

# Class IX Chapter 12 – Heron's Formula Maths

## Exercise 12.1 Question

1:

A traffic signal board, indicating 'SCHOOL AHEAD', is an equilateral triangle with side 'a'. Find the area of the signal board, using Heron's formula. If its perimeter is 180 cm, what will be the area of the signal board?

Answer:

Side of traffic signal board = a

Perimeter of traffic signal board = 3 × a

$$2s = 3a \Rightarrow s = \frac{3}{2}a$$

By Heron's formula,

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

$$\begin{aligned}\text{Area of given triangle} &= \sqrt{\frac{3}{2}a \left( \frac{3}{2}a - a \right) \left( \frac{3}{2}a - a \right) \left( \frac{3}{2}a - a \right)} \\ &= \sqrt{\left( \frac{3}{2}a \right) \left( \frac{a}{2} \right) \left( \frac{a}{2} \right) \left( \frac{a}{2} \right)} \\ &= \frac{\sqrt{3}}{4}a^2 \quad \dots (1)\end{aligned}$$

Perimeter of traffic signal board = 180 cm

$$(a) = \left( \frac{180}{3} \right) \text{cm} = 60 \text{cm}$$

Side of traffic signal board

$$= \frac{\sqrt{3}}{4} (60 \text{ cm})^2$$

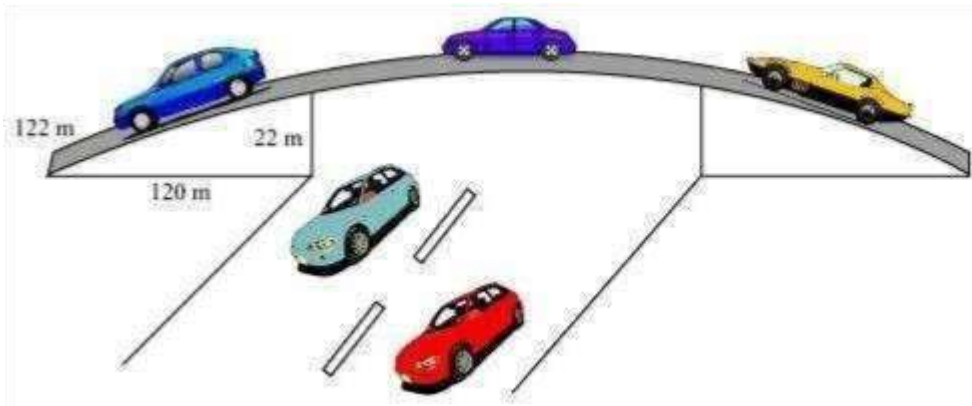
Using equation (1), area of traffic signal board

$$= \left( \frac{3600}{4} \sqrt{3} \right) \text{cm}^2 = 900\sqrt{3} \text{ cm}^2$$

Question 2:

The triangular side walls of a flyover have been used for advertisements. The sides of the walls are 122m, 22m, and 120m (see the given figure). The advertisements yield an earning of Rs 5000 per m<sup>2</sup> per year. A company hired one of its walls for 3 months.

How much rent did it pay?



Answer:

The sides of the triangle (i.e., a, b, c) are of 122 m, 22 m, and 120 m respectively.

Perimeter of triangle =  $(122 + 22 + 120)$  m

$2s = 264$  m  $s =$

132 m

By Heron's formula,

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

$$\begin{aligned} \text{Area of given triangle} &= \left[ \sqrt{132(132-122)(132-22)(132-120)} \right] \text{m}^2 \\ &= \left[ \sqrt{132(10)(110)(12)} \right] \text{m}^2 = 1320 \text{ m}^2 \end{aligned}$$

Rent of  $1 \text{ m}^2$  area per year = Rs 5000

$$\frac{5000}{12}$$

Rent of  $1 \text{ m}^2$  area per month = Rs

$$\text{Rs} \left( \frac{5000}{12} \times 3 \times 1320 \right)$$

Rent of  $1320 \text{ m}^2$  area for 3 months =

= Rs  $(5000 \times 330)$  = Rs 1650000

Therefore, the company had to pay Rs 1650000.

Question 3:

The floor of a rectangular hall has a perimeter 250 m. If the cost of painting the four walls at the rate of Rs.10 per  $\text{m}^2$  is Rs.15000, find the height of the hall.

