Government of Tamilnadu

STANDARD SEVEN

TERM II

VOLUME 2

MATHEMATICS | SCIENCE | SOCIAL SCIENCE

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Untouchability is Inhuman and a Crime

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MATHEMATICS

STANDARD SEVEN

TERM II

Chapter 1

1 LIFE MATHEMATICS

1.1 Introduction

In most of our daily activities like following a recipe or decorating our home or calculating our daily expenses we are unknowingly using mathematical principles. People have been using these principles for thousands of years, across countries and continents. Whether you're sailing a boat off the coast of Chennai or building a house in Ooty, you are using mathematics to get things done.

How can mathematics be so universal? First human beings did not invent mathematical concepts, we discovered them. Also the language of mathematics is numbers, not English or German or Russian. If we are well versed in this language of numbers, it can help us make important decisions and perform everyday tasks. Mathematics can help us shop wisely, remodel a house within a budget, understand population growth, invest properly and save happily.

Let us learn some basic mathematical concepts that are used in real life situations.

1.2 Revision - Ratio and Proportion

Try and recollect the definitions and facts on Ratio and Proportion and complete the following statements using the help box:

1. The comparison of two quantities of the same kind by means of division is termed as _________.
2. The two quantities to be compared are called the _________ of the ratio.
3. The first term of the ratio is called the _________ and the second term is called the _________.
4. In ratio, only quantities in the _________ units can be compared.
5. If the terms of the ratio have common factors, we can reduce it to its lowest terms by cancelling the _________.
6. When both the terms of a ratio are multiplied or divided by the same number (other than zero) the ratio remains _________. The obtained ratios are _________.

7. In a ratio the order of the terms is very important. (Say True or False)

8. Ratios are mere numbers. Hence units are not needed. (Say True or False)

9. Equality of two ratios is called a _________. If $a, b; c, d$ are in proportion, then $a : b :: c : d$.

10. In a proportion, the product of extremes =_________

Help Box:

1) Ratio	2) terms	3) antecedent, consequent
4) same	5) common factors	6) unchanged, equivalent ratios
7) True	8) True	9) proportion
10) product of means		

Example 1.1:

Find 5 equivalent ratios of 2:7

Solution: 2 : 7 can be written as $\frac{2}{7}$.

Multiplying the numerator and the denominator of $\frac{2}{7}$ by 2, 3, 4, 5, 6

we get $\quad \frac{2 \times 2}{7 \times 2} = \frac{4}{14}, \frac{2 \times 3}{7 \times 3} = \frac{6}{21}, \frac{2 \times 4}{7 \times 4} = \frac{8}{28}$

$$\frac{2 \times 5}{7 \times 5} = \frac{10}{35}, \frac{2 \times 6}{7 \times 6} = \frac{12}{42}$$

4 : 14, 6 : 21, 8 : 28, 10 : 35, 12 : 42 are equivalent ratios of 2 : 7.

Example 1.2:

Reduce 270 : 378 to its lowest term.

Solution:

$$270:378 = \frac{270}{378}$$

Dividing both the numerator and the denominator by 2, we get

$$\frac{270 \div 2}{378 \div 2} = \frac{135}{189}$$

Aliter:

Factorizing 270,378 we get

$$\frac{270}{378} = \frac{2 \times 3 \times 3 \times 3 \times 5}{2 \times 3 \times 3 \times 3 \times 7}$$

$$= \frac{5}{7}$$

by 3, we get

$$\frac{135 \div 3}{189 \div 3} = \frac{45}{63}$$

by 9, we get

$$\frac{45 \div 9}{63 \div 9} = \frac{5}{7}$$

270 : 378 is reduced to 5 : 7

Example 1.3

Find the ratio of 9 months to 1 year

Solution: 1 year = 12 months

Ratio of 9 months to 12 months = 9 : 12

9 : 12 can be written as $\frac{9}{12}$

$= \frac{9 \div 3}{12 \div 3} = \frac{3}{4}$

$= 3 : 4$

> Quantities in the same units only can be compared in the form of a ratio. So convert year to months.

Example 1.4

If a class has 60 students and the ratio of boys to girls is 2:1, find the number of boys and girls.

Solution:

Number of students = 60

Ratio of boys to girls = 2 : 1

Total parts = 2 + 1 = 3

Number of boys = $\frac{2}{3}$ of 60

$= \frac{2}{3} \times 60 = 40$

Number of boys = 40

Number of girls = Total Number of students – Number of boys

= 60 – 40

= 20

Number of girls = 20

[OR]

> Number of girls
> $= \frac{1}{3}$ of 60 $= \frac{1}{3} \times 60$
> $= 20$

Example 1.5

A ribbon is cut into 3 pieces in the ratio 3: 2: 7. If the total length of the ribbon is 24 m, find the length of each piece.

Solution:

Length of the ribbon = 24m

Ratio of the 3 pieces = 3 : 2 : 7

Total parts = 3 + 2 + 7 = 12

Length of the first piece of ribbon = $\frac{3}{12}$ of 24

$= \frac{3}{12} \times 24 = 6$ m

Length of the second piece of ribbon = $\frac{2}{12}$ of 24

$= \frac{2}{12} \times 24 = 4$ m

Length of the last piece of ribbon = $\frac{7}{12}$ of 24

$= \frac{7}{12} \times 24 = 14$ m

So, the length of the three pieces of ribbon are 6 m, 4 m, 14 m respectively.

Example 1.6

The ratio of boys to girls in a class is 4 : 5. If the number of boys is 20, find the number of girls.

Solution: Ratio of boys to girls = 4 : 5

Number of boys = 20

Let the number of girls be x

The ratio of the number of boys to the number of girls is 20 : x

4 : 5 and 20 : x are in proportion, as both the ratios represent the number of boys and girls.

