# MATHEMATICS

## Chapter 9: Area of Parallelograms andTriangles



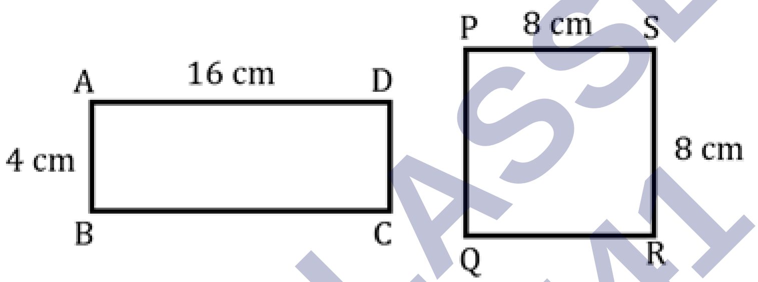
# Area of Parallelograms and Triangles

## Introduction to Planar region and Area

The part of the plane enclosed by a simple closed figure is called a **planar region** corresponding to that figure. The magnitude or measure of that planar region is called its **area**.

### Congruent figures and their areas

- Two figures are called **congruent**, if they have the same shape and the same size.
- If two figures A and B are **congruent**, they must have **equal areas**.
- Two figures having **equal areas need not be congruent**. In the figure,




Area of rectangle ABCD = $16 \times 4 = 64 \text{ cm}^2$

Area of square PQRS = $8^2 = 64 \text{ cm}^2$

Area of rectangle ABCD = Area of square PQRS

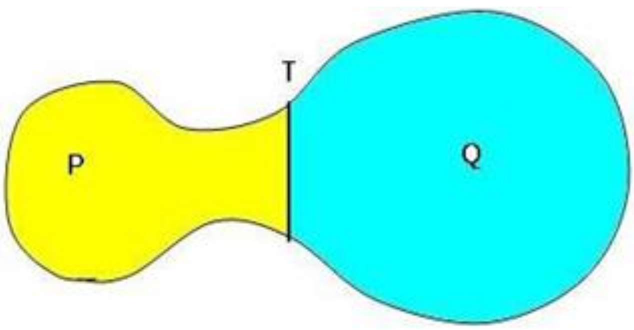
But rectangle ABCD and square PQRS are not congruent.

## Area of a figure

Area of a figure is a number (in some unit) associated with the part of the plane enclosed by the figure.

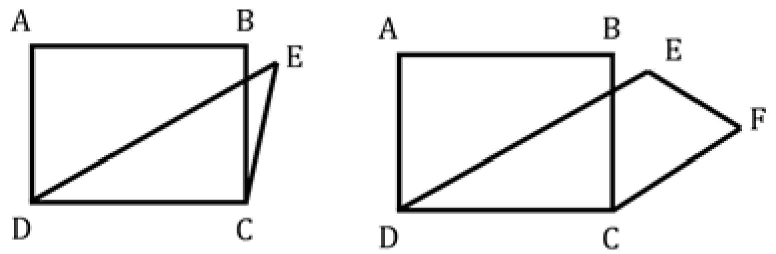
### Area of the planar region

If a planar region formed by a figure T is made up of two non-overlapping planar regions formed by figures P and Q, then ar(T) = ar(P) + ar(Q).

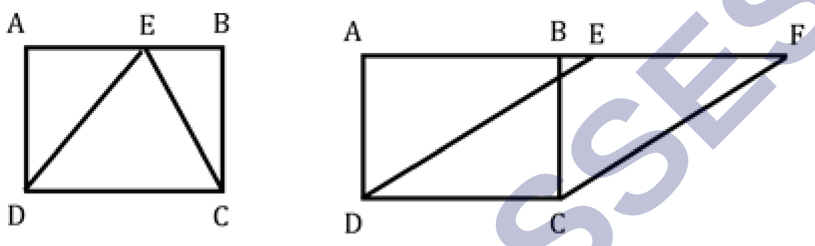



### Figure on the same base and between the same parallels

- Two figures are said to be on the same base and between the same parallels if they have a common base (side) and the vertices (or the vertex) opposite to the common base of each figure lie on a line parallel to the base.




On the same base but not between the same parallels

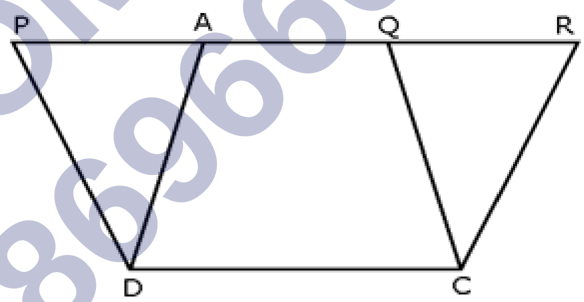



On the same base CD and between the same parallels AF and CD

- Please note that out of the two parallels, one must be the line containing the common base.

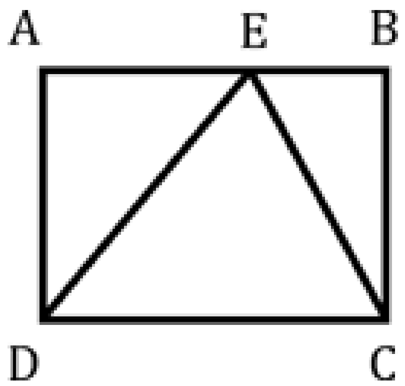
**Areas of figures on the same base and between the same parallels**

- Parallelograms on the same base and between the same parallels are equal in area.




In the figure, parallelograms PQCD and ARCD lie on the same base CD and between same parallels CD and PR. So, ar(PQCD) = ar(ARCD).

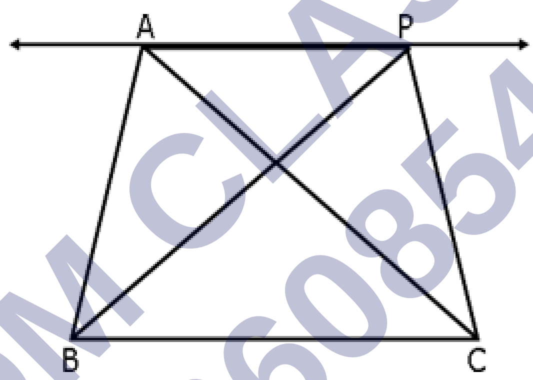
- **Area of a parallelogram** is the product of its any side and the corresponding altitude.
- Parallelograms on the same base (or equal bases) and having equal areas lie between the same parallels.
- If a triangle and a parallelogram are on the same base and between the same parallels, then the area of the triangle is equal to half of the area of the parallelogram.




In the figure, triangle DEC and parallelogram ABCD are on the same CD and between the same parallels AB and CD.

Therefore, area of triangle DEC = ½ × area of parallelogram ABCD.

- Two triangles on the same base (or equal base) and between the same parallel are equal in area.




In the figure, triangles ABC and PBC lie on the same base BC and between same parallels BC and AP.

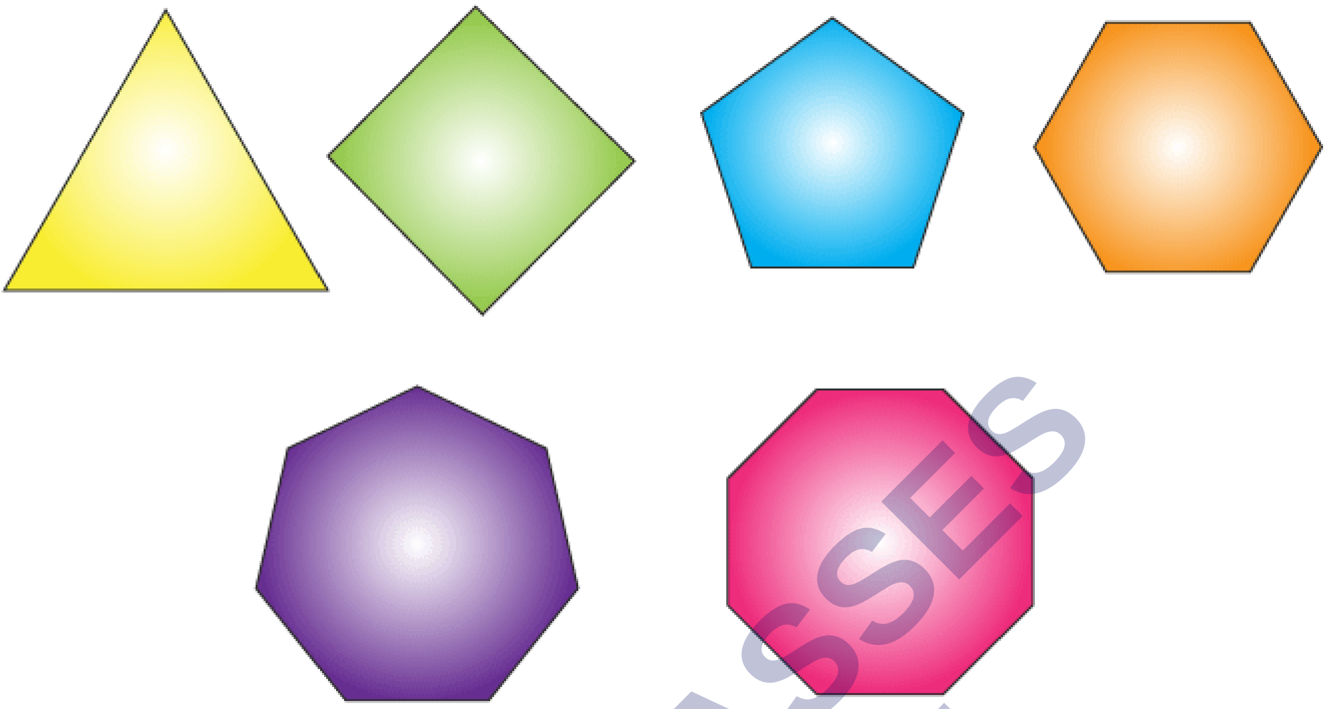
Therefore, ar(triangle ABC) = ar(triangle PBC).

