

Master Lesson Plan
for
Heron's Formula

Board	Standard	Subject	Chapter	Language
NCERT	STD IX	Mathematics	Heron's Formul a	English

CURRICULAR GOALS	CG-5: Derives and uses formulae to calculate areas of plane figures and surface areas and volumes of solid objects
COMPETENCIES AS PER NCF/NIPUN BHARAT	C-5.1: Visualises, represents, and calculates the area of a triangle using Heron's formula and its generalisation to cyclic quadrilaterals given by Brahmagupta's formula
SDG(Sustainable Development Goals)	SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
Technology aids	PPTS, Worksheets
Learning Teaching Materials (LTM)	A boat with two sails, one of which is a scalene triangle
Cross-Cutting Themes	Values and Dispositions: Thinking differently makes us unique and special. Technology in Education: PowerPoint Presentations Inclusion: Value content supports Cognitive Inclusion. It highlights that diverse minds and perspectives should be included and respected.

MS_Objectives_Herons formula

Objective: Teachers will be able to get an overview of the asset objectives in the MLP for the chapter 'Heron's formula'.

[Notes to the teacher: This asset lays down the proposed plan for transacting this chapter. It states the asset objectives of the MLP. This asset is for the teacher's reference and need not be taught to the students.]

Students will be able to –

- explore the need for a formula to find the area of a triangle when three sides of the triangle are given
- appreciate the contributions made by Heron, back in time somewhere between 10 AD - 70 AD
- calculate the area of triangle using Heron's formula
- calculate area of triangular and quadrilateral shapes using Heron's formula
- relate Heron's formula to calculate area of different shapes put together, like area of crops cultivated in farmlands
- to create an aeroplane using coloured paper and find the area of paper used by applying Heron's formula
- develop the courage to think differently.

Time to teach	Asset type	Theme	Sub Theme
5 minutes	Main Script	Triangle	Application of Heron's formula Area of a triangle Area of triangle - Heron's formula

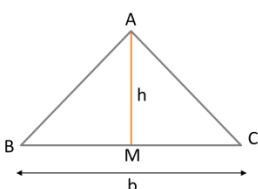
IQ_Area of Triangle Revision

Objective: Students will be able to explore the need for a formula to find the area of a triangle when three sides of the triangle are given.

Teaching Aids: PPT

Notes to the teacher: The teacher may pose the following questions to the students, allow them to think and come out with as many answers as possible before arriving at a conclusion. If there is any difficulty in getting the answers, the teacher can ask leading questions.

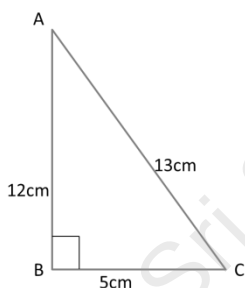
1) What is the formula used to find the area of the triangle as given in the figure?



Expected answer:

$\frac{1}{2} \times bh$ where b is the length of its base and h is its height.

2) Consider a right angled triangle as shown in the figure with measure of the three sides given.



a) What would be the area of this triangle?

Expected answer: 30 cm^2

b) How did you find it?

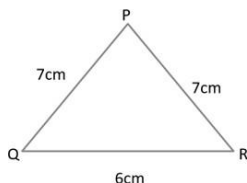
Expected answer: Using the formula, $A = \frac{1}{2} \times bh$ with $b = 5 \text{ cm}$ and $h = 12 \text{ cm}$

c) Why did you take h as 12 cm ?

Expected answer: The height is the perpendicular distance from the base to the vertex.

Since $\angle B = 90^\circ$, AB is taken to be the height of the triangle.

2) Let us consider ΔPQR as isosceles, with $PQ = PR = 7\text{ cm}$, $QR = 6\text{ cm}$.



a) How would you find the area of this triangle?

[Notes to the teacher: If the students are not able to respond, you could help by asking leading questions.

To suggest a few: What is the formula you know?

$$A = \frac{1}{2} \times bh$$

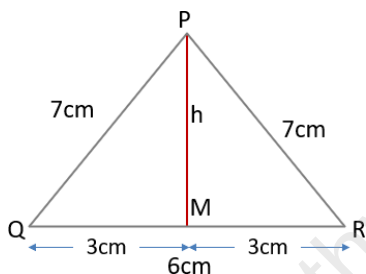
Why can't you use the formula directly?

Ans: Because the height of the triangle is not known.

Is there any way you can find the height of the triangle?

Expected answer: By measuring it, by drawing the perpendicular from P to base QR.]

Draw a perpendicular PM from P, to the base QR.



b) Now, what is the next step?

PM divides ΔPQR into two identical right angled triangles ΔPQM and ΔPRM .

[Notes to the teacher: The teacher may ask, how ΔPQM and ΔPRM are identical.]

$$\text{Area of } \Delta PQR = 2 \times \text{Area of } \Delta PQM \quad (1)$$

$$\text{Base of } \Delta PQM = b = QM = 3\text{ cm}$$

If height of the triangle is h , using Pythagoras theorem,

$$h^2 + QM^2 = PQ^2$$

$$h^2 + 3^2 = 7^2$$

$$h^2 + 9 = 49$$

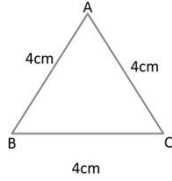
$$h^2 = 49 - 9 = 40$$

$$h = \sqrt{40}\text{ cm} = 2\sqrt{10}\text{ cm}$$

From equation (1)

$$\text{Area of } \Delta PQR = 2 \times \frac{1}{2}bh = 3 \times 2\sqrt{10} = 6\sqrt{10} \text{ cm}$$

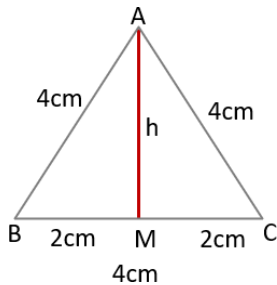
3) Consider ΔABC which is equilateral, with $AB = BC = CA = 4 \text{ cm}$



How would you find the area?

Expected answer:

We can use the same method. Draw a perpendicular AM from A, to the base BC.



It divides ΔABC into two identical right angled triangles ΔABM and ΔACM .

