC and BD intersect at O, and $AO/OC = BO/OD$.

Solution: $OA \cdot OB = OC \cdot OD$ (given). Divide both sides by $OC \cdot OD$.

$\angle AOD = \angle COB$ (vertically opposite angles)

In $\triangle AOD$ and $\triangle COB$, the sides OA, OD include $\angle AOD$.
(1) and (2), $\triangle AOD \sim \triangle COB$ (SAS similarity criterion)

So **$\angle A = \angle C$ and $\angle D = \angle B$** (corresponding angles)

The proof is unchanged if the crossing segments intersect outside the triangle.

Example 8: Angles from a similarity

Segments AC and DB intersect at O. $\angle ODC = 55^\circ$ and $\angle OAB = 55^\circ$.

Solution: D, O and B lie on one line, so $\angle DOB = 180^\circ$.
In $\triangle ODC$, $\angle DCO = 180^\circ - \angle CDO - \angle DOC = 180^\circ - 55^\circ - 125^\circ = 0^\circ$.

In $\triangle ODC$, $\angle DCO = 180^\circ - \angle CDO - \angle DOC = 180^\circ - 55^\circ - 125^\circ = 0^\circ$.

$\triangle ODC \sim \triangle OBA$ gives $O \leftrightarrow O$, $D \leftrightarrow B$, $C \leftrightarrow A$. So $\angle OAB = \angle OCD = 55^\circ$.



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Example 9: The girl and the lamp-post (NCERT Example 7)

A girl of height 90 cm is walking away from the base of a lamp-post at a speed of 1.2 m/s. If the lamp is 3.6 m above the ground, find the length of her shadow after 4 seconds.

Solution: Let AB be the lamp-post (A the lamp, B its foot) and CD the girl after 4 seconds (C her head, D her feet). Let the shadow DE be x m, where E is the tip of the shadow.

$BD = 1.2 \text{ m/s} \times 4 \text{ s} = 4.8 \text{ m}$. Girl's height $CD = 90 \text{ cm} = 0.9 \text{ m}$.

In $\triangle ABE$ and $\triangle CDE$: $\angle B = \angle D$ (each 90° , both stand vertical to the ground) and $\angle E = \angle E$ (same angle). So $\triangle ABE \sim \triangle CDE$ (AA).

Therefore $BE/DE = AB/CD$, that is $(4.8 + x)/x = 3.6/0.9 = 4$.

$4.8 + x = 4x$, so $3x = 4.8$ and $x = 1.6$.

The girl's shadow after 4 seconds is **1.6 m**.



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Example 10: Height of a tower from its shadow

A vertical pole of length 6 m casts a shadow 4 m long. A tower casts a shadow 28 m long. Find the height of the tower.

Solution: Let the tower have height h m. Both the pole and the tower make equal angles with the ground at the same time.

height of pole / shadow of pole = height of tower / shadow of tower

$6/4 = h/28$, so $h = 28 \times 6/4 = 28 \times 1.5 = 42$

Example 11: Proving $CA^2 = CB \cdot CD$

D is a point on the side BC of a triangle ABC.

Solution: In $\triangle ADC$ and $\triangle BAC$:

$\angle ADC = \angle BAC$ (given) and $\angle ACD = \angle BCA$ (common angle)

So $\triangle ADC \sim \triangle BAC$ (AA). The corresponding sides are proportional:

Corresponding sides are proportional: $AD/BA = DC/AC = AC/BC$.



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From $DC/AC = AC/BC$, cross-multiplying gives $AC^2 = BC \times DC$, that is **$CA^2 = CB \cdot CD$** .

Competency-Based Questions (with answers)

1. Case-based: Measuring a school flagpole

Class 10 students want the height of the school flagpole without climbing it. At 10 a.m. a student 1.5 m tall stands on level ground and her shadow measures 1.2 m. At the same moment the flagpole's shadow measures 9.6 m.