- **Area of a triangle** is half the product of its base (or any side) and the corresponding altitude (or height).

**Important facts about triangles on the same base**

- Two triangles with same base (or equal bases) and equal areas will have equal corresponding altitudes.
- Two triangles having the same base (or equal bases) and equal areas lie between the same parallels.
- A median of a triangle divides it into triangles of equal areas.

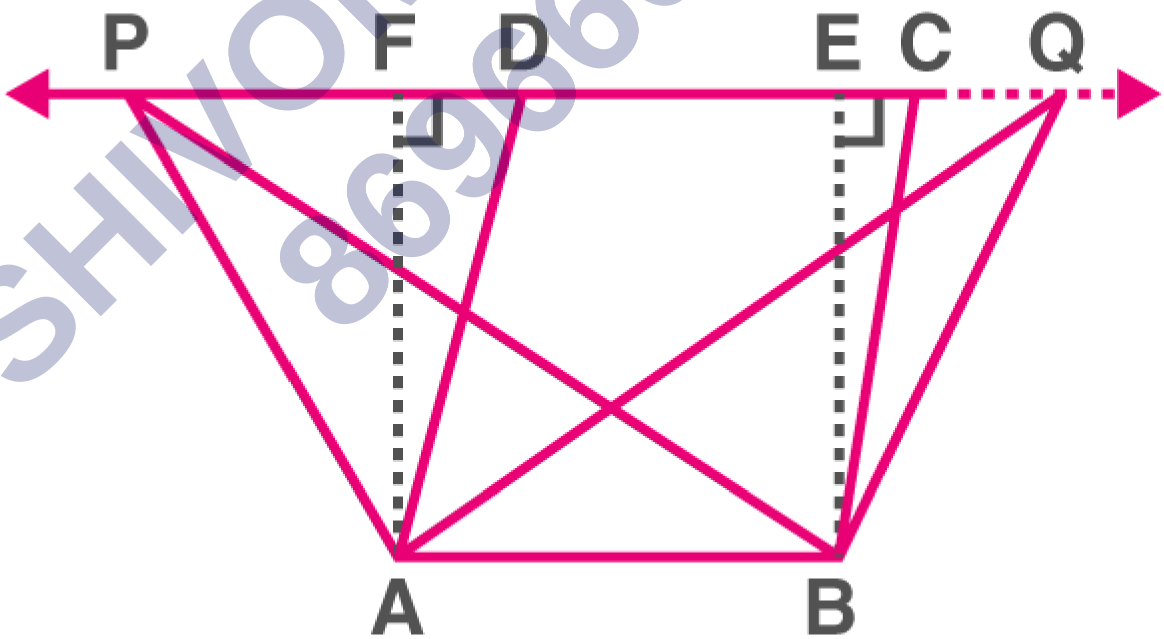
**The area represents the amount of planar surface being covered by a closed geometric figure.**



## Figures on the Common Base and Between the Same Parallels

Two shapes are stated to be on the common base and between the same parallels if:

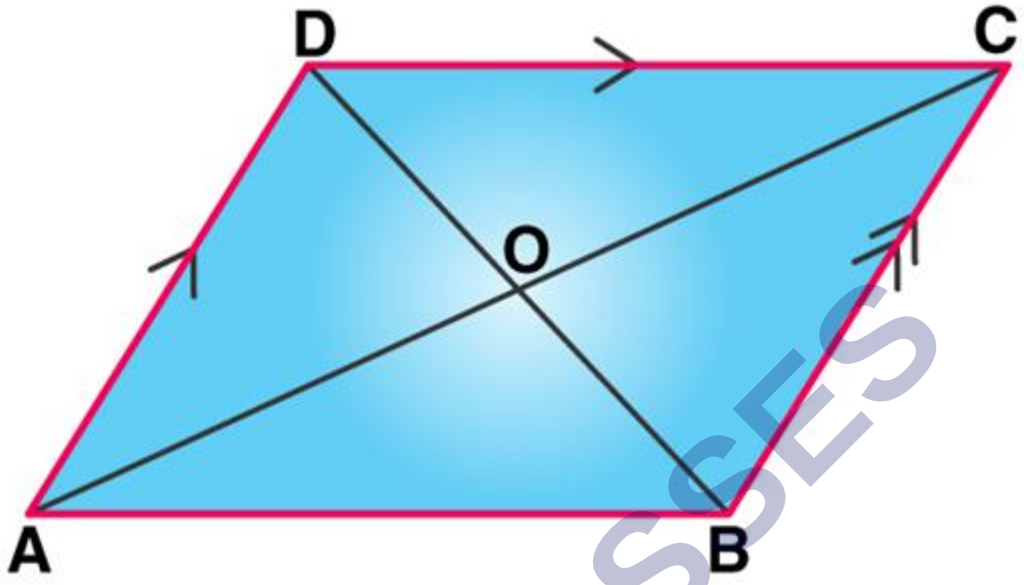
- They have a common side.
- The sides parallel to the common base and vertices opposite the common side lie on the same straight line parallel to the base.




For example Parallelogram ABCD, Rectangle ABEF and Triangles ABP and ABQ

**Area of a parallelogram**

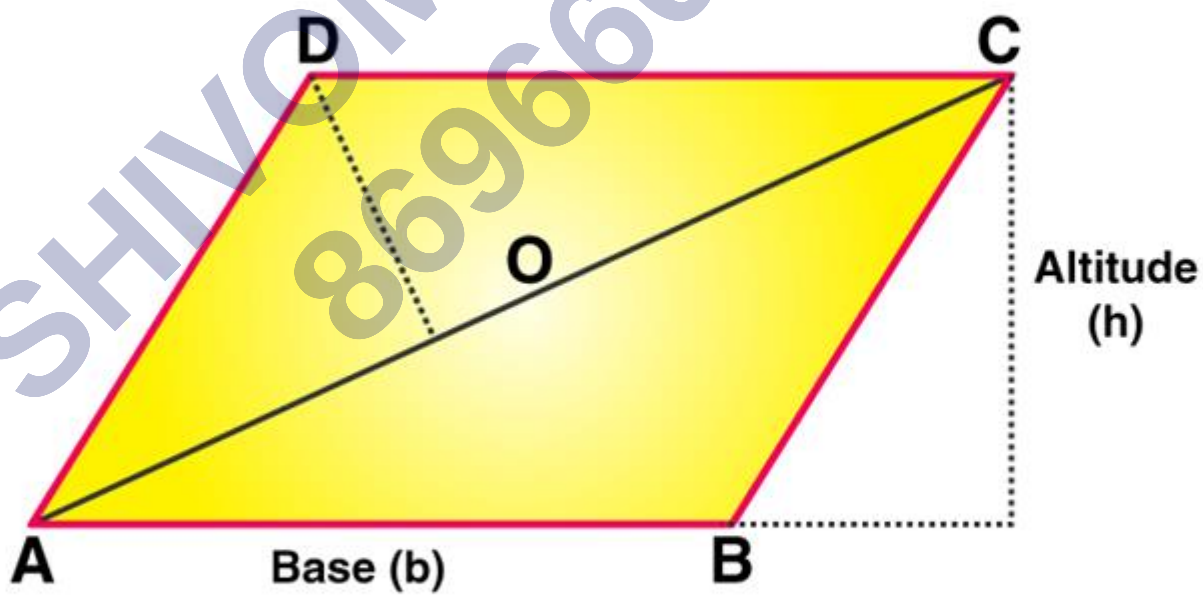
The area of a parallelogram is the region bounded by the parallelogram in a given two-dimension space. To recall, a parallelogram is a special type of quadrilateral which has four sides and the pair of opposite sides are parallel. In a parallelogram, the opposite sides are of equal length and opposite angles are of equal measures. Since the rectangle and the parallelogram have similar properties, the area of the rectangle is equal to the area of a parallelogram.