Base of $\Delta ABM = BM = b = 2 \text{ cm}$

Height of ΔABM , h , satisfies,

$$h^2 + BM^2 = AB^2$$

$$h^2 + 2^2 = 4$$

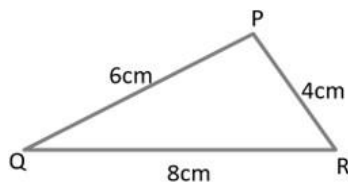
$$h^2 + 4 = 16$$

$$h^2 = 16 - 4 = 12$$

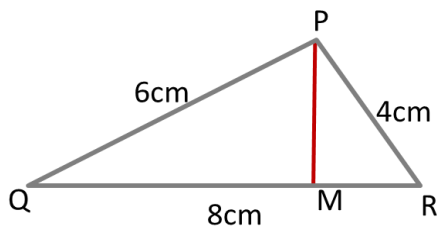
$$h = \sqrt{12} = 2\sqrt{3} \text{ cm}$$

$$4) \text{ Area of } \Delta ABC = 2 \times \text{Area of } \Delta ABM = 2 \times \frac{1}{2} \times bh = bh = 2 \times 2\sqrt{3} = 4\sqrt{3} \text{ cm}^2$$

5) Consider ΔPQR , a scalene triangle, with $PQ = 6 \text{ cm}$, $PR = 4 \text{ cm}$ and $QR = 8 \text{ cm}$



a) Can you calculate the length of the perpendicular PM from P to base QR?



Expected answer:

No, it's not possible to calculate length of PM, unless we know the lengths of QM or MR.

b) Can you measure the length of PM using a scale and use that value as the height of the triangle?

Expected answer:

If we measure the value of PM using a scale, we will get an approximate value of the height. If the exact value of the area of the triangle is required, we can't use this method.

Also in day to day life, we get examples of scalene triangles like fields, parks, roof truss, ramps, etc. In such cases, generally it's not possible to measure the heights of triangles.

A mathematician by name Heron solved this problem by finding a formula.

When the three sides of a triangle are given, we can find the area of the triangle using the given three sides, and this formula does not involve height of the triangle.

Time to teach	Asset type	Theme	Sub Theme
10 minutes	Inquisitive Questions	Triangle	Application of Heron's formula Area of a triangle Area of triangle - Heron's formula

MS_Herons Formula

Objective: Students will be able to calculate the area of a triangle using Heron's formula

Teaching Aids: PPT

Teaching Learning Material (TLM): A boat with two sails, one of which is a scalene triangle

What do you need?: Two A4 size sheets of paper of different colour, scissors, sellotape

Get ready:

Making the boat :

Step 1: Take an A4 size sheet of paper and cut it into a square.



Step 2: Fold the paper in the middle along its length.



Step 3: Now again fold the resulting paper in the middle along its breadth so that it forms a square.



Step 4: From the side of the paper with the loose end, collect three flaps and fold it along the middle to the other end.



Step 5: Take the remaining one flap of paper and fold it on the other side.



Step 6: Open the paper from the middle so as to form a hat and pull the hat apart from the centre so that it forms another square.



Step 7: Pull the resulting square from both the sides so that it forms a boat with a sail in the middle.



Making the sails of the boat:

Step 1: Take an A4 size sheet of paper and cut one right angled triangle and one scalene triangle.



Step 2: Attach these triangles on the triangular protrusion of the boat which was made above using the sellotape.



[Notes to the teacher: The teacher may introduce the topic by showing the sails of the boat. First teacher may show the sail of right angled triangle shape and ask the formula to calculate its area. Now the teacher shows the second sail which is a scalene triangle. The teacher may explain that the height of the triangle cannot be measured easily, and asks how they can find its area, if they know only 3 sides of the triangle.]

If three sides a , b and c of $\triangle ABC$ are given and its height is not given, we can use Heron's formula to calculate its area.

Heron's Formula :

$$\text{Area of } \triangle ABC = \sqrt{s(s-a)(s-b)(s-c)}$$

where a , b and c are the sides of the triangle; s is its semiperimeter.

$$\text{So, } s = \frac{a+b+c}{2}$$

E.g. In the boat shown below, the sails are triangular in shape. Find the total area of the material used to make the sails if,

- the sides of the sail on the right hand side are $11m$, $7m$ and $6m$
- two sides of the higher sail are $17m$, $15m$ and its perimeter is $40m$



Image Source: pixabay.com/photos/sailboat-sail-sailing-boat-river-1572874/

Attribution: paulbr75

Solution:

- To find the area of the triangular sail on the right side.
The sides of the triangle, $a = 11m$, $b = 7m$ and $c = 6m$

$$s = \frac{a+b+c}{2} = \frac{11+7+6}{2} = 12 \text{ m}$$

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

$$= \sqrt{12(12-11)(12-7)(12-6)}$$

$$= \sqrt{12 \times 1 \times 5 \times 6}$$

$$= \sqrt{6 \times 2 \times 5 \times 6}$$

$$= 6 \sqrt{1} \text{ m}^2$$

b) The given sides of the triangle, $a = 17 \text{ m}$, $b = 15 \text{ m}$. Let the third side be ' c '

Perimeter of the triangle = $a + b + c = 17 + 15 + c = 40 \text{ m}$

$$= 40 \text{ m}$$

$$32 + c = 40$$

$$c = 40 - 32 = 8$$

$$s = \frac{a+b+c}{2} = \frac{40}{2} = 20 \text{ m}$$

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

$$= \sqrt{20(20-17)(20-15)(20-8)}$$

$$= \sqrt{20 \times 3 \times 5 \times 12}$$

$$= \sqrt{60 \times}$$

$$= 60 \text{ m}^2$$

Total area of the material used = Sum of the areas of two triangles = $(6\sqrt{1} + 60) \text{ m}^2$

Derivation of the area of an equilateral triangle formula using Heron's formula.