[Hint: Area of the four walls = Lateral surface area.] Answer:

Let length, breadth, and height of the rectangular hall be  $l$  m,  $b$  m, and  $h$  m respectively.

$$\text{Area of four walls} = 2lh + 2bh$$

$$= 2(l + b) h$$

$$\text{Perimeter of the floor of hall} = 2(l + b) = 250 \text{ m}$$

$$\therefore \text{Area of four walls} = 2(l + b) h = 250h \text{ m}^2$$

$$\text{Cost of painting per } \text{m}^2 \text{ area} = \text{Rs } 10$$

$$\text{Cost of painting } 250h \text{ m}^2 \text{ area} = \text{Rs } (250h \times 10) = \text{Rs } 2500h$$

However, it is given that the cost of painting the walls is Rs 15000.

$$\therefore 15000 = 2500h$$

$$h = 6$$

Therefore, the height of the hall is 6 m.

Question 4:

Find the area of a triangle two sides of which are 18 cm and 10 cm and the perimeter is 42 cm.

Answer:

Let the third side of the triangle be x.

Perimeter of the given triangle = 42 cm

$$18 \text{ cm} + 10 \text{ cm} + x = 42 \text{ cm}$$
$$x = 42 \text{ cm} - 18 \text{ cm} - 10 \text{ cm}$$
$$x = 14 \text{ cm}$$

$$s = \frac{\text{Perimeter}}{2} = \frac{42 \text{ cm}}{2} = 21 \text{ cm}$$

By Heron's formula.

$$\text{Area of a triangle} = \sqrt{s(s-a)(s-b)(s-c)}$$
$$\text{Area of the given triangle} = \left( \sqrt{21(21-18)(21-10)(21-14)} \right) \text{ cm}^2$$
$$= \left( \sqrt{21(3)(11)(7)} \right) \text{ cm}^2$$
$$= 21\sqrt{11} \text{ cm}^2$$

Question 5:

Sides of a triangle are in the ratio of 12: 17: 25 and its perimeter is 540 cm. Find its area.

Answer:

Let the common ratio between the sides of the given triangle be x.

Therefore, the side of the triangle will be 12x, 17x, and 25x.

Perimeter of this triangle = 540 cm

$$12x + 17x + 25x = 540 \text{ cm}$$

$$54x = 540 \text{ cm}$$
$$x = \frac{540 \text{ cm}}{54}$$

$$x = 10 \text{ cm}$$

Sides of the triangle will be 120 cm, 170 cm, and 250 cm.

$$s = \frac{\text{Perimeter of triangle}}{2} = \frac{540 \text{ cm}}{2} = 270 \text{ cm}$$

By Heron's formula,

$$\begin{aligned}\text{Area of triangle} &= \sqrt{s(s-a)(s-b)(s-c)} \\ &= \left[ \sqrt{270(270-120)(270-170)(270-250)} \right] \text{cm}^2 \\ &= \left[ \sqrt{270 \times 150 \times 100 \times 20} \right] \text{cm}^2 \\ &= 9000 \text{ cm}^2\end{aligned}$$

Therefore, the area of this triangle is  $9000 \text{ cm}^2$ .

Question 6:

An isosceles triangle has perimeter 30 cm and each of the equal sides is 12 cm. Find the area of the triangle.

Answer:

Let the third side of this triangle be  $x$ .

Perimeter of triangle = 30 cm

$$12 \text{ cm} + 12 \text{ cm} + x = 30 \text{ cm}$$

$$x = 6 \text{ cm}$$

$$s = \frac{\text{Perimeter of triangle}}{2} = \frac{30 \text{ cm}}{2} = 15 \text{ cm}$$

By Heron's formula,

$$\begin{aligned}\text{Area of triangle} &= \sqrt{s(s-a)(s-b)(s-c)} \\ &= \left[ \sqrt{15(15-12)(15-12)(15-6)} \right] \text{cm}^2 \\ &= \left[ \sqrt{15(3)(3)(9)} \right] \text{cm}^2 \\ &= 9\sqrt{15} \text{ cm}^2\end{aligned}$$

### Exercise 12.2 Question

1:

A park, in the shape of a quadrilateral ABCD, has  $\angle C = 90^\circ$ ,  $AB = 9$  m,  $BC = 12$  m,  $CD = 5$  m and  $AD = 8$  m. How much area does it occupy?

Answer:

Let us join BD.