(i.e.) 4 : 5 :: 20 : x

Product of extremes = $4 \times x$

Product of means = 5×20

In a proportion, product of extremes = product of means

$$4 \times x = 5 \times 20$$

$$x = \frac{5 \times 20}{4} = 25$$

$$\text{Number of girls} = 25$$

Example 1.7

If A : B = 4 : 6, B : C = 18 : 5, find the ratio of A : B : C.

Solution:

A : B = 4 : 6

B : C = 18 : 5

L.C.M. of 6, 18 = 18

A : B = 12 : 18

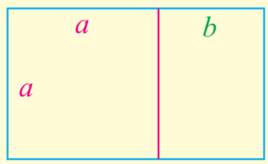
B : C = 18 : 5

A : B : C =12 : 18 : 5

HINT

To compare 3 ratios as given in the example, the consequent (2nd term) of the 1st ratio and the antecedent (1st term) of the 2nd ratio must be made equal.

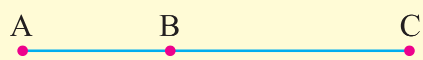
Do you Know?



Golden Ratio: Golden Ratio is a special number approximately equal to 1.6180339887498948482$\cdots$. We use the Greek letter Phi (Φ) to refer to this ratio. Like Phi the digits of the Golden Ratio go on forever without repeating.

Golden Rectangle: A Golden Rectangle is a rectangle in which the ratio of the length to the width is the Golden Ratio. If width of the Golden Rectangle is 2 ft long, the other side is approximately = 2 (1.62) = 3.24 ft

Golden segment: It is a line segment divided into 2 parts. The ratio of the length of the 2 parts of this segment is the Golden Ratio



$$\frac{AB}{BC} = \frac{BC}{AC}$$

Applications of Golden Ratio:

Think!

1. Use the digits 1 to 9 to write as many proportions as possible. Each digit can be used only once in a proportion. The numbers that make up the proportion should be a single digit number.
   Eg: $\frac{1}{2} = \frac{3}{6}$
2. Suppose the ratio of zinc to copper in an alloy is 4 : 9, is there more zinc or more copper in the alloy?
3. A bronze statue is made of copper, tin and lead metals. It has $\frac{1}{10}$ of tin, $\frac{1}{4}$ of lead and the rest copper. Find the part of copper in the bronze statue.

1.3 Variation

Cutting down of trees → RESULTS → Increase in temperature

Usage of more vehicles → RESULTS → Increase of pollutants

You walk faster → RESULTS → You take less time

More vehicles on the road → RESULTS → Less road space

These are some changes.

What happens when......

You study well? → You score more marks

You eat more? → You become fatter

You shout in class? → Class becomes noisy

In all the above cases we see that a change in one factor brings about a change in the related factor. Such changes are termed as variation.

Now, **try and match the answers to the given questions:**

What happens when............

You buy more pens?	More number of teachers
Number of students are more?	Costs you more
You travel less distance?	Weight of bag is less
Number of books are reduced?	Time taken is less

The above examples are interdependent quantities that change numerically.

We observe that, an increase (↑) in one quantity brings about an increase (↑) in the other quantity and similarly a decrease (↓) in one quantity brings about a decrease (↓) in the other quantity .

Now, look at the following tables:

Cost of 1 pen (₹)	Cost of 10 pens (₹)
5	$10 \times 5 = 50$
20	$10 \times 20 = 200$
30	$10 \times 30 = 300$

As the number of pens increases, the cost also increases correspondingly.

Cost of 5 shirts (₹)	Cost of 1 shirt (₹)
3000	$\frac{3000}{5} = 600$
1000	$\frac{1000}{5} = 200$

As the number of shirts decreases, the cost also decreases correspondingly.

Thus we can say, if an increase (↑) [decrease (↓)] in one quantity produces a proportionate increase (↑) [decrease (↓)] in another quantity, then the two quantities are said to be in **direct variation**.

Now, let us look at some more examples:

i) When the speed of the car increases, do you think that the time taken to reach the destination will increase or decrease?

ii) When the number of students in a hostel decreases, will the provisions to prepare food for the students last longer or not?

We know that as the speed of the car increases, the time taken to reach the given destination definitely decreases.

Similarly, if the number of students decreases, the provisions last for some more number of days.

Thus, we find that if an increase (↑) [decrease (↓)] in one quantity produces a proportionate decrease (↓) [increase (↑)] in another quantity, then we say that the two quantities are in **inverse variation**.

Try these

Identify the direct and inverse variations from the given examples.

1. Number of pencils and their cost
2. The height of poles and the length of their shadows at a given time
3. Speed and time taken to cover a distance
4. Radii of circles and their areas
5. Number of labourers and the number of days taken to complete a job
6. Number of soldiers in a camp and weekly expenses
7. Principal and Interest
8. Number of lines per page and number of pages in a book

Look at the table given below:

Number of pens	x	2	4	7	10	20
Cost of pens (₹)	y	100	200	350	500	1000

We see that as 'x' increases (↑) 'y' also increases (↑).

We shall find the ratio of number of pens to cost of pens

$$\frac{\text{Number of pens}}{\text{Cost of pens}} = \frac{x}{y}, \text{ to be } \frac{2}{100}, \frac{4}{200}, \frac{7}{350}, \frac{10}{500}, \frac{20}{1000}$$

and we see that each ratio = $\frac{1}{50}$ = Constant.

Ratio of number of pens to cost of pens is a constant.

$$\therefore \frac{x}{y} = \text{constant}$$

It can be said that **when two quantities vary directly the ratio of the two given quantities is always a constant**.