[Notes to the teacher: Teacher will explain to the students how area of an equilateral triangle formula can be derived using Heron's formula]

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

$$s = \frac{a+b+c}{2}$$

In an equilateral triangle all sides are equal.

$$a=b=c \Rightarrow a$$

$$s = \frac{a+b+c}{2} = \frac{3a}{2}$$

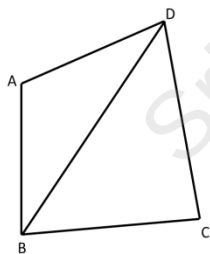
$$\text{Area} = \sqrt{\frac{3a}{2} \left(\frac{3a}{2} - a\right) \left(\frac{3a}{2} - a\right) \left(\frac{3a}{2} - a\right)}$$

$$= \sqrt{\frac{3a}{2} \left(\frac{a}{2}\right) \left(\frac{a}{2}\right) \left(\frac{a}{2}\right)} = \sqrt{\frac{3a^4}{16}}$$

$$= \frac{\sqrt{3}}{4} a^2$$

Area of quadrilateral using Heron's formula

Given a quadrilateral ABCD. Draw one of its diagonals.

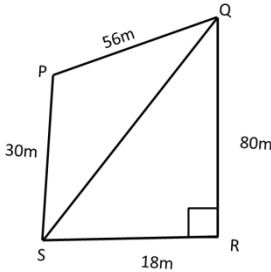


The diagonal BD, divides the quadrilateral into two triangles $\triangle ABD$ and $\triangle CBD$

Then area of quadrilateral ABCD = Area of $\triangle ABD$ + Area of $\triangle CBD$.

[Notes to the teacher: The teacher can explain, if the lengths of four sides and any one diagonal are known, we can find the areas of two triangles using Heron's formula] E.g.

- c) A farmhouse is in the shape of a quadrilateral. The sides of the farmhouse are 18 m, 80 m, 56 m and 30 m. The angle between the first two sides is a right angle. Find the area of the farmhouse.



Solution:

Let the farmhouse be PQRS

[Notes to the teacher: The teacher can explain as follows. We can draw any one diagonal to split the quadrilateral into two triangles. In this example, given that $\angle R = 90^\circ$, we can find the length of diagonal SQ using Pythagoras theorem. So, draw diagonal SQ]

In ΔSRQ ,

$$SQ^2 = SR^2 + RQ^2$$

$$SQ^2 = (18)^2 + (80)^2 = 324 + 6400 =$$

$$6724 \quad SQ = \sqrt{6724} = 82 \text{ m}$$

$$\text{Area of } \Delta SRQ = \frac{1}{2} \times b \times h = \frac{1}{2} \times 18 \times 80 = 720 \text{ m}^2$$

$$\text{Area of } \Delta PQS = \sqrt{s(s-a)(s-b)(s-c)}$$

The sides $a = 56 \text{ m}$, $b = 30 \text{ m}$ and $c = 82 \text{ m}$

$$s = \frac{a+b+c}{2} = \frac{56+30+82}{2} = 84 \text{ m}$$

$$\text{Area of } \Delta PQS = \sqrt{84(84-56)(84-30)(84-82)}$$

$$\begin{aligned} \text{Area of } \Delta PQS &= \sqrt{84 \times 28 \times 54 \times 2} \\ &= \sqrt{12 \times 7 \times 7 \times 4 \times 9 \times 6 \times 2} = \\ &\quad \sqrt{12 \times 7 \times 7 \times 4 \times 9 \times 12} \end{aligned}$$

$$\text{Area of } \Delta PQS = 12 \times 7 \times 2 \times 3 = 504 \text{ m}^2$$

Area of farmhouse = $720 + 504 = 1224 \text{ m}^2$

Time to teach	Asset type	Theme	Sub Theme
15 minutes	Main Script	Triangle	Application of Heron's formula Area of a triangle Area of triangle - Heron's formula

QA_Herons Formula to find Area

Objective: Students will be able to calculate area of triangular and quadrilateral shapes using Heron's formula

Teaching Aids: PPT

Notes to the teacher: Teacher may present the questions and allow the students to write or say the answers before revealing them.

I) Choose the correct option:

1. The value of semi-perimeter of an equilateral triangle having area $4\sqrt{3} \text{ cm}^2$ is
a) 8 cm b) 12 cm c) 16 cm d) 6 cm

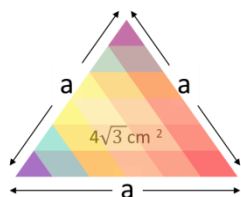


Image source: Equilateral Triangle: pixabay.com/vectors/triangle-ornament-the-colors-1995195/
Attribution: padrefilar

Solution: Correct option : (d)

Explanation: Let the side of the equilateral triangle be a . Then its area = $\frac{\sqrt{3}}{4} a^2$

$$\frac{\sqrt{3}}{4} a^2 = 4\sqrt{3}$$

$$a^2 = 4\sqrt{3} \times \frac{4}{\sqrt{3}}$$

$$a^2 = 4 \times 4 = 16$$

$a = 4$, Perimeter = 12 cm and semi-perimeter = 6 cm

2. The length of two adjacent sides of a parallelogram are 10 cm and 7 cm . One of its diagonals is 13 cm long. Area of the parallelogram is

- a) $13\sqrt{10} \text{ cm}^2$ b) $23\sqrt{5} \text{ cm}^2$ c) $40\sqrt{3} \text{ cm}^2$ d) $10\sqrt{5} \text{ cm}^2$

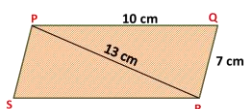


Image source - OC

Solution: Correct option: (c)

Explanation: Given PQRS is a parallelogram

PQ = 10 cm, QR = 7cm and PR = 13 cm

We know that the diagonal of a parallelogram divides it into two triangles of equal area.