In  $\triangle BCD$ , applying Pythagoras theorem,

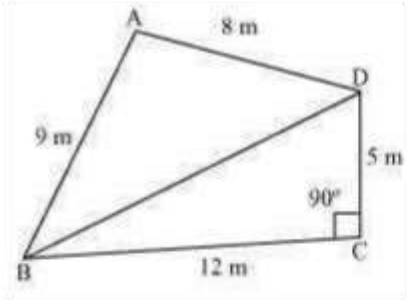
$$BD^2 = BC^2 + CD^2$$

$$= (12)^2 + (5)^2$$

$$= 144 + 25$$

$$BD^2 = 169$$

$$BD = 13 \text{ m}$$



$$= \frac{1}{2} \times BC \times CD = \left( \frac{1}{2} \times 12 \times 5 \right) \text{ m}^2 = 30 \text{ m}^2$$

Area of  $\triangle BCD$

For  $\triangle ABD$ ,

$$s = \frac{\text{Perimeter}}{2} = \frac{(9 + 8 + 13) \text{ m}}{2} = 15 \text{ m}$$

By Heron's formula,

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

Area of triangle

$$= \left[ \sqrt{15(15-9)(15-8)(15-13)} \right] \text{ m}^2$$

Area of  $\triangle ABD$

$$= \left( \sqrt{15 \times 6 \times 7 \times 2} \right) \text{ m}^2$$

$$= 6\sqrt{35} \text{ m}^2$$

$$= (6 \times 5.916) \text{ m}^2$$

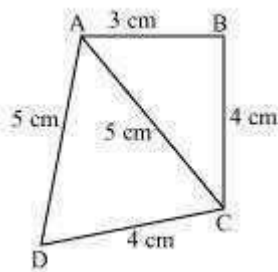
$$= 35.496 \text{ m}^2$$

$$\text{Area of the park} = \text{Area of } \triangle ABD + \text{Area of } \triangle BCD = 35.496$$

$$+ 30 \text{ m}^2 = 65.496 \text{ m}^2 = 65.5 \text{ m}^2 \text{ (approximately) Question 2:}$$

Find the area of a quadrilateral ABCD in which AB = 3 cm, BC = 4 cm, CD = 4 cm, DA = 5 cm and AC = 5 cm.

Answer:



For  $\triangle ABC$ ,

$$AC^2 = AB^2 + BC^2$$

$$(5)^2 = (3)^2 + (4)^2$$

Therefore,  $\triangle ABC$  is a right-angled triangle, right-angled at point B.

$$\text{Area of } \triangle ABC = \frac{1}{2} \times AB \times BC = \frac{1}{2} \times 3 \times 4 = 6 \text{ cm}^2$$

For  $\triangle ADC$ ,

$$\text{Perimeter} = 2s = AC + CD + DA = (5 + 4 + 5) \text{ cm} = 14 \text{ cm } s =$$

$$7 \text{ cm}$$

By Heron's formula,

$$\begin{aligned} \text{Area of triangle} &= \sqrt{s(s-a)(s-b)(s-c)} \\ \text{Area of } \triangle ADC &= \left[ \sqrt{7(7-5)(7-5)(7-4)} \right] \text{ cm}^2 \\ &= \left( \sqrt{7 \times 2 \times 2 \times 3} \right) \text{ cm}^2 \\ &= 2\sqrt{21} \text{ cm}^2 \\ &= (2 \times 4.583) \text{ cm}^2 \\ &= 9.166 \text{ cm}^2 \end{aligned}$$

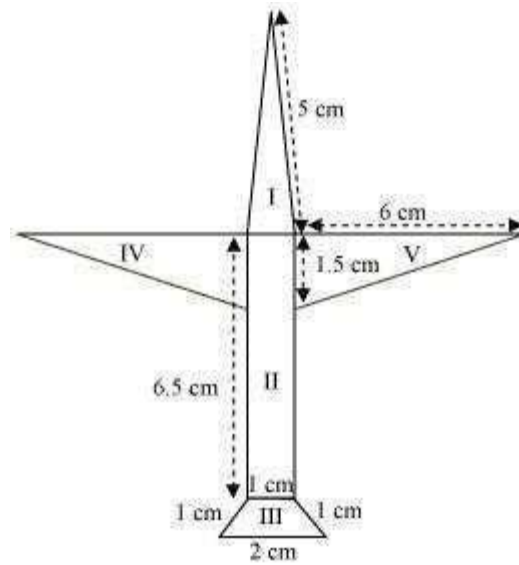
$$\text{Area of } ABCD = \text{Area of } \triangle ABC + \text{Area of } \triangle ACD$$

$$= (6 + 9.166) \text{ cm}^2 = 15.166 \text{ cm}^2 = 15.2 \text{ cm}^2 \text{ (approximately) Question}$$