Now, look at the example given below:

Time taken (Hrs)	$x_1 = 2$	$x_2 = 10$
Distance travelled (km)	$y_1 = 10$	$y_2 = 50$

We see that as time taken increases (↑), distance travelled also increases (↑).

$$X = \frac{x_1}{x_2} = \frac{2}{10} = \frac{1}{5}$$

$$Y = \frac{y_1}{y_2} = \frac{10}{50} = \frac{1}{5}$$

$$X = Y = \frac{1}{5}$$

From the above example, it is clear that in **direct variation, when a given quantity is changed in some ratio then the other quantity is also changed in the same ratio**.

Now, study the relation between the given variables and find *a* and *b*.

Time taken (hrs)	x	2	5	6	8	10	12
Distance travelled (Km)	y	120	300	a	480	600	b

Here again, we find that the ratio of the time taken to the distance travelled is a constant.

$$\frac{\text{Time taken}}{\text{Distance travelled}} = \frac{2}{120} = \frac{5}{300} = \frac{10}{600} = \frac{8}{480} = \frac{1}{60} = \text{Constant}$$

(i.e.) $\frac{x}{y} = \frac{1}{60}$. Now, we try to find the unknown

$$\frac{1}{60} = \frac{6}{a}$$

$$\frac{1 \times \boxed{6}}{60 \times \boxed{6}} = \frac{6}{360}$$

$$a = 360$$

$$\frac{1}{60} = \frac{12}{b}$$

$$\frac{1 \times \boxed{12}}{60 \times \boxed{12}} = \frac{12}{720}$$

$$b = 720$$

Look at the table given below:

Speed (Km / hr)	x	40	48	60	80	120
Time taken (hrs)	y	12	10	8	6	4

Here, we find that as x increases (↓) y decreases (↑)

$$xy = 40 \times 12 = 480$$

$$= 48 \times 10 = 60 \times 8 = 80 \times 6 = 120 \times 4 = 480$$

$$\therefore xy = \text{constant}$$

It can be stated that **if two quantities vary inversely, their product is a constant**.

Look at the example below:

Speed (Km/hr)	$x_1 = 120$	$x_2 = 60$
Time taken (hrs)	$y_1 = 4$	$y_2 = 8$

As speed increases (↑), time taken decreases (↓).

$$X = \frac{x_1}{x_2} = \frac{120}{60} = 2$$

$$Y = \frac{y_1}{y_2} = \frac{4}{8} = \frac{1}{2} \quad 1/Y = 2$$

$$X = \frac{1}{Y}$$

Thus, it is clear that in inverse variation, when a given quantity is changed in some ratio the other quantity is changed in inverse ratio.

Now, study the relation between the variables and find a and b.

No of men	x	15	5	6	b	60
No of days	y	4	12	a	20	1

We see that, $xy = 15 \times 4 = 5 \times 12 = 60 = \text{constant}$

$$xy = 60$$

$$6 \times a = 60$$

$$6 \times 10 = 60$$

$$a = 10$$

$$xy = 60$$
$$b \times 20 = 60$$
$$3 \times 20 = 60$$
$$b = 3$$

Try these

1. If x varies directly as y, complete the given tables:

(i)

x	1	3			9	15
y	2		10	16		

(ii)

x	2	4	5		
y	6			18	21

2. If x varies inversely as y, complete the given tables:

(i)

x	20	10	40	50	
y			50		250

(ii)

x		200	8	4	16
y	10		50		

Example 1.8

If the cost of 16 pencils is ₹48, find the cost of 4 pencils.

Solution:

Let the cost of four pencils be represented as 'a'.

Number of pencils	**Cost (₹)**
x	y
16	48
4	a

As the number of pencils decreases (↓), the cost also decreases (↓). Hence the two quantities are in **direct variation**.

We know that, in direct variation, $\frac{x}{y}$ = constant

$$\frac{16}{48} = \frac{4}{a}$$

$$16 \times a = 48 \times 4$$

$$a = \frac{48 \times 4}{16} = 12$$

Cost of four pencils = ₹12

Aliter:

Let the cost of four pencils be represented as 'a' .

Number of pencils	Cost (₹)
x	y
16	48
4	a

As number of pencils decreases (↓), cost also decreases (↓), **direct variation (Same ratio)**.

$$\frac{16}{4} = \frac{48}{a}$$

$$16 \times a = 4 \times 48$$

$$a = \frac{4 \times 48}{16} = 12$$

Cost of four pencils = ₹12.

Example 1.9

A car travels 360 km in 4 hrs. Find the distance it covers in 6 hours 30 mins at the same speed.

Solution:

Let the distance travelled in $6\frac{1}{2}$ hrs be a

Time taken (hrs)	Distance travelled (km)
x	y
4	360
$6\frac{1}{2}$	a

30 mins $= \frac{30}{60}$ hrs

$= \frac{1}{2}$ of an hr

6 hrs 30 mins $= 6\frac{1}{2}$ hrs

As time taken increases (↑), distance travelled also increases (↑), **direct variation.**

In direct variation, $\frac{x}{y}$ = constant

$$\frac{4}{360} = \frac{6\frac{1}{2}}{a}$$

$$4 \times a = 360 \times 6\frac{1}{2}$$

$$4 \times a = 360 \times \frac{13}{2}$$

$$a = \frac{360 \times 13}{4 \times 2} = 585$$

Distance travelled in $6\frac{1}{2}$ hrs = 585 km

Aliter: Let the distance travelled in $6\frac{1}{2}$ hrs be a

Time taken (hrs)	**Distance travelled (km)**
4	360
$6\frac{1}{2}$	a

As time taken increases (↑), distance travelled also increases (↑), **direct variation (same ratio).**

$$\frac{4}{6\frac{1}{2}} = \frac{360}{a}$$

$$4 \times a = 360 \times 6\tfrac{1}{2}$$

$$4 \times a = 360 \times \frac{13}{2}$$

$$a = \frac{360}{4} \times \frac{13}{2} = 585$$

Distance travelled in $6\frac{1}{2}$ hrs = 585 km.