Parallelogram

Area of Parallelogram Formula

To find the area of the parallelogram, multiply the base of the perpendicular by its height. It should be noted that the base and the height of the parallelogram are perpendicular to each other, whereas the lateral side of the parallelogram is not perpendicular to the base. Thus, a dotted line is drawn to represent the height.

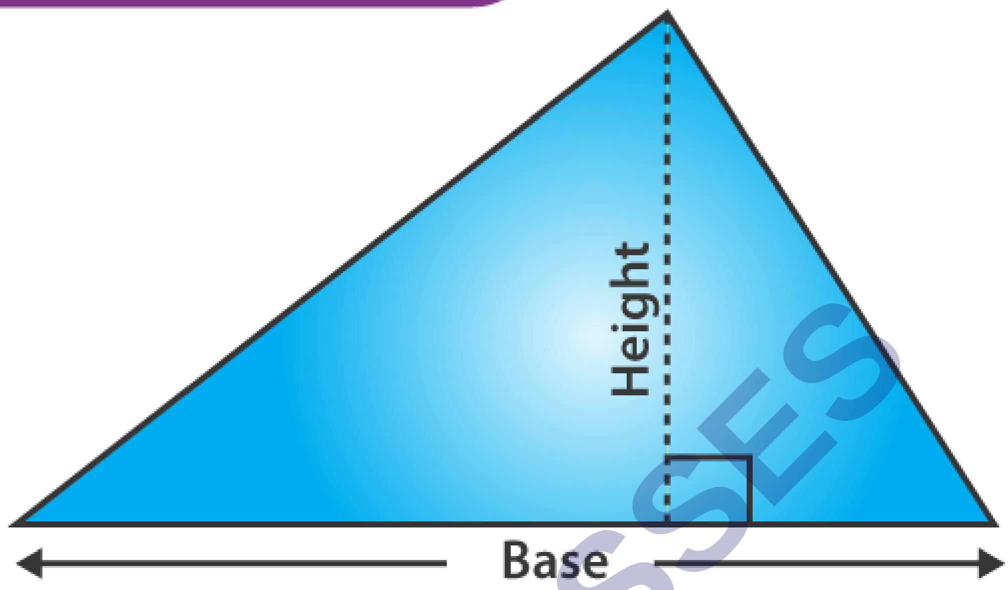



Area of a parallelogram = b × h

Where ‘b’ is the base and ‘h’ is the corresponding altitude (Height).

## Area of a triangle

# AREA OF TRIANGLE




Area $= \frac{1}{2}$ x base x perpendicular height

**Area of a Triangle Formula**

The area of the triangle is given by the formula mentioned below:

Area of a Triangle = A = ½ (b × h) square units

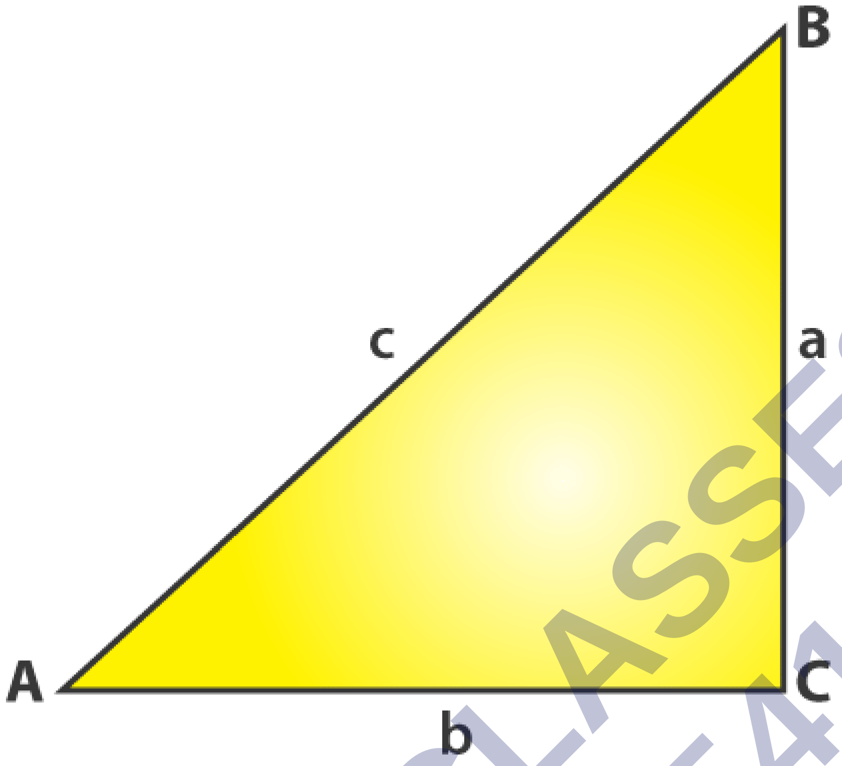
where b and h are the base and height of the triangle, respectively.

Now, let's see how to calculate the area of a triangle using the given formula. The area formulas for all the different types of triangles like an area of an equilateral triangle, right-angled triangle, an isosceles triangle are given below. Also, how to find the area of a triangle with 3 sides using Heron's formula with examples.

**Area of a Right-Angled Triangle**

A right-angled triangle, also called a right triangle has one angle at 90° and the other two acute angles sums to 90°. Therefore, the height of the triangle will be the length of the perpendicular side.

# AREA OF A RIGHT ANGLED TRIANGLE




Area of a Right Triangle = A = ½ × Base × Height (Perpendicular distance)

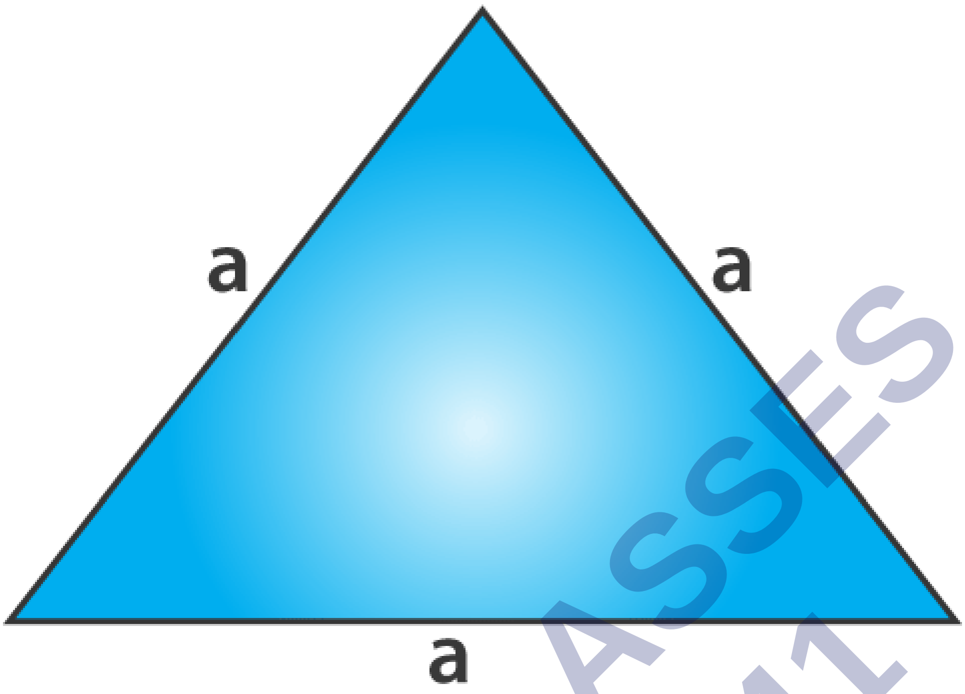
From the above figure,

Area of triangle ACB = 1/2 ab

**Area of an Equilateral Triangle**

An equilateral triangle is a triangle where all the sides are equal. The perpendicular drawn from the vertex of the triangle to the base divides the base into two equal parts. To calculate the area of the equilateral triangle, we have to know the measurement of its sides.