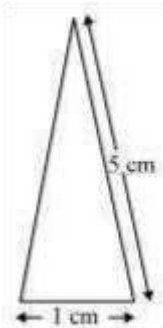
3:



Radha made a picture of an aeroplane with coloured papers as shown in the given figure. Find the total area of the paper used.



Answer:



For triangle I

This triangle is an isosceles triangle.

$$\text{Perimeter} = 2s = (5 + 5 + 1) \text{ cm} = 11 \text{ cm}$$

$$s = \frac{11 \text{ cm}}{2} = 5.5 \text{ cm}$$

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

$$= \left[ \sqrt{5.5(5.5-5)(5.5-5)(5.5-1)} \right] \text{ cm}^2$$

$$= \left[ \sqrt{(5.5)(0.5)(0.5)(4.5)} \right] \text{ cm}^2$$

$$= 0.75\sqrt{11} \text{ cm}^2$$

$$= (0.75 \times 3.317) \text{ cm}^2$$

$$= 2.488 \text{ cm}^2 \text{ (approximately)}$$

For quadrilateral II

This quadrilateral is a rectangle.

$$\text{Area} = l \times b = (6.5 \times 1) \text{ cm}^2 = 6.5 \text{ cm}^2$$

For quadrilateral III

This quadrilateral is a trapezium.

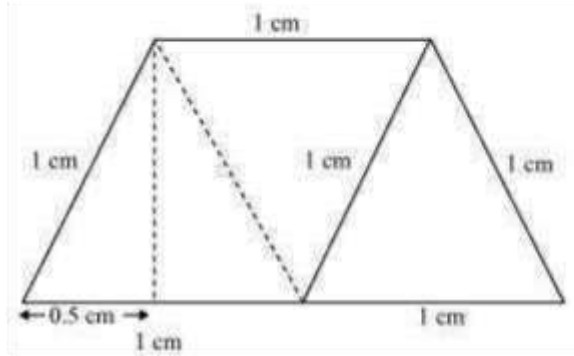
$$\text{Perpendicular height of parallelogram} = \left( \sqrt{1^2 - (0.5)^2} \right) \text{ cm}$$

$$= \sqrt{0.75} \text{ cm} = 0.866 \text{ cm}$$

Area = Area of parallelogram + Area of equilateral triangle

$$= (0.866)1 + \frac{\sqrt{3}}{4}(1)^2$$

$$= 0.866 + 0.433 = 1.299 \text{ cm}^2$$



Area of triangle (IV) = Area of triangle in (V)

$$= \left( \frac{1}{2} \times 1.5 \times 6 \right) \text{ cm}^2 = 4.5 \text{ cm}^2$$

Total area of the paper used =  $2.488 + 6.5 + 1.299 + 4.5 \times 2$

=  $19.287 \text{ cm}^2$  Question

4:

A triangle and a parallelogram have the same base and the same area. If the sides of triangle are 26 cm, 28 cm and 30 cm, and the parallelogram stands on the base 28 cm, find the height of the parallelogram.

Answer:

For triangle

Perimeter of triangle =  $(26 + 28 + 30) \text{ cm} = 84 \text{ cm}$

$2s = 84 \text{ cm}$   $s =$

42 cm

By Heron's formula,

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

Area of triangle

$$= \left[ \sqrt{42(42-26)(42-28)(42-30)} \right] \text{cm}^2$$

Area of triangle

$$= \left[ \sqrt{42(16)(14)(12)} \right] \text{cm}^2 = 336 \text{ cm}^2$$

Let the height of the parallelogram be h.