Example 1.10

7 men can complete a work in 52 days. In how many days will 13 men finish the same work?

Solution: Let the number of unknown days be a.

Number of men	**Number of days**
x	y
7	52
13	a

As the number of men increases (↑), number of days decreases (↓), **inverse variation**

In inverse variation, xy = constant

$$7 \times 52 = 13 \times a$$

$$13 \times a = 7 \times 52$$

$$a = \frac{7 \times 52}{13} = 28$$

13 men can complete the work in 28 days.

Aliter:

Let the number of unknown days be a.

Number of men	**Number of days**
7	52
13	a

As number of men increases (↑), number of days decreases (↓), **inverse variation (inverse ratio).**

$$\frac{7}{13} = \frac{a}{52}$$

$$7 \times 52 = 13 \times a$$

$$13 \times a = 7 \times 52$$

$$a = \frac{7 \times 52}{13} = 28$$

13 men can complete the work in 28 days

Example 1.11

A book contains 120 pages. Each page has 35 lines . How many pages will the book contain if every page has 24 lines per page?

Solution: Let the number of pages be a.

Number of lines per page	**Number of pages**
35	120
24	a

As the number of lines per page decreases (↓) number of pages increases (↑) it is in **inverse variation (inverse ratio)**.

$$\frac{35}{24} = \frac{a}{120}$$

$$35 \times 120 = a \times 24$$

$$a \times 24 = 35 \times 120$$

$$a = \frac{35 \times 120}{24}$$

$$a = 35 \times 5 = 175$$

If there are 24 lines in one page, then the number of pages in the book = 175

Exercise 1.1

1. Choose the correct answer

i) If the cost of 8 kgs of rice is ₹160, then the cost of 18 kgs of rice is

(A) ₹480 (B) ₹180 (C) ₹360 (D) ₹1280

ii) If the cost of 7 mangoes is ₹35, then the cost of 15 mangoes is

(A) ₹75 (B) ₹25 (C) ₹35 (D) ₹50

iii) A train covers a distance of 195 km in 3 hrs. At the same speed, the distance travelled in 5 hours is

(A) 195 km. (B) 325 km. (C) 390 km. (D) 975 km.

iv) If 8 workers can complete a work in 24 days, then 24 workers can complete the same work in

(A) 8 days (B) 16 days (C) 12 days (D) 24 days

v) If 18 men can do a work in 20 days, then 24 men can do this work in

(A) 20 days (B) 22 days (C) 21 days (D) 15 days

2. A marriage party of 300 people require 60 kg of vegetables. What is the requirement if 500 people turn up for the marriage?

3. 90 teachers are required for a school with a strength 1500 students. How many teachers are required for a school of 2000 students?

4. A car travels 60 km in 45 minutes. At the same rate, how many kilo metres will it travel in one hour?

5. A man whitewashes 96 sq.m of a compound wall in 8 days. How many sq.m will be white washed in 18 days?

6. 7 boxes weigh 36.4 kg. How much will 5 such boxes weigh?

7. A car takes 5 hours to cover a particular distance at a uniform speed of 60 km / hr. How long will it take to cover the same distance at a uniform speed of 40 km / hr?

8. 150 men can finish a piece of work in 12 days. How many days will 120 men take to finish the same work?

9. A troop has provisions for 276 soldiers for 20 days. How many soldiers leave the troop so that the provisions may last for 46 days?

10. A book has 70 pages with 30 lines of printed matter on each page. If each page is to have only 20 lines of printed matter, how many pages will the book have?

11. There are 800 soldiers in an army camp. There is enough provisions for them for 60 days. If 400 more soldiers join the camp, for how many days will the provisions last?

Just for fun

If an owl builds a nest in 1 second , then what time will it take if there were 200 owls?
Owls don't build their own nests. They simply move into an old hawk's nest or rest in ready made cavities.

Try these

Read the questions. Recollect the different methods that you have learnt earlier. Try all the different methods possible and solve them.

1. A wheel makes 48 revolutions in 3 seconds. How many revolutions does it make in 30 seconds?
2. A film processor can develop 100 negatives in 5 minutes. How many minutes will it take to develop 1200 negatives?
3. There are 36 players in 2 teams. How many players are there in 5 teams?

Points to Remember

1. Two quantities are said to be in direct variation if the increase (decrease) in one quantity results in a proportionate increase (decrease) in the other quantity.

2. Two quantities are said to be in inverse variation if the increase (decrease) in one quantity results in a proportionate decrease (increase) in the other quantity.

3. In direct proportion, the ratio of one quantity is equal to the ratio of the second quantity.

4. In indirect proportion, the ratio of one quantity is equal to the inverse ratio of the second quantity.

2 MEASUREMENTS

In class VI, we have learnt about the concepts and formulae for finding the perimeter and area of simple closed figures like rectangle , square and right triangle. In this chapter, we will learn about the area of some more closed figures such as triangle, quadrilateral, parallelogram, rhombus, trapezium and circle.

2.1 Revision

Let us recall what we have learnt about the area and perimeter of rectangle, square and right triangle.

Perimeter

When we go around the boundary of the closed figure, the distance covered by us is called the perimeter.