In $\triangle PQR$, $a = 10$ cm, $b = 7$ cm and $c = 13$ cm

$$s = \frac{a+b+c}{2} = \frac{10+7+13}{2} = 15 \text{ cm}$$

$$\text{Area of } \triangle PQR = \sqrt{s(s-a)(s-b)(s-c)}$$

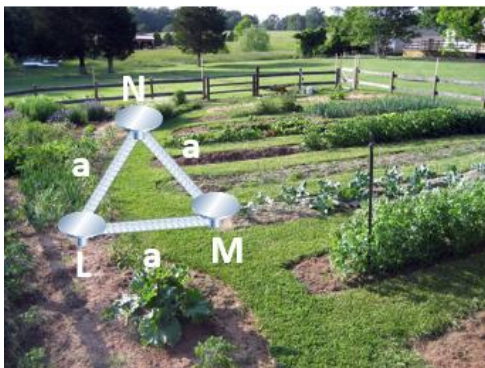
$$= \sqrt{15(15-13)(15-10)(15-7)}$$

$$= \sqrt{\frac{15 \times 2 \times 5 \times 8}{3 \times 5 \times 2 \times 5 \times 8}} =$$

$$= 20\sqrt{3} \text{ cm}^2$$

Area of parallelogram PQRS = $2 \times \text{area of } \triangle PQR = 2 \times 20\sqrt{3} \text{ cm}^2 = 40\sqrt{3} \text{ cm}^2$

3. Mr. and Mrs. Sharma used some empty space in their backyard for growing vegetables. They marked three points L, M and N. They fenced the region enclosed between these stakes using a rope from point L to M, M to N and N to L.



Garden area: flickr.com/photos/opengatefarm/512905307

Attribution: Open Gate Farm

Rope: pixabay.com/vectors/rope-cord-sisal-string-material-160161/

Attribution: OpenClipart-Vector

Nail: pixabay.com/vectors/nail-tool-metal-pointed-crafts-157432/

Attribution: OpenClipart-Vector

- a. If L, M and N are equidistant, and the distance between them is $2a$, then the area of the region enclosed by the points is

a) $\sqrt{3} a^2$ b) $\sqrt{\frac{3}{4}} a^2$ c) $\frac{\sqrt{3}}{4} a^2$ d) $\sqrt{\frac{3}{2}} a^2$

Solution: Correct option: (a)

$$\text{Area} = \frac{\sqrt{3}}{4} (2a)^2$$

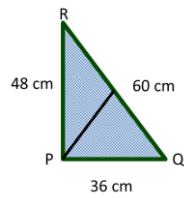
- b. If the distance between L, M and N becomes twice its original length, then how many times will the area of the new region enclosed become as compared to the original area?

a) 12 times b) 16 times c) 8 times d) 4 times

Solution: correct option: (d)

II) Solve the following

1. Find the area of a triangle whose sides are 36 cm , 48 cm and 60 cm . Also, find the length of altitude drawn to the largest side of the triangle.



Solution:

$$\text{Area of } \Delta PQR = \sqrt{s(s-a)(s-b)(s-c)}$$

$$s = \frac{a+b+c}{2} = \frac{36+48+60}{2} = 72$$

The sides $a = 36 \text{ cm}$, $b = 48 \text{ cm}$ and $c = 60 \text{ cm}$

$$\text{Area of } \Delta PQR = \sqrt{72(72-36)(72-48)(72-60)}$$

$$\begin{aligned} \text{Area of } \Delta PQR &= \sqrt{72 \times 36 \times 24 \times 12} \\ &= \sqrt{2 \times 36 \times 36 \times 2 \times 12 \times 12} \end{aligned}$$

$$= 2 \times 12 \times 36$$

$$\text{Area of } \Delta PQR = 864 \text{ cm}^2$$

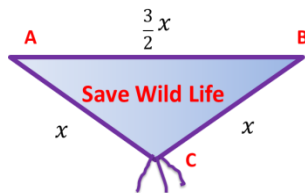
To find the length of altitude, drawn to the largest side of the triangle:

$$\text{Area} = \frac{1}{2} \times \text{base} \times \text{altitude}$$

$$864 = \frac{1}{2} \times 60 \times \text{altitude}$$

$$\text{Altitude} = \frac{864 \times 2}{60} = 28.8 \text{ cm}$$

Every year on the third Friday in May, National Endangered Species Day is observed across the country to promote awareness about endangered species of flora and fauna. Some students of class 9th started a campaign to save wild life for which they prepared triangular banners with the title 'Save Wild Life'. Each banner is an isosceles triangle with its base $\frac{3}{2}$ times of the equal sides and perimeter 42 cm. Find the length of each side and the area of the triangle.



Solution:

Perimeter of banner = 42 cm

$$\text{base} = \frac{3}{2}x$$

$$x + x + \frac{3}{2}x = 42$$

$$\frac{7}{2}x = 42$$

$$x = \frac{42 \times 2}{7} = 12 \text{ cm}$$

$\therefore$ Each of equal sides = 12 cm

$$\text{and the base} = \frac{12 \times 3}{2} = 18 \text{ cm}$$

a

$$\text{Area of } \Delta ABC = \sqrt{s(s-a)(s-b)(s-c)}$$

$$s = \frac{a+b+c}{2}$$

$$= \frac{12+12+18}{2} = \frac{42}{2} = 21 \text{ cm}^2$$

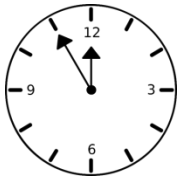
$$\text{Area of } \Delta ABC = \sqrt{21(21-12)(21-12)(21-18)}$$

$$= \sqrt{21 \times 9 \times 9 \times 3}$$

$$= \sqrt{3 \times 7 \times 9 \times 9 \times 3}$$

$$= 27\sqrt{7} \text{ cm}^2$$

2. Ravi and his friends went to a museum where they saw an antique clock displayed on a wall. He was very curious to know the area of the hour hand and minute hand of the clock as they both were in the form of triangles. Guide provided the details of the sides of the hour hand which were 15 , 35 and 40 and minute hand 7.5 , 5.5 and 12 . Find the area of both the hands.