## AREA OF AN EQUILATERAL TRIANGLE

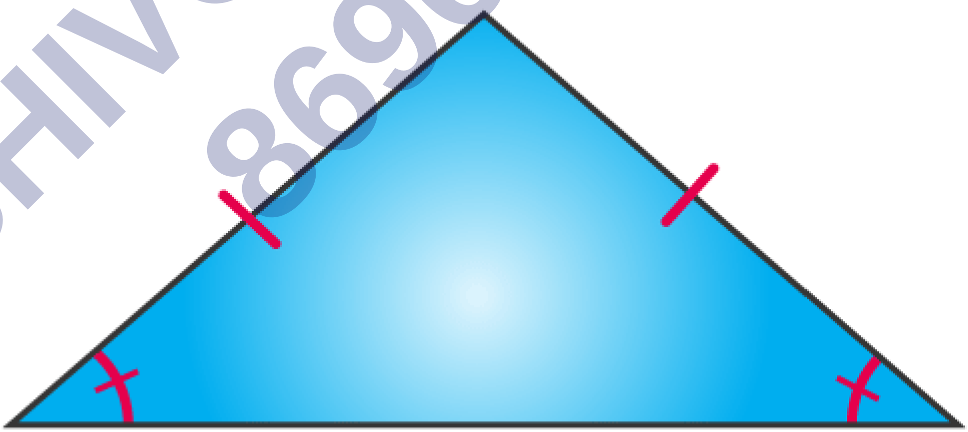



Area of an Equilateral Triangle = A = (√3)/4 × side$^2$

**Area of an Isosceles Triangle**

An isosceles triangle has two of its sides equal and also the angles opposite the equal sides are equal.

## AREA OF AN ISOSCELES TRIANGLE



Area of an Isosceles Triangle = 1/4 b√(4a$^2$ – b$^2$)

## Perimeter of a Triangle

The perimeter of a triangle is the distance covered around the triangle and is calculated by adding all three sides of a triangle.

The perimeter of a triangle = P = (a + b + c) units

where a, b and c are the sides of the triangle.

**Area of Triangle with Three Sides (Heron's Formula)**

The area of a triangle with 3 sides of different measures can be found using Heron's formula. Heron's formula includes two important steps. The first step is to find the semi perimeter of a triangle by adding all the three sides of a triangle and dividing it by 2. The next step is that, apply the semi-perimeter of triangle value in the main formula called "Heron's Formula" to find the area of a triangle.

$$A = \sqrt{s(s-a)(s-b)(s-c)}$$

where, s is semi-perimeter of the triangle = s = (a + b + c) / 2

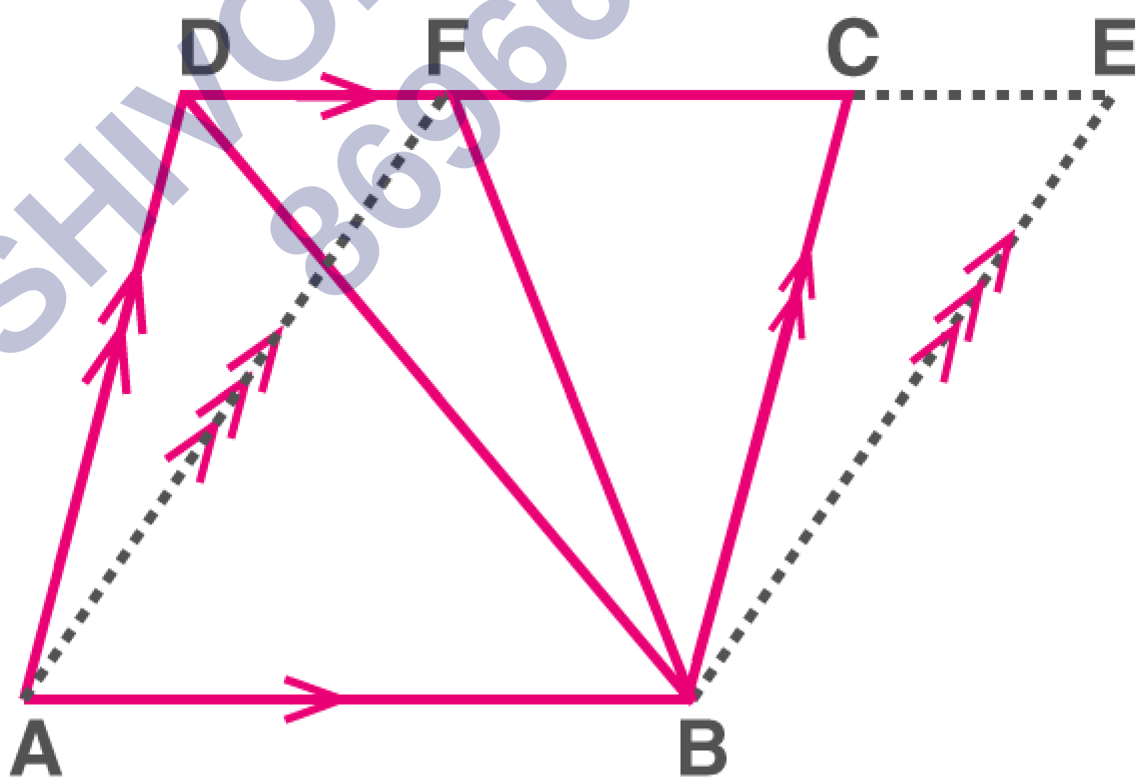
We have seen that the area of special triangles could be obtained using the triangle formula. However, for a triangle with the sides being given, the calculation of height would not be simple. For the same reason, we rely on Heron's Formula to calculate the area of the triangles with unequal lengths.

## Theorems

Parallelograms on the Common Base and Between the Same Parallels

Two parallelograms are said to be on the common/same base and between the same parallels if

- They have a common side.
- The sides parallel to the common side lie on the same straight line.




Parallelogram ABCD and ABEF

Theorem: Parallelograms that lie on the common base and between the same parallels are said to have equal in area.

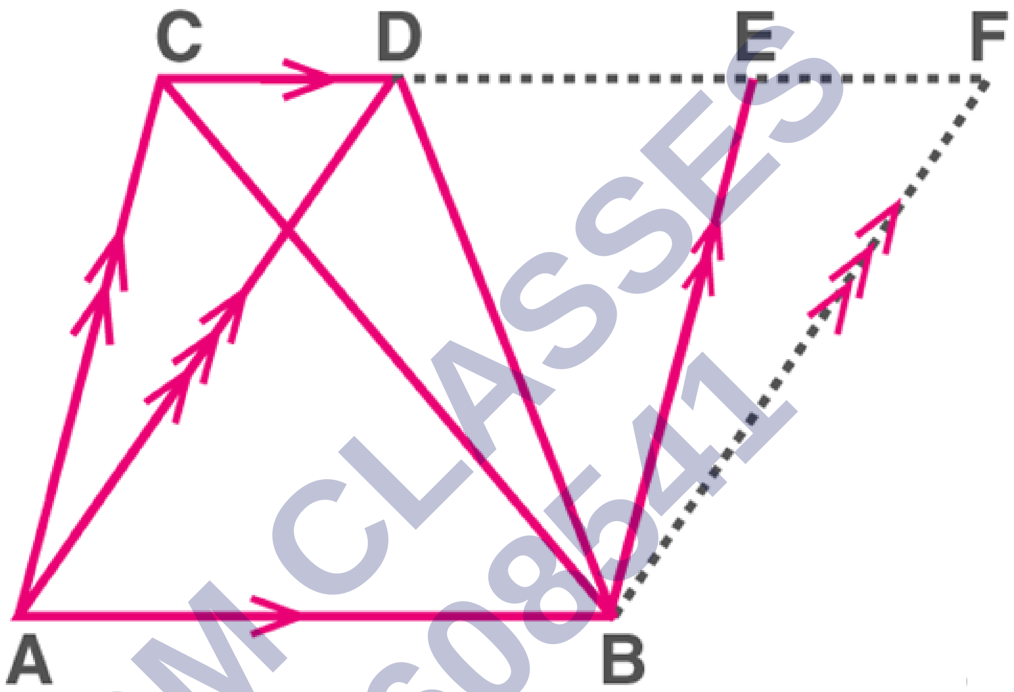
Here, ar (parallelogram ABCD) = ar(parallelogram ABEF)

**Triangles on the Common Base and Between the Same Parallels**

Two triangles are said to be on the common base and between the same parallels if

They have a common side.

The vertices opposite the common side lie on a straight line parallel to the common side.