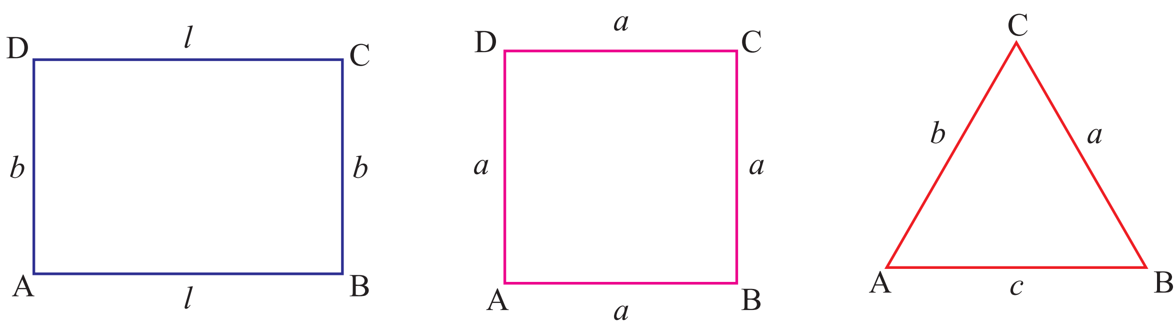


Fig. 2.1

Perimeter of the rectangle = 2 × (length) + 2 × (breadth)

= 2 [length + breadth]

Perimeter of the rectangle = 2 $(l + b)$ units where l = length, b = breadth

Perimeter of the square = 4 × length of its side

= 4 × side

Perimeter of the square = 4 a units where a = side

Perimeter of the triangle = Sum of the sides of the triangle

Perimeter of the triangle = $(a + b + c)$ units

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

Area

The surface enclosed by a closed figure is called its area.

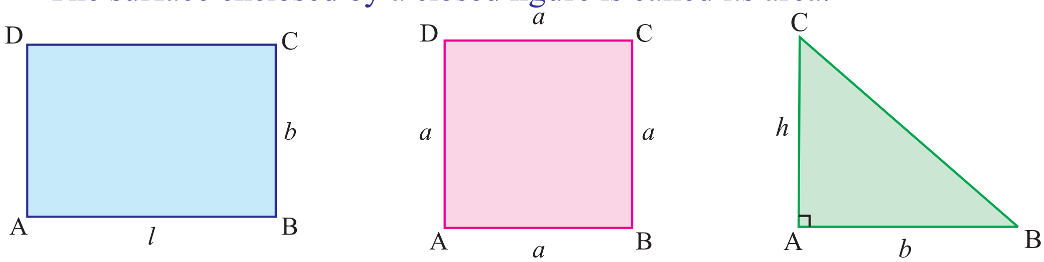


Fig. 2.2

Area of the rectangle	=	length × breadth
Area of the rectangle	=	$l \times b$ sq. units
Area of the square	=	side × side
Area of the square	=	$a \times a$ sq. units
Area of the right triangle	=	$\frac{1}{2} \times$ product of the sides containing 90°
Area of the right triangle	=	$\frac{1}{2} \times (b \times h)$ sq. units

where b and h are adjacent sides of the right angle.

Try these

* Find the area and perimeter of your class room blackboard, table and windows.
* Take a sheet of paper, cut the sheet into different measures of rectangles, squares and right triangles. Place them on a table and find the perimeter and area of each figure.

Example 2.1

Find the area and the perimeter of a rectangular field of length 15 m and breadth 10 m.

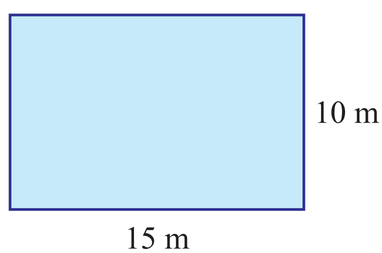


Fig.2.3

Solution

Given: length = 15 m and breadth = 10 m

Area of the rectangle = length × breadth

= 15 m × 10 m

= 150 m^2

Perimeter of the rectangle = 2 [length + breadth]

= 2 [15 +10] = 50 m

$\therefore$ Area of the rectangle = 150 m^2

Perimeter of the rectangle = 50 m

Example 2.2

The area of a rectangular garden 80m long is 3200sq.m. Find the width of the garden.

Solution

Given: length = 80 m, Area = 3200 sq.m

Area of the rectangle = length $\times$ breadth

breadth = $\frac{\text{area}}{\text{length}}$

= $\frac{3200}{80}$ = 40 m

$\therefore$ Width of the garden = 40 m

Example 2.3

Find the area and perimeter of a square plot of length 40 m.

Solution

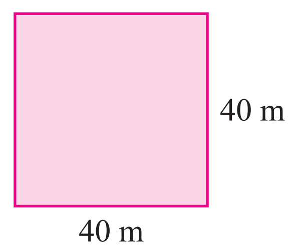


Fig. 2.4

Given the side of the square plot = 40 m

Area of the square = side × side

= 40 m × 40 m

= 1600 sq.m

Perimeter of the square = 4 × side

= 4 × 40 = 160 m

$\therefore$ Area of the square = 1600 sq.m

Perimeter of the square = 160 m

Example 2.4

Find the cost of fencing a square flower garden of side 50 m at the rate of ₹10 per metre.

Solution

Given the side of the flower garden = 50 m

For finding the cost of fencing, we need to find the total length of the boundary (perimeter) and then multiply it by the rate of fencing.

Perimeter of the square flower garden = 4 × side

= 4 × 50

= 200 m

cost of fencing 1m = ₹10 (given)

∴ cost of fencing 200m = ₹10 × 200

= ₹2000

Example 2.5

Find the cost of levelling a square park of side 60 m at ₹2 per sq.m.

Solution

Given the side of the square park = 60 m

For finding the cost of levelling, we need to find the area and then multiply it by the rate for levelling.

Area of the square park = side × side

= 60 × 60

= 3600 sq.m

cost of levelling 1 sq.m = ₹2

∴ cost of levelling 3600 sq.m = ₹2 × 3600

= ₹7200

Example 2.6

In a right triangular ground, the sides adjacent to the right angle are 50 m and 80 m. Find the cost of cementing the ground at ₹5 per sq.m

Solution

For finding the cost of cementing, we need to find the area and then multiply it by the rate for cementing.