Clock: pixabay.com/vectors/clock-timer-face-time-hour-minute-26092/

Attribution: Clker-Free-Vector-Images

Solution:

Area of hour hand =

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

$$a = 15, b = 35 \text{ and } c = 40$$

$$s = \frac{a+b+c}{2} = \frac{15+35+40}{2}$$

$$= 45 \text{ mm}$$

$$\text{Area of hour hand} = \sqrt{45(45-15)(45-35)(45-40)}$$

$$= \sqrt{45 \times 30 \times 10 \times 5}$$

$$\sqrt{15 \times 3 \times 15 \times 2 \times 5 \times 2 \times 5}$$

$$= 150\sqrt{3}mm^2$$

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Area of minute hand = $a = 7.5 \text{ mm}$, $b = 5.5$ and $c = 12 \text{ mm}$,

$$s = \frac{7.5 + 5.5 + 12}{2} = \frac{25}{2} = 12.5 \text{ mm}$$

$$\sqrt{12.5(12.5 - 7.5)(12.5 - 5.5)(12.5 - 12)}$$

$$\text{Area of minute hand} = \sqrt{12.5 \times 5 \times 7 \times 0.5}$$

$$\text{Total area of both the hands} = 150\sqrt{} + 14.79 = 166.52 \text{ mm}^2$$

3. There was an Inter House Rangoli competition in a school and the below was judged as the best rangoli. One of the students of the school who was a math enthusiast wanted to know the area of symmetrical quadrilaterals surrounding the rangoli. By joining a diagonal, each quadrilateral could be divided into two identical triangles with sides 13 cm , 14 cm and 15 cm . There were 15 quadrilaterals in the rangoli. Find the total area of the quadrilaterals.

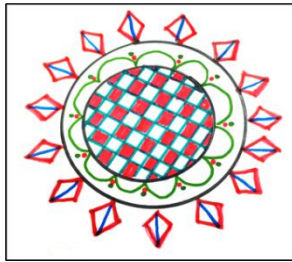


Image source: OC

Solution:

$$\begin{aligned} \text{Area of triangle} &= \sqrt{s(s-a)(s-b)(s-c)} \\ a &= 13 \text{ cm}, b = 14 \text{ cm and } c = 15 \text{ cm} \end{aligned}$$

$$s = \frac{a+b+c}{2}$$

$$= \frac{13+14+15}{2} = \frac{42}{2} = 21 \text{ cm}$$

$$\text{Area of triangle} = \sqrt{21(21-13)(21-14)(21-15)}$$

$$\text{Area of triangle} = \sqrt{21 \times 8 \times 7 \times 6}$$

$$\begin{aligned} &= \sqrt{3 \times 7 \times 2 \times 2 \times 2 \times 7 \times 2 \times 3} \\ &= 2 \times 2 \times 3 \times 7 = 84 \text{ cm}^2 \end{aligned}$$

$$\text{Total area of the quadrilaterals} = \text{Area of 30 triangles} = 30 \times 84 \text{ cm}^2 = 2520 \text{ cm}^2$$

Time to teach	Asset type	Theme	Sub Theme
20 minutes	Questions to Assess	Triangle	Application of Heron's formula Area of a triangle Area of triangle - Heron's formula

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DD_Use of Herons Formula

Objective: Students will be able to relate Heron's formula to calculate area of different shapes put together, like area of crops cultivated in farm lands

Teaching Aids: PPT

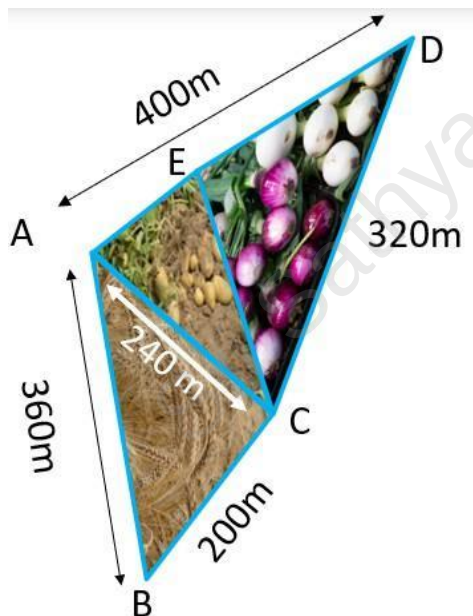
Notes to the teacher: The asset will show how the students can apply Heron's formula to calculate the area of each crop grown, in a quadrilateral shaped field. The teacher can use the PPT along with interaction with the students to present the content. The teacher will show students the examples in the powerpoint and prompt students to identify the application of Heron's formula.

We know that the lands, agriculture lands, parks, lakes etc are not rectangular shapes every time. In such cases many times we get triangular/ quadrilateral shapes.

The Heron's formula is of great use for measurement of area of triangular/quadrilateral shapes, as in some of the examples shown below:

Example 1:

Our farmer, Kamala, has a farm field in the shape of a quadrilateral that can be split into 3 triangular fields, as shown below. Kamala would like to grow wheat, potatoes and onions as shown.



Source: Wheat: pixabay.com/photos/wheat-field-grass-wheat-field-8762/

Attribution: Hans

Potatoes: pixabay.com/photos/potato-harvest-crop-farm-garden-373822/

Attribution: Jing

Onion: pixabay.com/photos/onion-white-green-purple-fresh-7276296

Attribution: LAWJR

One triangular field ACB with sides measuring 240 m, 200 m, 360 m, will be used to cultivate wheat.

In the other triangular field ACD with sides 240 m, 320 m, 400 m, adjacent to this field,

she wanted to grow potatoes and onions. She divided the field into two parts, by joining the mid-point of the longest side to the opposite vertex CE, and grew potatoes in one part AEC and onions in the other part CED.

Kamala hires labourers to plant the crops and she pays them based on the area of the crop cultivated.

If she pays Rs. 36,000 per hectare to the labourers, how much is the total cost she incurred?

1 hectare = 10000 m^2

Calculate Area of wheat field:

ACB field has sides a (AB) = 360 m, b (AC) = 240 m, c (BC) = 200 m

According to Heron's formula, the area for growing wheat = 2.26 hectares (approximately)

Calculate Area of Potato and Onion fields:

Instead of calculating the individual areas of triangles AEC and CED, we can calculate the area of the two triangles together that form ACD and divide it into 2.

[Notes to the teacher: Why would the area of triangles AEC (growing potatoes) and CED (growing onions) be equal? The line segment joining the mid-point E of AD to C divides the triangle ACD in two parts equal in area. The bases AE and ED are equal.]