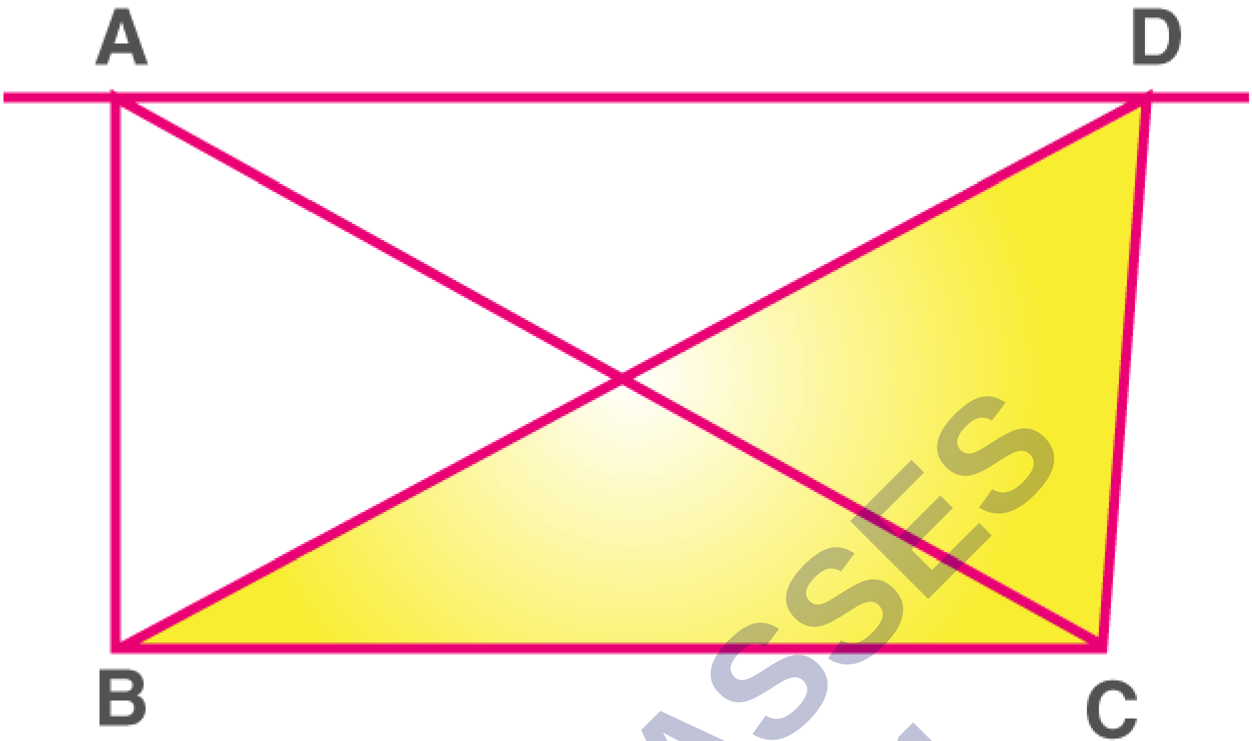



Triangles ABC and ABD

Theorem: Triangles that lie on the same or the common base and also between the same parallels are said to have an equal area.

Here, ar (ΔABC) = ar (ΔABD)

**Two Triangles Having the Common Base & Equal Areas**

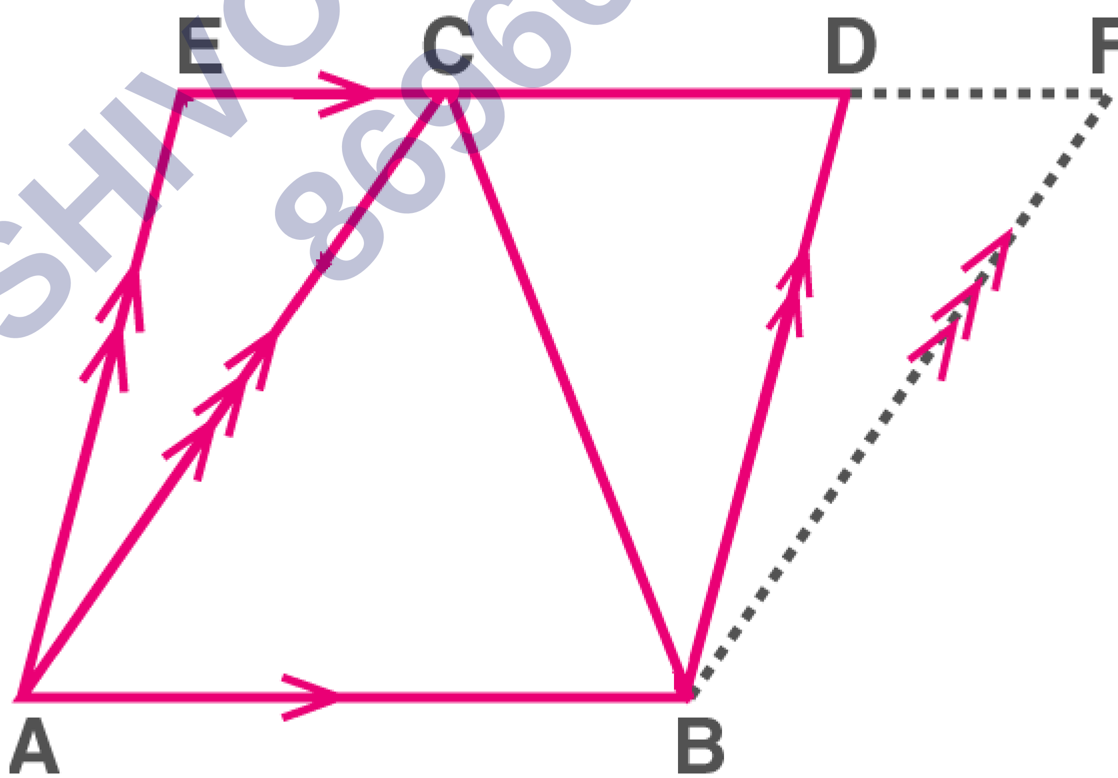



If two triangles have equal bases and are equal in area, then their corresponding altitudes are equal.

A Parallelogram and a Triangle Between the Same parallels

A triangle and a parallelogram are said to be on the same base and between the same parallels if

- They have a common side.
- The vertices opposite the common side lie on a straight line parallel to the common side.




A triangle ABC and a parallelogram ABDE

Theorem: If a triangle and a parallelogram are on the common base and between the same parallels, then the area of the triangle is equal to half the area of the parallelogram.

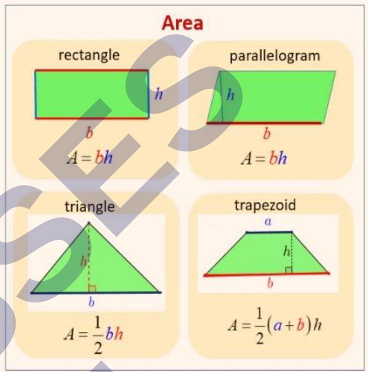
Here, ar (ΔABC) = (1/2) ar (parallelogram ABDE)

**Class : 9th mathematics**
**Chapter- 9: Areas of Parallelograms and Triangles**

## Areas of Parallelograms and Triangles

### Area

Number (in some unit) associated with part of the plane enclosed by the figure




### Theorems

| Statement | Figure |
|---|---|
| 1. Parallelograms on the same base and between same parallels are equal in area. | ar (ABCD) = ar (PQCD) |
| 2. Two triangles on the same base (or equal bases) and between the same parallels are equal in area | ar $\Delta$ADC = ar $\Delta$ABC |
| 3. Two triangles having the same base (or equal bases) and equal areas lie between the same parallels | if ar $\Delta$ADC = ar $\Delta$ABC then AB \|\| CD |

### Properties

| | | |
|---|---|---|
| (i) If *A* and *B* are congruent figures, | ar (*A*) = ar (*B*) | if PQR ≅ DEF then ar (A) = ar (B) |
| (ii) If a planar region formed by a figure T is made up of two non-overlapping planar regions formed by figures *P* and *Q* | ar (*T*) = ar(*P*) + ar (*Q*) | Area of figure *T* = Area of figure *P* + Area of figure *Q* |

# Important Questions

## Multiple Choice questions-

Question 1. What is the area of a parallelogram?

(a) $\frac{1}{2}$ × Base × Altitude

(b) Base × Altitude

(c) $\frac{1}{4}$ × Base × Median

(d) Base × Base

Question 2. AE is a median to side BC of triangle ABC. If area(ΔABC) = 24cm, then area(ΔABE) =

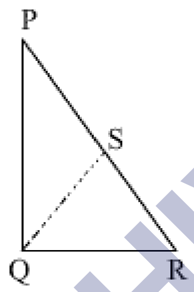
(a) 8cm

(b) 12cm

(c) 16cm

(d) 18cm

Question 3. In the figure, ∠PQR = 90°, PS = RS, QP = 12cm and QS = 6.5cm. The area of ΔPQR is




(a) $30cm^2$

(b) $20cm^2$

(c) $39cm^2$

(d) $60cm^2$

Question 4. BCD is quadrilateral whose diagonal AC divides it into two parts, equal in area, then ABCD

ABCD is quadrilateral whose diagonal AC divides it into two parts, equal in area, then ABCD

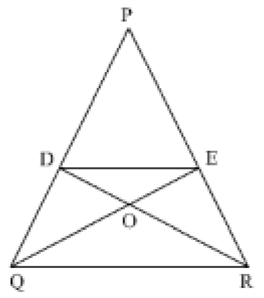
(a) Is a rectangles

(b) Is a parallelogram

(c) Is a rhombus

(d) Need not be any of (a), (b) or (c).