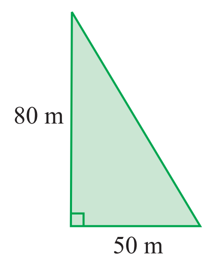


Fig. 2.5

Area of right triangular ground = $\frac{1}{2} \times b \times h$

where b and h are adjacent sides of the right anlges.

$= \frac{1}{2} \times (50\,m \times 80\,m)$

$= 2000\ \text{m}^2$

cost of cementing one sq.m = ₹5

∴ cost of cementing 2000 sq.m = ₹5 × 2000

= ₹10000

Do you know?

1 are = 100 m^2

1 hectare = 100 are (or)

= 10000 m^2

2.2 Area of Combined Plane Figures

In this section we will learn about the area of combined plane figures such as rectangle, square and right triangle taken two at a time.

A villager owns two pieces of land adjacent to each other as shown in the Fig.2.6. He did not know the area of land he owns. One land is in the form of rectangle of dimension 50 m × 20 m and the other land is in the form of a square of side 30m. Can you guide the villager to find the total area he owns?

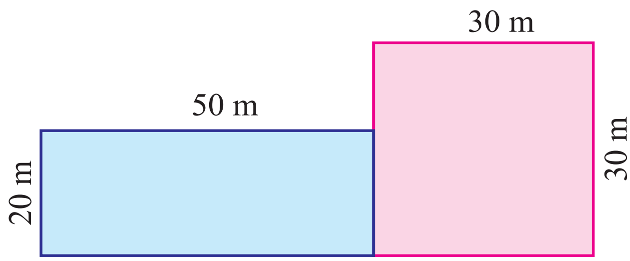


Fig. 2.6

Now, Valarmathi and Malarkodi are the leaders of Mathematics club in the school. They decorated the walls with pictures. First, Valarmathi made a rectangular picture of length 2m and width 1.5m. While Malarkodi made a picture in the shape of a right triangle as in Fig. 2.7. The adjacent sides that make the right angle are 1.5m and 2m. Can we find the total decorated area?

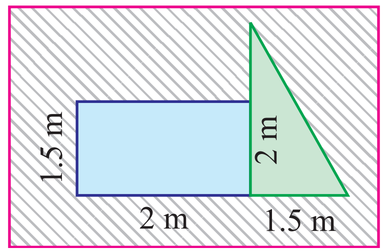


Fig. 2.7

Now, let us see some examples for combined figures

Example 2.7

Find the area of the adjacent figure:

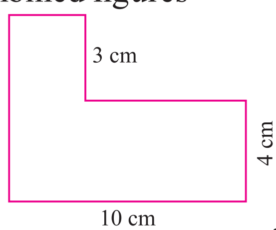


Fig. 2.8

Solution

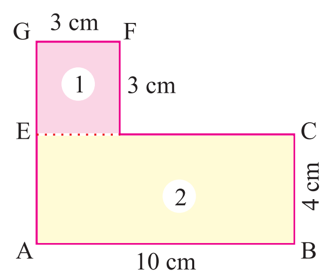


Fig. 2.9

Area of square (1) $= 3\text{ cm} \times 3\text{ cm} = 9\text{ cm}^2$

Area of rectangle (2) $= 10\text{ cm} \times 4\text{ cm} = 40\text{ cm}^2$

$\therefore$ Total area of the figure (Fig. 2.9) $= (9 + 40)\text{ cm}^2$

$= 49\text{ cm}^2$

Aliter:

Area of rectangle (1) $= 7\text{ cm} \times 3\text{ cm} = 21\text{ cm}^2$

Area of rectangle (2) $= 7\text{ cm} \times 4\text{ cm} = 28\text{ cm}^2$

$\therefore$ Total area of the figure (Fig. 2.10) $= (21 + 28)\text{ cm}^2$

$= 49\text{ cm}^2$

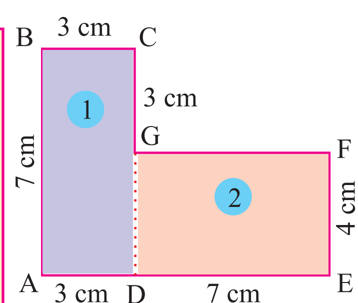


Fig. 2.10

Example 2.8

Find the area of the following figure:

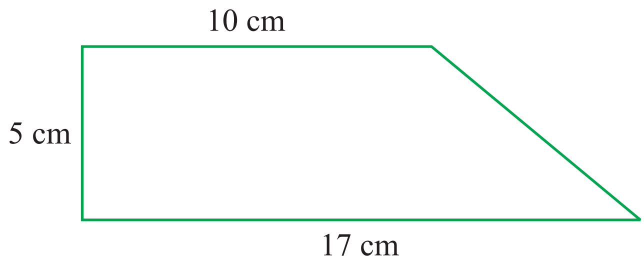


Fig. 2.11

Solution

The figure contains a rectangle and a right triangle

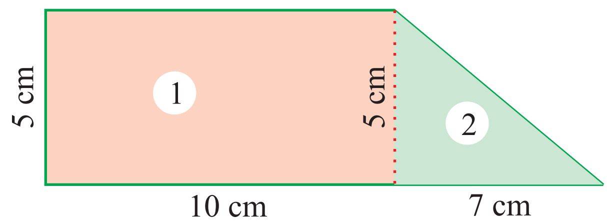


Fig. 2.12

Area of the rectangle (1) $= 5 \text{ cm} \times 10 \text{ cm}$

$= 50 \text{ cm}^2$

Area of the right triangle (2) $= \frac{1}{2} \times (7 \text{ cm} \times 5 \text{ cm})$