Area of parallelogram = Area of triangle h

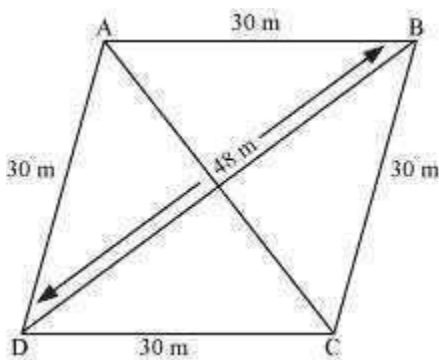
$$\times 28 \text{ cm} = 336 \text{ cm}^2 \quad h = 12 \text{ cm}$$

Therefore, the height of the parallelogram is 12 cm.

Question 5:

A rhombus shaped field has green grass for 18 cows to graze. If each side of the rhombus is 30 m and its longer diagonal is 48 m, how much area of grass field will each cow be getting?

Answer:



Let ABCD be a rhombus-shaped field.

For  $\triangle BCD$ ,

$$s = \frac{(48 + 30 + 30) \text{ cm}}{2}$$

Semi-perimeter,  $= 54 \text{ m}$

By Heron's formula,

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

Area of triangle

$$= \left[ \sqrt{54(54-48)(54-30)(54-30)} \right] \text{ m}^2$$

Therefore, area of  $\triangle BCD$

$$= \sqrt{54(6)(24)(24)} = 3 \times 6 \times 24 = 432 \text{ m}^2$$

Area of field  $= 2 \times \text{Area of } \triangle BCD$

$$= (2 \times 432) \text{ m}^2 = 864 \text{ m}^2$$

Area for grazing for 1 cow  $= \frac{864}{18} = 48 \text{ m}^2$  Each cow  
will get  $48 \text{ m}^2$  area of grass field.

Question 6:

An umbrella is made by stitching 10 triangular pieces of cloth of two different colours (see the given figure), each piece measuring 20 cm, 50 cm and 50 cm. How much cloth

of each colour is required for the umbrella?

For each triangular piece,

$$s = \frac{(20 + 50 + 50) \text{ cm}}{2} = 60 \text{ cm}$$

Semi-perimeter,

By Heron's formula,

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

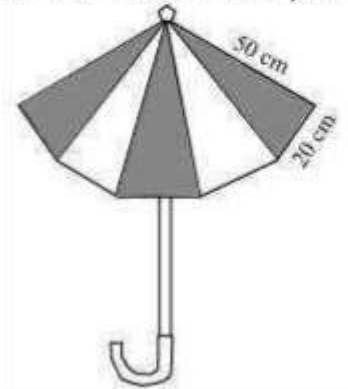
Area of triangle

$$\begin{aligned} \text{Area of each triangular piece} &= \left[ \sqrt{60(60-50)(60-50)(60-20)} \right] \text{ cm}^2 \\ &= \left[ \sqrt{60(10)(10)(40)} \right] \text{ cm}^2 = 200\sqrt{6} \text{ cm}^2 \end{aligned}$$

Since there are 5 triangular pieces made of two different coloured cloths,

$$= (5 \times 200\sqrt{6}) \text{ cm}^2$$

Area of each cloth required



Answer:

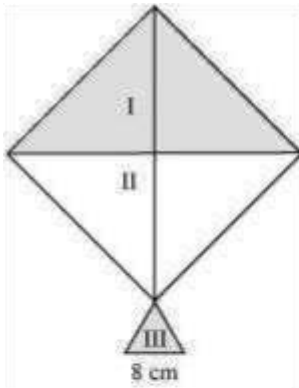
$$= 1000\sqrt{6} \text{ cm}^2$$

Question 7:

A kite in the shape of a square with a diagonal 32 cm and an isosceles triangles of base 8 cm and sides 6 cm each is to be made of three different shades as shown in

the given

figure. How much paper of each shade has been used in it?



Answer:

We know that

$$\text{Area of square} = \frac{1}{2} (\text{diagonal})^2$$

$$= \frac{1}{2} (32 \text{ cm})^2 = 512 \text{ cm}^2$$

Area of the given kite

Area of 1<sup>st</sup> shade = Area of 2<sup>nd</sup> shade

$$= \frac{512 \text{ cm}^2}{2} = 256 \text{ cm}^2$$

Therefore, the area of paper required in each shape is 256 cm<sup>2</sup>.