Question 5. In ΔPQR, if D and E are points on PQ and PR respectively such that DE || QR, then ar (PQE) is equal to




(a) ar (PRD)

(b) ar (DQM)

(c) ar (PED)

(d) ar (DQR)

Question 6. If Diagonals AC and BD of a trapezium ABCD with AB || DC intersect each other at O. Then,

(a) ar (AOD) = ar (BOC)

(b) ar (AOD) > ar (BOC)

(c) ar (AOD) < ar (BOC)

(d) None of the above

Question 7. For two figures to be on the same base and between the same parallels, one of the lines must be.

(a) Making an acute angle to the common base

(b) The line containing the common base

(c) Perpendicular to the common base

(d) Making an obtuse angle to the common base

Question 8. Two parallelograms are on equal bases and between the same parallels. The ratio of their areas is:

(a) 1 : 3

(b) 1 : 2

(c) 2 : 1

(d) 1 : 1

Question 9. If P and Q are any two points lying on the sides DC and AD respectively of a parallelogram ABCD, then:

(a) ar (APB) > ar(BQC)

(b) ar (APB) < ar(BQC)

(c) ar (APB) = ar(BQC)

(d) None of the above

Question 10. A triangle and a rhombus are on the same base and between the same parallels. Then the ratio of area of triangle to that rhombus is:

(a) 1 : 3

(b) 1 : 2

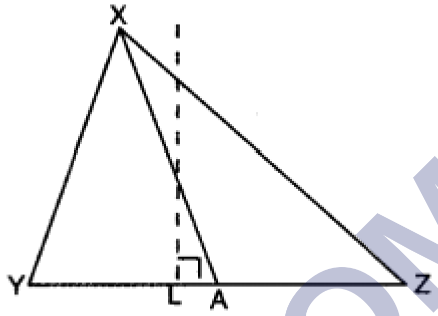
(c) 1 : 1

(d) 1 : 4

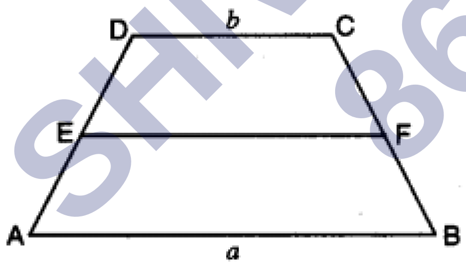
## Very Short:

1. Two parallelograms are on equal bases and between the same parallels. Find the ratio of their areas.

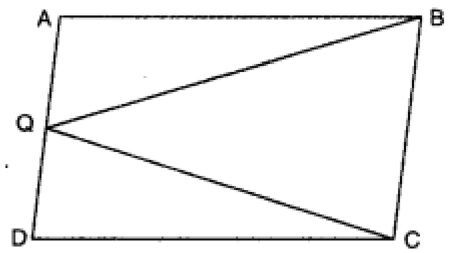
2. In ΔXYZ, XA is a median on side YZ. Find ratio of ar(ΔXYA) : ar(ΔXZA)



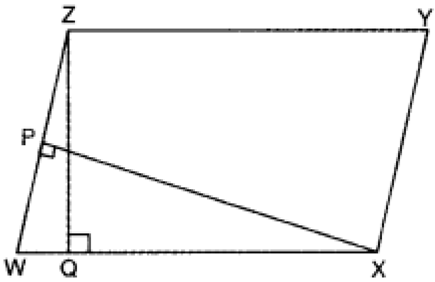

3. ABCD is a trapezium with parallel sides AB = a cm and DC = b cm (fig.). E and F are the mid-points of the non parallel sides. Find the ratio of ar(ABFE) and ar(EFCD).



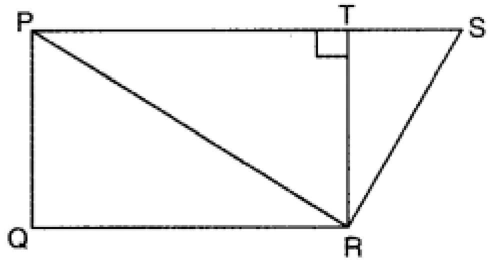

4. ABCD is a parallelogram and Q is any point on side AD. If ar(ΔQBC) = 10 cm2, find ar(ΔQAB) + ar(ΔQDC).




5. WXYZ is a parallelogram with XP ⊥ WZ and ZQ ⊥ WX. If WX = 8 cm, XP = 8 cm and ZQ = 2 cm, find YX.

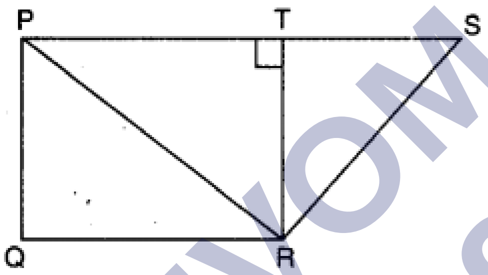



6. In figure, TR ⊥ PS, PQ || TR and PS || QR. If QR = 8 cm, PQ = 3 cm and SP = 12 cm, find ar(quad. PQRS).



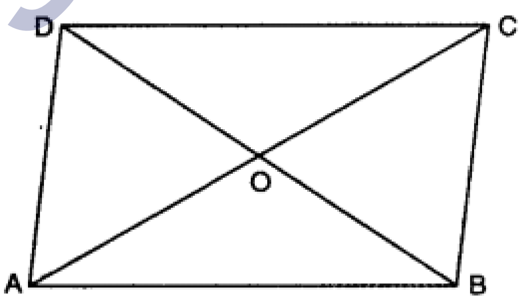

7. In the given figure, ABCD is a parallelogram and L is the mid-point of DC. If ar(quad. ABCL) is 72 cm, then find ar(ΔADC).

8. In figure, TR ⊥ PS, PQ || TR and PS || QR. If QR = 8 cm, PQ = 3 cm and SP = 12 cm, find ar (PQRS).

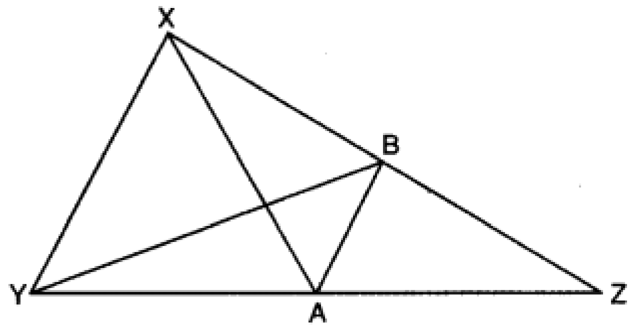



## Short Questions:

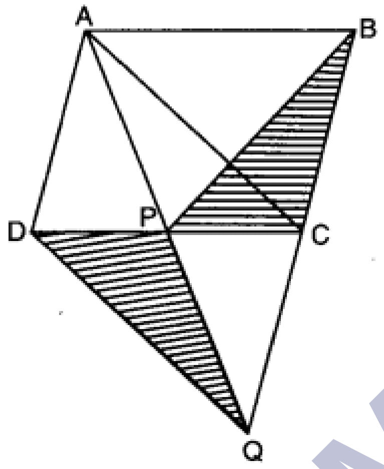
1. ABCD is a parallelogram and O is the point of intersection of its diagonals. If ar(A AOD) = 4 cm\(2\) find area of parallelogram ABCD.



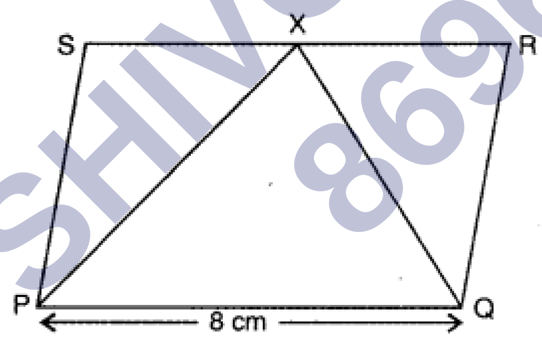

2. In the given figure of ΔXYZ, XA is a median and AB || YX. Show that YB is also a median.



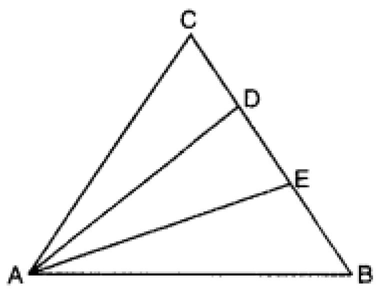

3. ABCD is a trapezium. Diagonals AC and BD intersect each other at O. Find the ratio ar (ΔAOD) : ar (ΔBOC).
4. ABCD is a parallelogram and BC is produced to a point Q such that AD = CQ (fig.). If AQ intersects DC at P, show that ar(ΔBPC) = ar(ΔDPQ).