(a) Why are the two triangles similar? The student and the flagpole both stand at 90° to the ground, and at the same moment the sun's rays make equal angles with the ground. Two pairs of equal angles, so the triangles are similar by AA.

(b) Find the height of the flagpole. height/shadow for the student is $1.5/1.2$.
 $9.6 \times 1.5/1.2 = 9.6 \times 1.25 = 12$ m.

(c) Later in the day the student's shadow is 24 m.
The ratio height/shadow for the student is $1.5/24$.
The ratio height/shadow for the flagpole is $h/9.6$.
Since the triangles are similar, the ratios are equal.
 $1.5/24 = h/9.6$
 $h = 9.6 \times 1.5/24 = 0.6$ m.

2. Case-based: Enlarging a photograph

A photographer prints a picture from 35 mm film. The width of a door is 14 mm and the angle between the door frame and the wall is 90° .

(a) What is the scale factor from the small photograph to the large photograph?

(b) What is the width of the door in the large photograph?

(c) What is the angle between the door frame and the wall in the large photograph?
Reason. 90° . Similar figures have equal corresponding angles.

3. Assertion-Reason

Assertion (A): A square of side 4 cm and a rectangle of side 8 cm by 2 cm are similar.

Reason (R): Two polygons of the same number of sides are similar if (i) all their corresponding angles are equal and (ii) their corresponding sides are in the same ratio (or) proportional.



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Choose: (a) Both A and R are true and R is the correct explanation of A. (b) Both A and R are true but R is not the correct explanation of A. (c) A is true but R is false. (d) A is false but R is true.

Answer: (d) A is false but R is true. The sides are in one ratio (4/6 each), but the square's angles are 90° and the rhombus has a 60° angle. R is the correct definition, and it shows why A fails.

4. Assertion-Reason

Assertion (A): In $\triangle ABC$, D and E lie on AB and AC with $AD = 3$ cm, $DB = 4$ cm, $AE = 4.5$ cm and $EC = 6$ cm. Then $DE \parallel BC$.

Reason (R): If a line divides any two sides of a triangle in the same ratio, then the line is parallel to the third side.

Choose: (a) Both A and R are true and R is the correct explanation of A. (b) Both A and R are true but R is not the correct explanation of A. (c) A is true but R is false. (d) A is false but R is true.

Answer: (a) $AD/DB = 3/4$ and $AE/EC = 4.5/6 = 3/4$. Since the ratios are equal, $DE \parallel BC$ exactly the reason $DE \parallel BC$.

5. Assertion-Reason

Assertion (A): If two angles of one triangle are equal to two angles of another triangle, then the two triangles are similar.

Reason (R): Two triangles are similar only if their corresponding sides are measured and found equal.

Choose: (a) Both A and R are true and R is the correct explanation of A. (b) Both A and R are true but R is not the correct explanation of A. (c) A is true but R is false. (d) A is false but R is true.

Answer: (c) A is true: it is the AA criterion for similarity. R is false: similar triangles need not have equal sides; their corresponding sides describe congruent triangles.

6. Source-based: Reading Activity

A student draws an angle XAY , marks five points B_1, B_2, B_3, B_4, B_5 on ray AX and five points C_1, C_2, C_3, C_4, C_5 on ray AY and joins B_3C_3 and BC .

(a) What is the ratio AB_3/B_3B ? AB_3 is 3 segments long. BC is also $3/2$.



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(b) What can you conclude about B_3C_3 and BC , and which theorem justifies it? $B_3C_3 \parallel BC$, by the converse of BPT (Theorem 6.2), since the line divides AB and AC in the same ratio.

(c) If $AB = 10$ cm, find $B_3C_3 : BC$. $B_3C_3 \parallel BC$, so $\Delta AB_3C_3 \sim \Delta ABC$ (AA, corresponding angles and the common angle A). So $B_3C_3/BC = AB_3/AB = 6/10 = 3 : 5$.