Thus, area of triangle AEC = area of triangle CED = $\frac{\text{Area of larger triangle ACD}}{2}$

Now, based on Heron's formula, the area of triangle ACD = 3.84 hectares

Area of Potato field = Area of Onion Field = $\frac{3.84}{2}$ = 1.92 hectares

Total Cost incurred:

Labourer's cost for Wheat field = Rs. 81,360

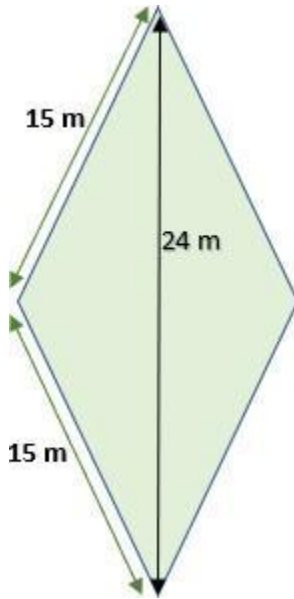
Labourer's cost for Potato field = Rs. 69,120

Labourer's cost for Onion field = Rs. 69,120

Total Cost for the farmer = Rs. 2,19,600

Example 2:

A rhombus shaped field has green grass for cows to graze. If each side of the rhombus is 15 m and its longer diagonal is 24 m, find the area of grass field grazed by the cows.



Rhombus – PPT Shapes

$$\text{Area of rhombus} = 2 \times \text{area of triangle} = 2 \times \frac{1}{2} \times 27 \times (27 - 15) \times (27 - 15) \times (27 - 24) = 2 \times 108 = 216 \text{ m}^2$$

Example 3:

The triangular side walls of a flyover have been used for advertisements. The sides of the walls are 149 m, 116 m, and 65 m as shown in the image. The advertisements yield an earning of Rs.50 per m² per year. A company hired one of its walls for 3 months. How much rent did it pay for one advertisement?

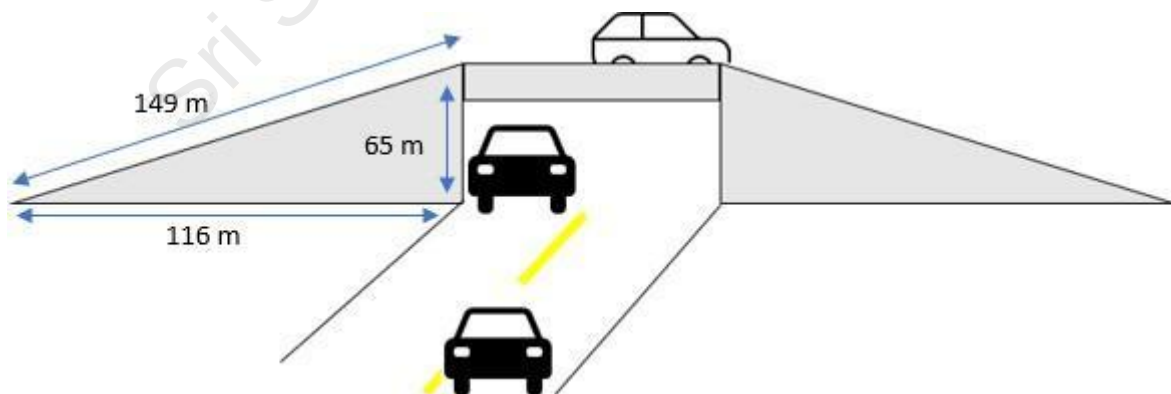


Image Source: Cars – PPT Icons
Triangles – PPT Shapes

$$\text{Area of triangle} = \frac{1}{2} \times 165 \times (165 - 149) \times (165 - 65) \times (165 - 116) = \text{Approximately } 3596.67 \text{ m}^2$$

Rent = approximately $3596.67 \times (50/4) = \text{Rs. } 44,958$ (Approximately)

Time to teach	Asset type	Theme	Sub Theme
15 minutes	Day-to-day Relevance	Triangle	Application of Heron's formula

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SA_Area of Aeroplane

Objective: Students will be able to create an aeroplane using coloured paper and find the area of paper used by applying Heron's formula.

Notes to the Teacher: The teacher will help the students to create a paper aeroplane by assembling triangular, trapezium and rectangular shapes. The students will find the area of paper used in making the aeroplane by using Heron's formula wherever required.

Aim: To assist students to apply Heron's formula, while building a paper aeroplane.

Resources Required:

1. Tape or stapler to hold the different pieces together
2. Different coloured sheets of paper cut in following shapes

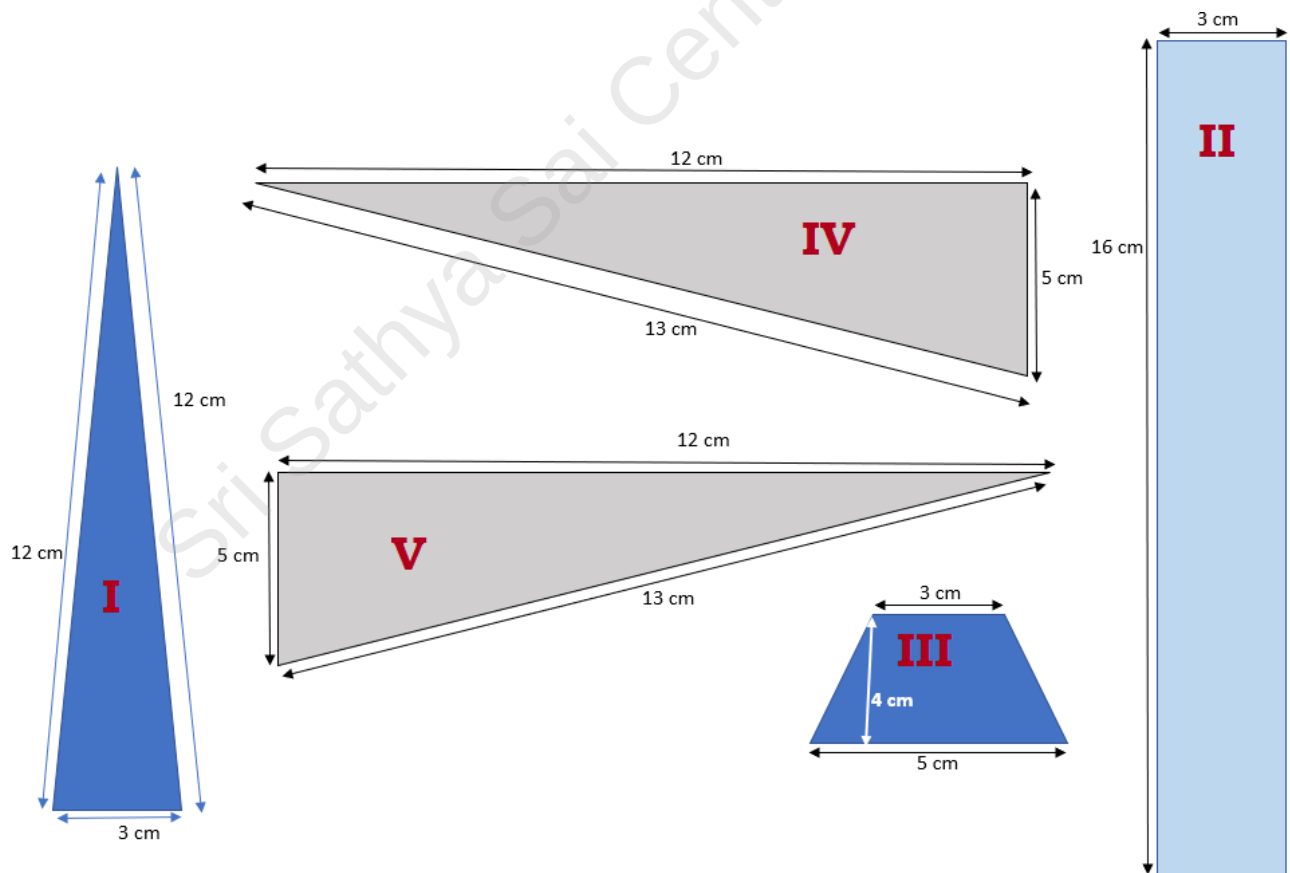


Image source: OC

Setting for the Activity: Indoor activity

Type of Activity: Construction using coloured paper

Preparation of Activity:

The teacher can either prepare beforehand by having paper cut into pieces as specified above, or the students can cut the coloured papers into pieces in the classroom.

Role of the Teacher: Facilitator

Procedure:

1. Assemble the coloured paper pieces as shown in picture below

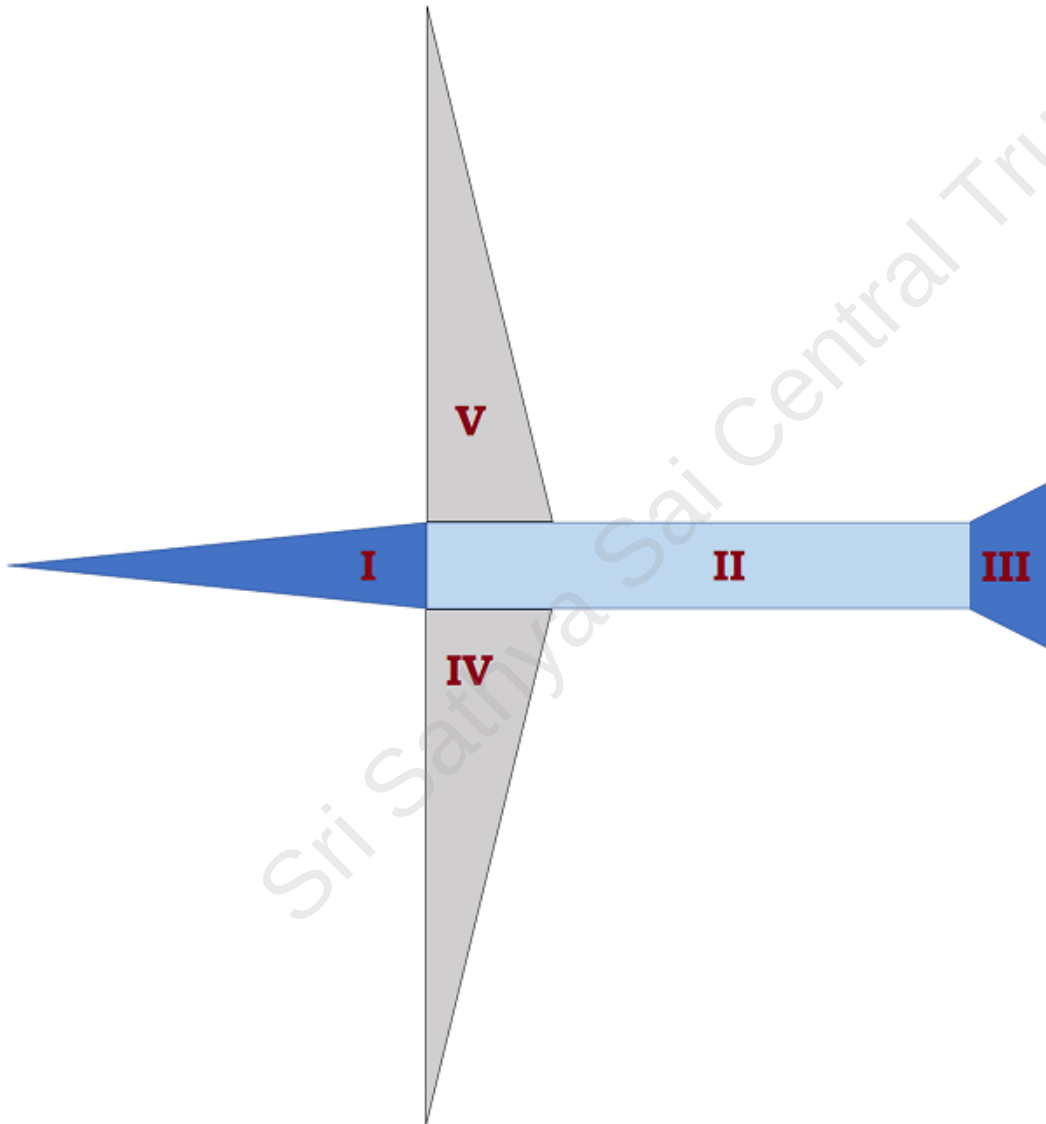


Image source: OC

Observation:

The students would use Heron's formula to calculate the area of the three triangles I, IV and V. Students may record the observations individually in their notebook and calculate the total area of the airplane that they have built.