5. In the figure, PQRS is a parallelogram with PQ = 8 cm and ar(ΔPXQ) = 32 cm2. Find the altitude of gm PQRS and hence its area.

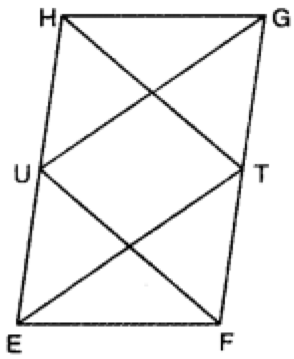



6. In ΔABC. D and E are points on side BC such that CD = DE = EB. If ar(ΔABC) = 27cm, find ar(ΔADE)



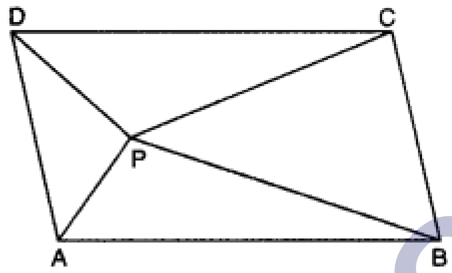

## Long Questions:

1. EFGH is a parallelogram and U and T are points on sides EH and GF respectively. If ar(ΔEHT) = 16cm, find ar(ΔGUF).

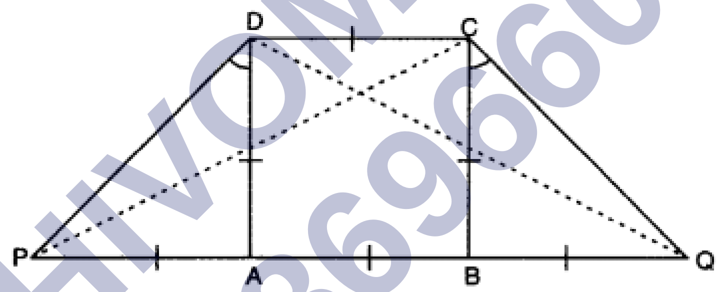



2. ABCD is a parallelogram and P is any point in its interior. Show that:

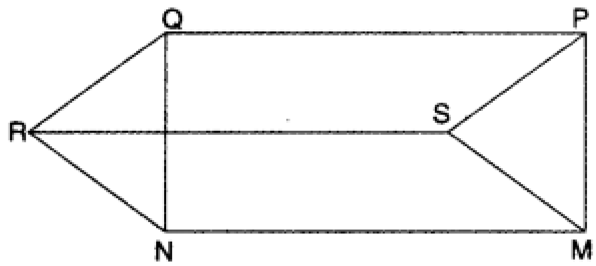
   ar(ΔAPB) + ar(ΔCPD) = ar(ΔBPC) + ar(ΔAPD)




3. In the given figure, ABCD is a square. Side AB is produced to points P and Q in such a way that PA = AB = BQ. Prove that DQ = CP.




4. In the given figure, PQRS, SRNM and PQNM are parallelograms, Show that : ar(ΔPSM) = ar(ΔQRN).




5. Naveen was having a plot in the shape of a quadrilateral. He decided to donate some portion of it to construct a home for orphan girls. Further he decided to buy a land in lieu of his donated portion of his plot so as to form a triangle.

   (i) Explain how this proposal will be implemented?

   (ii) Which mathematical concept is used in it?

(iii) What values are depicted by Naveen?

## Assertion and Reason Questions-

**1.** In these questions, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

**Assertion:** The area of a parallelogram and a rectangle having a common base and between same parallels are equal.

**Reason:** Another name of a rectangle is a parallelogram.

**2.** In these questions, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

**Assertion:** The parallelogram on the same and between the same parallel are equal in area.

**Reason:** The areas of parallelogram between the same parallels are equal

## Answer Key:

## MCQ:

1. (b) Base × Altitude
2. (b) 12cm
3. (c) $30cm^2$
4. (d) Need not be any of (a), (b) or (c).
5. (a) ar (PRD)
6. (a) ar (AOD) = ar (BOC)
7. (b) The line containing the common base
8. (d) 1 : 1

9. (c) ar(APB) = ar(BQC)

10.(b) 1 : 2

## Very Short Answer:

1. 1:1 [∵ Two parallelograms on the equal bases and between the same parallels are equal in

   area.]

2. Here, XA is the median on side YZ.

   ∴ YA = AZ

   Draw XL ⊥ YZ

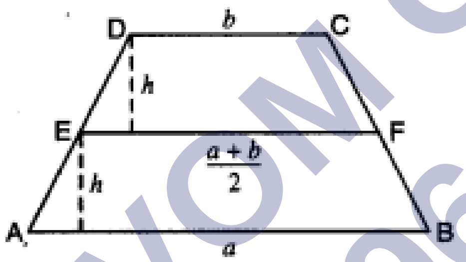
   $$\therefore \; ar(\Delta XYA) = \frac{1}{2} \times YA \times XL$$

   $$ar(\Delta XZA) = \frac{1}{2} \times AZ \times XL$$

   $$\text{Thus, } ar(\Delta XYA) : ar(\Delta XZA) = \frac{1}{2} \times YA \times XL : \frac{1}{2} \times AZ \times XL$$

   $$= 1 : 1 \qquad [\because YA = AZ]$$

3.




$$\text{Clearly, } EF = \frac{AB + DC}{2} = \frac{a+b}{2}$$

Let $h$ be the height, then

ar(Trap. ABFE) : ar(Trap. EFCD)

$$\Rightarrow \quad \frac{1}{2}\left[a+\left(\frac{a+b}{2}\right)\right] \times h : \frac{1}{2}\left[b+\left(\frac{a+b}{2}\right)\right] \times h$$

$$\Rightarrow \quad \frac{2a+a+b}{2} : \frac{2b+a+b}{2}$$

$$\Rightarrow \quad 3a + b : 3b + a$$

4. Here, ΔQBC and parallelogram ABCD are on the same base BC and lie between the same parallels BC || AD.

   ∴ ar(||gm ABCD) = 2 ar(ΔQBC) ar(ΔQAB) + ar(ΔQDC) + ar(ΔQBC) = 2 ar(ΔQBC)

   ar(ΔQAB) + ar(ΔQDC) = ar(ΔQBC)

   Hence, ar(ΔQAB) + ar(ΔQDC) = 10cm$^2$

[∵ ar(ΔQBC) = 10 cm2 (given)]

5. ar(||gm WXYZ) = ar(||gm WXYZ)

WX × ZQ = WZ × XP

8 × 2 = WZ × 8

⇒ WZ = 2cm

Now, YX = WZ = 2cm

[∵ opposite sides of parallelogram are equal]

6. Here,

PS || QR [given]

∴ PQRS is a trapezium

Now, TR ⊥ PS and PQ || TR [given]

⇒ PQ ⊥ PS

∴ PQ = TR = 3cm [given]

Now, ar(quad. PQRS) = $\frac{1}{2}$ (PS + QR) × PQ = $\frac{1}{2}$ (12 + 8) × 3 = 30cm$^2$

7. In ||gm ABCD, AC is the diagonal

$$\therefore \quad ar(\Delta ABC) = ar(\Delta ADC) = \frac{1}{2} ar(||^{gm} ABCD)$$

In ΔADC, AL is the median

$$\therefore \quad ar(\Delta ADL) = ar(\Delta ACL) = \frac{1}{2} ar(\Delta ADC) = \frac{1}{4} ar(||^{gm} ABCD)$$

$$\text{Now, } ar(\text{quad. } ABCL) = ar(\Delta ABC) + ar(\Delta ACL) = \frac{3}{4} ar(||^{gm} ABCD)$$

$$72 \times \frac{4}{3} = ar(||^{gm} ABCD)$$

$$\Rightarrow \quad ar(||^{gm} ABCD) = 96 \text{ cm}^2$$

$$\therefore \quad ar(\Delta ADC) = \frac{1}{2} ar(||^{gm} ABCD) = \frac{1}{2} \times 96 = 48 \text{ cm}^2$$

8. Here, PS || QR

∴ PQRS is a trapezium in which PQ = 3cm, QR = 8cm and SP = 12cm

Now, TR I PS and PQ || TR

∴ PQRT is a rectangle

[∵ PQ || TR, PT || QR and ∠PTR = 90°]

⇒ PQ = TR = 3cm

Now, ar(PQRS) = $\frac{1}{2}$ (PS + QR) × TR = $\frac{1}{2}$ (12 + 8) × 3 = 30cm$^2$.

## Short Answer:

**Ans: 1.** Here, ABCD is a parallelogram in which its diagonals AC and BD intersect each other in O.

∴ O is the mid-point of AC as well as BD.