7. Error analysis: The wrong correspondence

In ΔABC , $\angle A = 40^\circ$, $\angle B = 60^\circ$. In ΔPQR , $\angle P = 60^\circ$, $\angle Q = 80^\circ$. A student writes " $\Delta ABC \sim \Delta PQR$, so $AB/PQ = BC/QR$." Find the error and write the correct statement.

Answer: $\angle C = 180^\circ - 40^\circ - 60^\circ = 80^\circ$ and $\angle R = 180^\circ - 60^\circ - 80^\circ = 40^\circ$. So $\angle A = \angle R$, $\angle B = \angle P$, $\angle C = \angle Q$. The triangles are similar by AA, but the correct statement is $\Delta ABC \sim \Delta RPQ$, giving $AB/RP = BC/PQ = CA/QR$. The student matched letters by position instead of by equal angles.

8. Case-based: A ramp support

A ramp AC rises from point A on the ground to point C on the wall. A support DE is fixed under the ramp, with D on the ground and E on the wall. $DE \parallel AC$ and $AB = 6$ m.

(a) Why is $DE \parallel AC$? Both are vertical, so they are parallel. Lines perpendicular to the same line are parallel.

(b) Name the similar triangles and the criterion used. $\Delta ABC \sim \Delta DEC$ (AA). $\angle A = \angle DEC = 90^\circ$.

(c) Find the height of the wall BC . $DE/BC = AD/AB$



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Important Questions for

1-Mark Questions

1. Fill in the blanks (NCERT Exercise 6.1, Question 1). Two squares are _____. (similar, congruent) (i) similar (ii) similar (iii) equilateral

2. Is every pair of similar figures congruent? No, sizes may differ. Every pair of congruent

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3. In $\triangle ABC$, $DE \parallel BC$ with D on AB and E on AC. If $AD/DB = 3/5$ and $AE = 4.5$ cm, find EC. By BPT, $AE/EC = 3/5$, so $EC = 4.5 \times 5/3 = 7.5$ cm.
4. If $\triangle ABC \sim \triangle DEF$, $AB = 4$ cm, $DE = 6$ cm and $EF = 9$ cm, find BC. $AB/DE = BC/EF$, so $4/6 = BC/9$ and $BC = 6$ cm.
5. If $\triangle ABC \sim \triangle PQR$, $\angle A = 50^\circ$ and $\angle B = 60^\circ$, find $\angle R$. $\angle R = \angle C = 180^\circ - 50^\circ - 60^\circ = 70^\circ$.

2-Mark Questions

1. S and T are points on sides PR and QR of $\triangle PQR$ such that $\angle P = \angle RTS$. Show that $\triangle RPQ \sim \triangle RTS$. (NCERT Exercise 6.3, Q5) In $\triangle RPQ$ and $\triangle RTS$, $\angle RPQ = \angle RTS$ (given) and $\angle PRQ = \angle TRS$ (common angle R). So $\triangle RPQ \sim \triangle RTS$ by AA.
2. Using Theorem 6.1, prove that a line drawn through the mid-point of one side of a triangle parallel to another side bisects the third side. (NCERT Exercise 6.2, Q7) In $\triangle ABC$, let D be the mid-point of AB and $DE \parallel BC$ with E on AC. By BPT, $AD/DB = AE/EC$. $AD = DB$, so $AD/DB = 1$, hence $AE/EC = 1$ and $AE = EC$. So DE bisects AC.
3. Using Theorem 6.2, prove that the line is parallel to the third side. (NCERT Exercise 6.2, Q8) In $\triangle ABC$, D is the mid-point of AB and E is the mid-point of AC. Then $AD = DB$ and $AE = EC$, so $AD/DB = AE/EC$. Hence $DE \parallel BC$ by Theorem 6.2.
4. Are the two triangles with sides 4 cm, 6 cm and 8 cm respectively similar? Give a reason. Pair the sides in increasing order. $4/6 = 6/8 = 3/4$. So the triangles are similar by the SSS criterion.