$= \frac{35}{2} \text{ cm}^2 = 17.5 \text{ cm}^2$

$\therefore$ Total area of the figure $= (50 + 17.5) \text{ cm}^2$

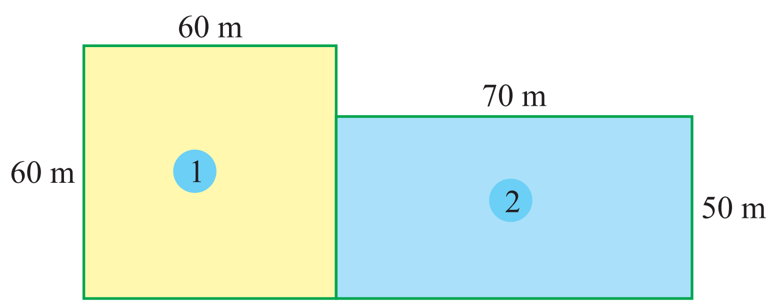
$= 67.5 \text{ cm}^2$

Total area $= 67.5 \text{ cm}^2$

Example 2.9

Arivu bought a square plot of side 60 m. Adjacent to this Anbu bought a rectangular plot of dimension 70 m $\times$ 50 m. Both paid the same amount. Who is benefited ?

Solution



Fi.g 2.13

Area of the square plot of Arivu (1) $= 60\text{ m} \times 60\text{ m} = 3600\text{ m}^2$

Area of the rectangular plot of Anbu (2) $= 70\text{ m} \times 50\text{ m} = 3500\text{ m}^2$

The area of the square plot is more than the rectangular plot.

So, Arivu is benefited.

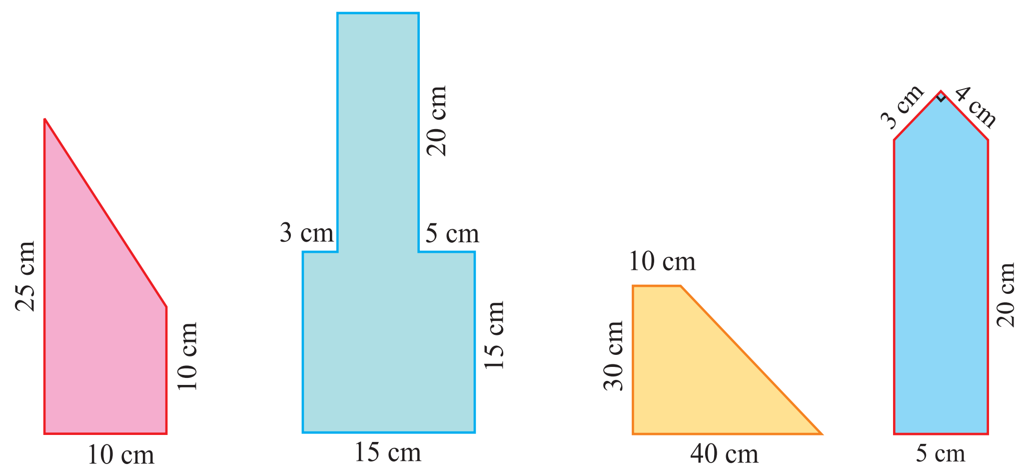
Try these

Take two square sheets of same area. Cut one square sheet along the diagonal. How many right triangles do you have? What can you say about their area? Place them on the other square sheet. Observe and discuss.

Now, take two rectangular sheets of same dimensions. Cut one rectangular sheet along the diagonal. How many right triangles do you have? What can you say about their area? Place them on the other sheet. What is the relationship between the right triangle and the rectangle?

Exercise 2.1

1. Find the area of the following figures:



(i) (ii) (iii) (iv)

2. Sibi wants to cover the floor of a room 5 m long and width 4 m by square tiles. If area of each square tiles is $\frac{1}{2}m^2$, then find the number of tiles required to cover the floor of a room.
3. The cost of a right triangular land and the cost of a rectangular land are equal. Both the lands are adjacent to each other. In a right triangular land the adjacent sides of the right angles are 30 m and 40 m. The dimensions of the rectangular land are 20 m and 15 m. Which is best to purchase?
4. Mani bought a square plot of side 50 m. Adjacent to this Ravi bought a rectangular plot of length 60 m and breadth 40 m for the same price. Find out who is benefited and how many sq. m. are more for him?
5. Which has larger area? A right triangle with the length of the sides containing the right angle being 80 cm and 60 cm or a square of length 50 cm.

2.3 Area of Triangle

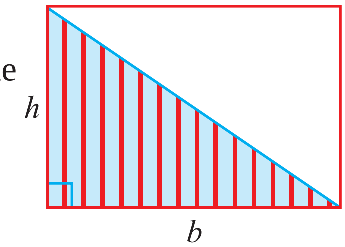


Fig. 2.14

The area of a right triangle is half the area of the rectangle that contains it.

The area of the right triangle

$= \frac{1}{2}$(Product of the sides containing 90^0)

(or) $= \frac{1}{2} b\, h$ sq.units

where b and h are adjacent sides of the right triangle.

In this section we will learn to find the area of triangles.