Now, in ΔADB, AO is its median

∴ ar(ΔADB) = 2 ar(ΔAOD)

[∵ median divides a triangle into two triangles of equal areas]

So, ar(ΔADB) = 2 × 4 = 8cm$^2$

Now, ΔADB and ||gm ABCD lie on the same base AB and lie between same parallels AB and CD

∴ ar(ABCD) = 2 ar(ΔADB).

= 2 × 8

= 16cm$^2$

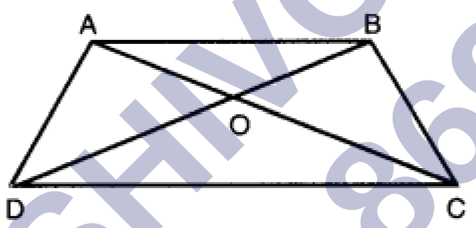
**Ans: 2**. Here, in ΔXYZ, AB || YX and XA is a median.

∴ A is the mid-point of YZ. Now, AB is a line segment from mid-point of one side (YZ) and parallel to another side (AB || YX), therefore, it bisects the third side XZ.

⇒ B is the mid-point of XZ.

Hence, YB is also a median of ΔXYZ.

**Ans: 3.**




Here, ABCD is a trapezium in which diagonals AC and BD intersect each other at O. ΔADC and ΔBCD are on the same base DC and between the same 'parallels i.e., AB || DC.

∴ ar(ΔADC) = ar(ΔBCD)

⇒ ar(ΔAOD) + ar(ΔODC)

= ar(ABOC) + ar (AODC)

⇒ ar(ΔAOD) = ar(ΔBOC)

⇒ $\frac{\text{ar }(\Delta AOD)}{\text{ar }(\Delta BOC)} = 1$

**Ans: 4.** In ||$^{gm}$ ABCD,

ar(ΔAPC) = ar(ΔBCP) ...(i)

[∵ triangles on the same base and between the same parallels have equal area]

Similarly, ar(ΔADQ) = ar(ΔADC) i …(ii)

Now, ar(ΔADQ) – ar(ΔADP) = ar(ΔADC) – ar(ΔADP)

ar(ΔDPQ) = ar(ΔACP) … (iii)

From (i) and (iii), we have

ar(ΔBCP) = ar(ΔDPQ)

or ar(ΔBPC) = ar(ΔDPQ)

**Ans: 5.** Since parallelogram PQRS and APXQ are on the same base PQ and lie between the same

parallels PQ | | SR

∴ Altitude of the ΔPXQ and | |gm PQRS is same.

Now, $\frac{1}{2}$ PQ × altitude = ar(ΔPXQ)

⇒ $\frac{1}{2}$ × 8 × altitude = 32

altitude = 8cm

ar(| |gm PQRS) = 2 ar(ΔPXQ)

= 2 × 32 = 64cm$^2$

Hence, the altitude of parallelogram PQRS is 8cm and its area is 64cm$^2$.

**Ans: 6.** Since in ΔAEC, CD = DE, AD is a median.

∴ ar(ΔACD) = ar(ΔADE)

[∵ median divides a triangle into two triangles of equal areas]

Now, in ΔABD, DE = EB, AE is a median

ar(ΔADE) = ar(ΔAEB) … (ii)

From (i), (ii), we obtain

ar(ΔACD) = ar(ΔADE) = ar(ΔAEB) $\frac{1}{3}$ ar(ΔABC)

∴ ar(ΔADE) = $\frac{1}{3}$ × 27 = 9cm$^2$

## Long Answer:

**Ans: 1**. ∴ ar(ΔEHT) = $\frac{1}{2}$ ar(| |gm EFGH) …..(i)

Similarly, ΔGUF and parallelogram EFGH are on the same base GF and lie between the same parallels GF and HE

∴ ar(ΔGUF) = $\frac{1}{2}$ ar(| |gm EFGH) …..(ii)

From (i) and (ii), we have

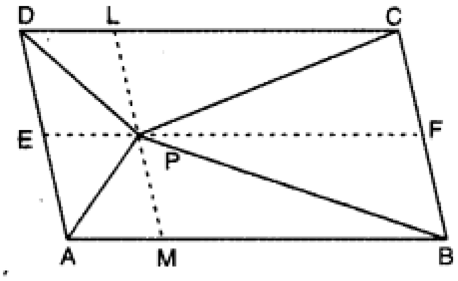
ar(ΔGUF) = ar(ΔEHT)

= 16cm$^2$ [∵ ar(ΔEHT) = 16cm$^2$] [given]

**Ans: 2.** Through P, draw a line LM || DA and EF || AB

Since ΔAPB and ||gm ABFE are on the same base AB and lie between the same parallels AB and EF.

∴ ar(ΔAPB) = $\frac{1}{2}$ ar(||gm ABFE) … (i)




Similarly, ACPD and parallelogram DCFE are on the same base DC and between the same parallels DC and EF.

∴ ar(ΔCPD) = $\frac{1}{2}$ ar(||$^{gm}$ DCFE) … (ii)

Adding (i) and (ii), we have

ar(ΔAPB) + ar(ΔCPD) = $\frac{1}{2}$ ar (||$^{gm}$ ABFE) + ar(||$^{gm}$ DCFE)

= $\frac{1}{2}$ ar(||$^{gm}$ ABCD) … (iii)

Since ΔAPD and parallelogram ADLM are on the same base AB and between the same parallels AD and ML

∴ ar(ΔAPD) = $\frac{1}{2}$ ar(||$^{gm}$ ADLM) …..(iv)

Similarly, ar(ΔBPC) = $\frac{1}{2}$ = arc||$^{gm}$ BCLM) ….(v)

Adding (iv) and (u), we have

ar(ΔAPD) + ar (ΔBPC) = $\frac{1}{2}$ ar(||$^{gm}$ ABCD) ….(vi)

From (iii) and (vi), we obtain

ar(ΔAPB) + ar(ΔCPD) = ar(ΔAPD) + ar(ABPC)

**Ans: 3.** In ΔPAD, ∠A = 90° and DA = PA = AB

⇒ ∠ADP = ∠APD = $\frac{90°}{2}$ = 45°

Similarly, in ΔQBC, ∠B = 90° and BQ = BC = AB

⇒ ∠BCQ = ∠BQC = $\frac{90°}{2}$ = 45°

In ΔPAD and ΔQBC, we have

PA = BQ [given]

∠A = ∠B [each = 90°]

AD = BC [sides of a square]

⇒ ∠PAD ≅ ΔQBC [by SAS congruence rule]

⇒ PD = QC [c.p.c.t.]

Now, in APDC and ΔQCD

DC = DC [common]

PD = QC [prove above]

∠PDC = ∠QCD [each = $90° + 45° = 135°$]

⇒ ΔPDC = ΔQCD [by SAS congruence rule]

⇒ PC = QD or DQ = CP

**Ans: 4.** Since PQRS is a parallelogram.

∴ PS = QR and PS || QR

Since SRNM is also a parallelogram.

∴ SM = RN and SM || RN

Also, PQNM is a parallelogram

∴ PM || QM and PM = QM

Now, in APSM and ΔQRN

PS = QR

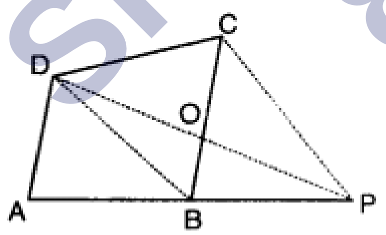
SM = RN

PM = QN

ΔPSM ≅ ΔQRN [by SSS congruence axiom]

∴ ar (ΔPSM) = ar (ΔQRN) [congruent triangles have same areas)

**Ans: 5.**




(i) Let ABCD be the plot and Naveen decided to donate some portion to construct a home for orphan girls from one corner say C of plot ABCD. Now, Naveen also purchases equal amount of land in lieu of land CDO, so that he may have triangular form of plot. BD is joined. Draw a line through C parallel to DB to meet AB produced in P.

Join DP to intersect BC at 0.

Now, ABCD and ABPD are on the same base and between same parallels CP || DB.

ar(ΔBCD) = ar(ΔBPD) ar(ΔCOD) + ar(ΔDBO) = ar(ΔBOP) + ar(ΔDBO)

ar(ACOD) = ar(ABOP) ar(quad. ABCD)

= ar(quad. ABOD) + ar(ΔCOD)

= ar(quad. ABOD) + ar(ΔBOP)

[∵ ar(ACOD) = ar(ABOP)] (proved above]

= ar(ΔAPD)

Hence, Naveen purchased the portion ABOP to meet his requirement.

(ii) Two triangles on the same base and between same parallels are equal in area.

(iii) We should help the orphan children.

## Assertion and Reason Answers-

**1.** a) Assertion and reason both are correct statements and reason is correct explanation for assertion**.**

**2.** c) Assertion is correct statement but reason is wrong statement.