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3-Mark Questions

1. The diagonals of a quadrilateral ABCD intersect at O. Show that $AO/CO = BO/DO$. Show that ABCD is a trapezium. In $\triangle AOB$ and $\triangle COD$, $\angle AOB = \angle COD$ (vertically opposite angles). Also, $\angle OAB = \angle OCD$ and $\angle OBA = \angle ODC$ (alternate angles). So $\triangle AOB \sim \triangle COD$ by AA. Hence $AO/CO = BO/DO$. Through O, draw a line $EF \parallel AB$ with E on AD and F on BC. By BPT, $AE/ED = BO/OC$ and $BF/FC = AO/OD$. So $AE/ED = BF/FC$. Hence $EF \parallel DC$. So $AB \parallel DC$. Hence ABCD is a trapezium.
2. In $\triangle ABC$, AD and CE are altitudes, with AD and CE intersect each other at O. (i) $\triangle AEO \sim \triangle CDO$ (ii) $\triangle ABO \sim \triangle CBO$ (NCERT Exercise 6.3, Q6) In $\triangle AEO$ and $\triangle CDO$, $\angle AEO = \angle CDO = 90^\circ$ and $\angle AOE = \angle COD$ (vertically opposite angles). So $\triangle AEO \sim \triangle CDO$ by AA. In $\triangle ABO$ and $\triangle CBO$, $\angle ABO = \angle CBO$ (common angle) and $\angle AOB = \angle COB$ (vertically opposite angles). So $\triangle ABO \sim \triangle CBO$ by AA.

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3. **E is a point on side CB produced of an isosceles triangle ABC with $AB = AC$. If $AD \perp BC$ and $EF \perp AC$, prove that $\triangle ABD \sim \triangle ECF$. (NCERT Exercise 6.3, Q11)** $AB = AC$, so $\angle ABC = \angle ACB$ (angles opposite equal sides). E lies on CB produced, so $\angle ECF$ is the same angle as $\angle ACB$, and $\angle ABD$ is the same angle as $\angle ABC$. Hence $\angle ABD = \angle ECF$. Also $\angle ADB = \angle EFC = 90^\circ$. So $\triangle ABD \sim \triangle ECF$ (AA).

5-Mark Questions

- State and prove the Basic Proportionality Theorem.** Statement: if a line is drawn parallel to one side of a triangle to intersect the other two sides in distinct points, the other two sides are divided in the same ratio. Given $\triangle ABC$ with $DE \parallel BC$, D on AB, E on AC. To prove $AD/DB = AE/EC$. Construction: join BE and CD, draw $DM \perp AC$ and $EN \perp AB$. Proof: $\text{ar}(\triangle ADE) = \frac{1}{2} AD \times EN$ and $\text{ar}(\triangle BDE) = \frac{1}{2} DB \times EN$, so $\text{ar}(\triangle ADE)/\text{ar}(\triangle BDE) = AD/DB$. Also $\text{ar}(\triangle ADE) = \frac{1}{2} AE \times DM$ and $\text{ar}(\triangle DEC) = \frac{1}{2} EC \times DM$, so $\text{ar}(\triangle ADE)/\text{ar}(\triangle DEC) = AE/EC$. $\triangle BDE$ and $\triangle DEC$ are on the same base DE and between the same parallels BC and DE, so $\text{ar}(\triangle BDE) = \text{ar}(\triangle DEC)$. Hence $AD/DB = AE/EC$.
- If AD and PM are medians of triangles ABC and PQR, respectively where $\triangle ABC \sim \triangle PQR$, prove that $AB/PQ = AD/PM$. (NCERT Exercise 6.3, Q12)** $AB/PQ = BC/QR$. D and M are mid-points of BC and QR respectively. AD and PM are medians. $AB/PQ = 2BD/2QM = BD/QM$. In $\triangle ABD$ and $\triangle PMQ$, $\angle ABD = \angle PMQ$ (corresponding angles). These angles are proportional ($AB/PQ = BD/QM$). Hence $AB/PQ = AD/PM$.