For III<sup>rd</sup> triangle

$$s = \frac{(6+6+8)\text{cm}}{2} = 10\text{ cm}$$

Semi-perimeter,

By Heron's formula,

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

Area of triangle

$$= \sqrt{10(10-6)(10-6)(10-8)}$$

Area of III<sup>rd</sup> triangle

$$= (\sqrt{10 \times 4 \times 4 \times 2})\text{cm}^2$$

$$= (4 \times 2\sqrt{5})\text{cm}^2$$

$$= 8\sqrt{5}\text{ cm}^2$$

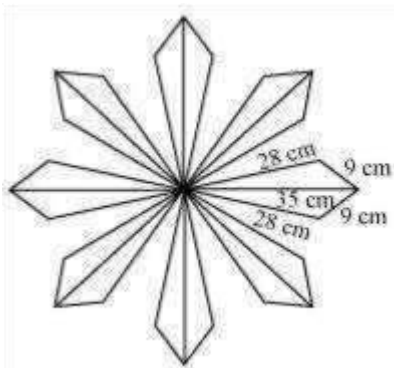
$$= (8 \times 2.24)\text{cm}^2$$

$$= 17.92\text{ cm}^2$$

Area of paper required for III<sup>rd</sup> shade =  $17.92\text{ cm}^2$

Question 8:

A floral design on a floor is made up of 16 tiles which are triangular, the sides of the triangle being 9 cm, 28 cm and 35 cm (see the given figure). Find the cost of polishing the tiles at the rate of 50p per  $\text{cm}^2$ .



Answer:

It can be observed that



$$s = \frac{(35 + 28 + 9) \text{ cm}}{2} = 36 \text{ cm}$$

Semi-perimeter of each triangular-shaped tile,

By Heron's formula,

$$\begin{aligned} \text{Area of triangle} &= \sqrt{s(s-a)(s-b)(s-c)} \\ &= \left[ \sqrt{36(36-35)(36-28)(36-9)} \right] \text{ cm}^2 \end{aligned}$$

Area of each tile

$$\begin{aligned} &= \left[ \sqrt{36 \times 1 \times 8 \times 27} \right] \text{ cm}^2 \\ &= 36\sqrt{6} \text{ cm}^2 \end{aligned}$$

$$= (36 \times 2.45) \text{ cm}^2$$

$$= 88.2 \text{ cm}^2$$

$$\text{Area of 16 tiles} = (16 \times 88.2) \text{ cm}^2 = 1411.2 \text{ cm}^2$$

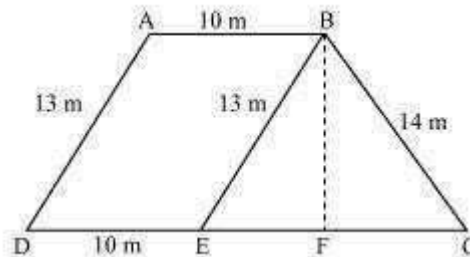
Cost of polishing per  $\text{cm}^2$  area = 50 p

Cost of polishing  $1411.2 \text{ cm}^2$  area = Rs  $(1411.2 \times 0.50)$  = Rs 705.60 Therefore, it will cost Rs 705.60 while polishing all the tiles.

Question 9:

A field is in the shape of a trapezium whose parallel sides are 25 m and 10 m. The nonparallel sides are 14 m and 13 m. Find the area of the field.

Answer:



Draw a line BE parallel to AD and draw a perpendicular BF on CD.  
It can be observed that ABED is a parallelogram.

$$BE = AD = 13 \text{ m}$$

$$ED = AB = 10 \text{ m}$$

$$EC = 25 - ED = 15 \text{ m}$$

For  $\triangle BEC$ ,

$$s = \frac{(13+14+15)\text{m}}{2} = 21 \text{ m}$$

Semi-perimeter,

By Heron's formula.

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

Area of triangle

$$= \left[ \sqrt{21(21-13)(21-14)(21-15)} \right] \text{m}^2$$

Area of  $\triangle BEC$

$$= \left[ \sqrt{21(8)(7)(6)} \right] \text{m}^2 = 84 \text{ m}^2$$

$$= \frac{1}{2} \times CE \times BF$$

Area of  $\triangle BEC$

$$84 \text{ cm}^2 = \frac{1}{2} \times 15 \text{ cm} \times BF$$

$$BF = \left( \frac{168}{15} \right) \text{ cm} = 11.2 \text{ cm}$$

$$\text{Area of ABED} = BF \times DE = 11.2 \times 10 = 112 \text{ m}^2$$

$$\text{Area of the field} = 84 + 112 = 196 \text{ m}^2$$