Area of part I = _____ cm²

Area of part IV = _____ cm²

Area of part V = _____ cm²

Area of part II using the formula $A = lb$ for area of a rectangle = _____ cm²

Area of part III using the formula $A = \frac{1}{2}h(a+b)$ for area of a trapezium = _____ cm²

Total area of the paper used in making the airplane = _____ cm²

Conclusion: Area of the aeroplane is calculated using suitable formulae.

Time to teach	Asset type	Theme	Sub Theme
20 minutes	Suggested Activity	Triangle	Application of Heron's formula Area of triangle - Heron's formula

VC_Think Beyond

Concept/Value Connect:

Heron gave us the formula to calculate the area of a triangle when the height of the same is not known. He was among many who worked on this problem, and he succeeded because he thought differently. This is one common quality among the great thinkers, scientists and experts in all fields of knowledge. They push the boundaries and seek newer frontiers with courage. They think beyond!

Activity-Think beyond:

Notes To The Teacher:

1. Please divide the class into two or three groups of 10 or 15 students in each.
2. Each group is given the first two sentences of a story (given below).
3. After the two sentences, the students have to develop the story.
4. Each student in the group has to add one sentence, thinking creatively.
5. After one student adds a sentence as per his / her imagination, the next person has to take it further adding his / her line creatively.
6. The story gets developed.
7. The last person in the group ends the story with a message.
8. Each group works simultaneously and is given 5 minutes to finish the exercise.
9. After 5 minutes, one student from each group comes and reads the story of their respective group.
10. Once the reading is completed, please pose the questions (given below) and encourage the students to think well and answer.

Story:

Once a boy was walking along the road. He was hungry. He came across a Rs.10 note on the pavement. He took it, looked at it longingly and thought.....
(Please continue the story)

Questions:

1. Did you ever think you can create a story?
2. Were you taken by surprise when the person before your turn added a sentence which you didn't expect?
3. Were you able to build the story despite that?
4. Could you add a human value to the story? If yes, what is the value you considered?

Points to ponder:

- Creativity exists in all of us.
- We all can think differently based on our personal experiences and attitudes.
- Thinking differently makes us unique and special.
- Most discoveries and inventions were made by people who dared to think differently.



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Annexure to Master Lesson Plan

What is the purpose of this Master lesson Plan?	This Master Lesson Plan (MLP) prepared by Sri Sathya Sai Vidya Vahini (SSSVV), covers the entire chapter for the given board. The MLP for the chapter given in the textbook is broken down into smaller modules known as assets. Any chapter can be taught using the 7 asset types in SSSVV methodology. Several different assets together complete the entire chapter. Depending on the requirement, each asset is supported by teaching aids such as animated presentation, audio, video, and learning aids such as worksheets. The MLP is for the teacher's preparation and the teaching aids are for use in the classroom.
How to use it?	You can prepare for your class with this MLP by following 3 simple steps: 1. Read your textbook; 2. Go through the information given in the assets (document & multimedia); 3. Prepare your teaching notes. Great! Now you are ready to transact the chapter.
Duration	Kindly note the duration given for each asset. Due care has been taken in planning the assets, to ensure the chapter is completed within the time specified by the Board. Note: Preparation time is not included in the asset duration. The teaching time depends on the duration of the teaching aids and is not impacted by the length of the MLP.
What is a 'Main Script' (MS) Asset?	The Main Script asset is there for explaining the main concepts of the chapter clearly. The information given in the textbook is simplified, organised and structured to give more clarity. Additionally, you may find a video or mnemonics or a graphic organiser to deepen the understanding of the concept.
How to teach using the MS asset?	Please use the blackboard, slides and interaction to develop the concept.
What is an 'Inquisitive Questions' (IQ) asset?	The Inquisitive Questions asset uses questions to promote higher order thinking like the n th why, what-if, new perspectives, cause-effect, and others, creating curiosity.
How to teach using the IQ asset?	You may use the questions to connect with the students, encourage exploration to engage them in the learning process. You may allow multiple responses and instead of rejecting any of the responses, ask why, before revealing the suggested answer or hints.
What is a 'Day to day Relevance' (DD) Asset?	The Day to Day Relevance asset helps students understand the practical relevance of every topic, making them eager participants in the classroom. If students connect the concepts to their environment, they would learn meaningfully without dislike or simply memorizing for exams.
How to teach using the DD	You may use the asset by asking questions about their experience and use it to establish why they are learning the topic. If necessary you may substitute with a

asset?	recent or local example.
What is an 'Interesting Aside' (IA) asset?	The Interesting Aside asset uses attention grabbing tidbits or anecdotes to bring joy and satisfy the child's hunger to know more. This is a quick/short asset intended to bring attention back to the main concept being taught.
How to teach using the IA asset?	You may use this asset to give a piece of interesting information relevant to the topic, without prolonged explanation/discussion. You may suggest appropriate books for further reading.
What is a 'Suggested Activity' (SA) Asset?	The Suggested Activity asset provides a detailed step by step procedure for the teacher to conduct a hands-on activity. This promotes Activity Based Learning.
How to teach using the SA asset?	You may use this asset to energise your students to learn by doing simple, fun-filled activities based on the topic. The asset includes - preparation, activity, and follow-up. You may engage the students in the preparation and follow-up stages to develop collaboration and responsibility. You could try it once, yourself, before the actual delivery to be more comfortable with it. Note: The duration mentioned in the asset is usually for the activity part only.
What is a 'Value Content' (VC) Asset?	The Value Content asset integrates Universal Human Values (such as empathy, inclusivity, respect for nature that translates into responsible behaviour) seamlessly into the curriculum, as the "End of education is character".
How to teach using the VC asset?	You may use this asset to engage with the students to bring out their innate values and connect with the intrinsic values in the topic/concept. The asset includes pointers on the specific pedagogical technique followed.
What is a 'Questions to Assess' (QA) asset?	The Questions to Assess asset uses an interactive approach to check learning of different types of learners, and provides feedback to the teacher for appropriate action. The questions cater to all the levels of Bloom's Taxonomy. Questions from 'Apply' level and above enable students to reflect on their learning.
How to teach using the QA asset?	You may go through the slides to understand its flow and know when to click for the answer (slides include suggested answers). While presenting in the class, you may display the question and encourage multiple responses, before revealing the answer. In some cases, this asset may include extra questions/worksheet that can be given as homework.