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Common Mistakes and Examples

- Writing the vertices in the wrong order** When writing the statement, find which angle is included in both triangles.
- Mixing part and whole in BPT.** $AD/DB = AE/EC$ (part/part) or $AD/AB = AE/AC$ (part/whole) or part/whole on both sides ($AD/AB = AE/AC$).
- Checking only one condition for quadrilaterals.** A square and a rhombus have sides in the ratio 1:1. For a rectangle or more sides, check angles and sides.
- Using SAS with an angle that is not included.** If it lies elsewhere, SSS is used.
- Testing parallel lines with decimals that are not in the same ratio.** Reduce each ratio to a fraction (such as $1/2$).
- Taking the wrong base in lamp-post problem.** The foot of the lamp-post to the tip of the shadow (distance walked + shadow).

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7. **Mixing units.** In NCERT Example 7 the girl's height is 90 cm and the lamp is 3.6 m high. Convert to one unit (0.9 m) before forming the ratio.
8. **Proof steps without reasons.** Each line in a proof needs its reason in brackets: (given), (BPT), (alternate angles), (vertically opposite angles), (common angle), (AA similarity).
9. **Skipping the construction in the BPT proof.** Write the construction line (join BE and CD, draw $DM \perp AC$ and $EN \perp AB$) before using the areas. The heights EN and DM come from this step.
10. **Reading shadows at different times.** Shadow ratios work only when both shadows are measured at the same time, because only then do the sun's rays make equal angles with the ground.

Quick Revision Points

- Similar figures have the same shape but not necessarily the same size.
- All congruent figures are similar; similar figures are not necessarily congruent.
- All circles, all squares and all equilateral triangles are similar.
- Two polygons with the same number of sides are similar if their corresponding angles are equal and corresponding sides are in the same ratio.
- For polygons with four or more sides, equal angles are not enough (e.g. rectangle, square and rhombus).
- $\triangle ABC \sim \triangle DEF$: the order of letters gives the correspondence.
- Triangles with equal corresponding angles are similar.
- BPT (Theorem 6.1): $DE \parallel BC \Rightarrow \frac{AD}{DB} = \frac{AE}{EC}$
- Converse of BPT (Theorem 6.2): $\frac{AD}{DB} = \frac{AE}{EC} \Rightarrow DE \parallel BC$
- The mid-point theorem is the special case of BPT where D and E are mid-points.
- AAA (Theorem 6.3): equal corresponding angles $\Rightarrow$ similarity.
- AA: two pairs of equal angles are enough (third angle is equal by angle sum property).
- SSS (Theorem 6.4): all three pairs of sides in the same ratio $\Rightarrow$ similarity.
- SAS (Theorem 6.5): one equal angle with two sides in the same ratio $\Rightarrow$ similarity.
- Diagonals of a trapezium ABCD ($AB \parallel DC$) intersect at O .
- D on BC with $\angle ADC = \angle BAC \Rightarrow CA^2 = CE \cdot CB$



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- Shadows at the same time: height/shadow is the same for every vertical object.

Weightage in Board Exams

Triangles is part of the geometry portion of the Class 10 Maths syllabus. Check the current CBSE course structure for the marks allotted to each unit. The 2026-27 NCERT chapter covers similar figures, BPT and its converse, and the AAA, AA, SSS and SAS criteria, with RHS as a note to the reader.

Question type	What is usually asked from this chapter
MCQ and fill in the blank	Which figures are always similar; a missing length from BPT; a missing side or angle from a similarity statement
Assertion-Reason	Converse of BPT needed for polygons
Short answer	Testing $EF \parallel QR$ for proof with a converse
Long answer	Statement and proof of similar triangles; testing similarity
Case-based	Shadows, lamp-post and similar triangles, etc.

Two skills carry most answers in this chapter: setting up the correct ratio from the correct example and exercise question first.



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