To find the area of a triangle

Take a rectangular piece of paper. Name the vertices as A, B, C and D. Mark any point E on DC. Join AE and BE. We get a triangle ABE inscribed in the rectangle ABCD as shown in the Fig. 2.15 (i)

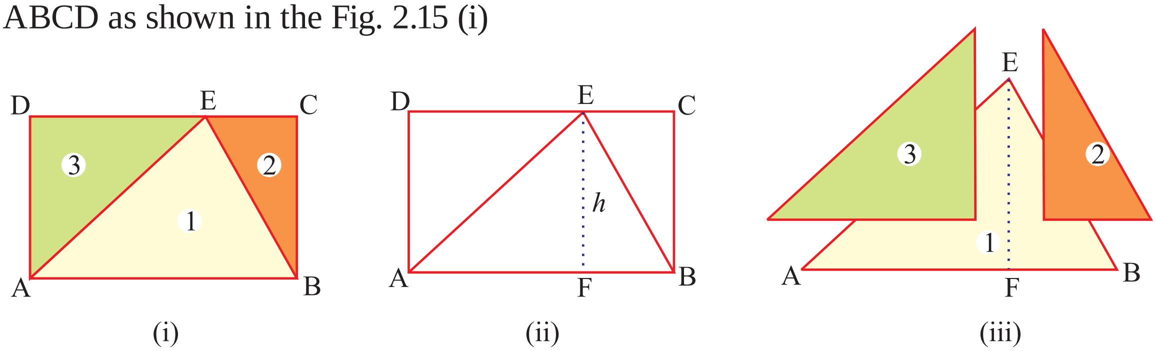


Fig. 2.15

Now mark a point F on AB such that DE = AF. Join EF. We observe that EF = BC. We call EF as h and AB as b.

Now cut along the lines AE and BE and superpose two triangles (2) and (3) on ABE as shown in the Fig. 2.15 (iii).

$\therefore$ Area of ΔABE = Area of ΔADE + Area of ΔBCE ..... (1)

Area of Rectangle ABCD = Area of ΔABE + (Area of ΔADE + Area of ΔBCE)

= Area of ΔABE + Area of Δ ABE (By using (1))

= 2 Area of ΔABE

(i.e.) 2 Area of ΔABE = Area of the rectangle ABCD

$\therefore$ Area of the triangle ABE

$= \frac{1}{2}$(area of rectangle ABCD)

$= \frac{1}{2}$(length × breadth)

$= \frac{1}{2}\ bh$ sq.units

$\therefore$ Area of any triangle $= \frac{1}{2}\ bh$ sq.units

Where b is the base and h is the height of the triangle.

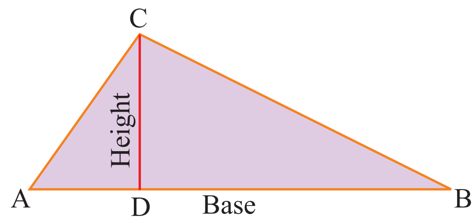


Fig. 2.16

Think it!

Consider an obtuse angled triangle ABC. The perpendicular drawn from C meets the base BA produced at D.

What is the area of the triangle?

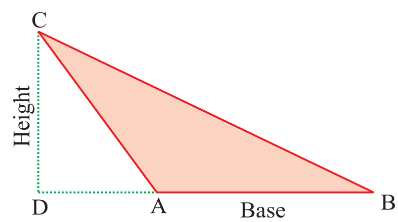


Fig. 2.17

Try these

Paper folding method

Take a triangular piece of paper. Name the vertices as A, B and C. Consider the base AB as b and altitude by h.

Find the midpoint of AC and BC, say D and E respectively. Join D and E and draw a perpendicular line from C to AB. It meets at F on DE and G on AB. We observe that CF = FG.

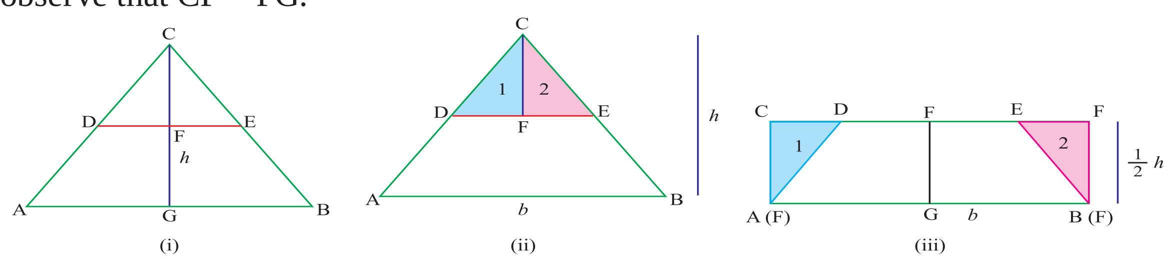


Fig. 2.18

Cut along DE and again cut it along CF to get two right triangles. Now, place the two right triangles beside the quarilateral ABED as shown in the Fig. 2.18 (iii).

Area of figure (i) = Area of figure (iii)

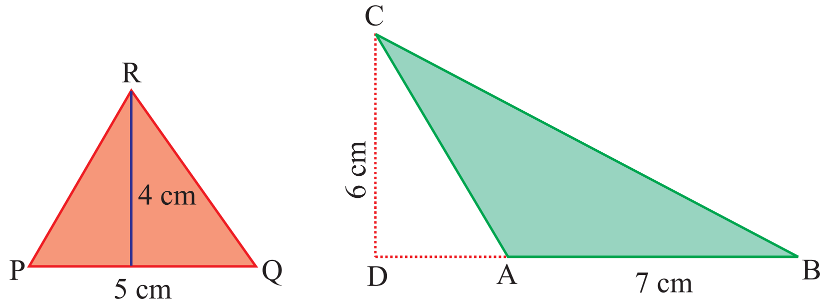
(i.e.) Area of the triangle = Area of the rectangle

$= b \times (\frac{1}{2}h)$ sq. units [CF + FG = h]

$= \frac{1}{2} b\, h$ sq. units.

Example 2.10

Find the area of the following figures:



(i) (ii)

Fig. 2.19

Solution

(i) Given: Base $= 5$ cm, Height $= 4$ cm

$$\text{Area of the triangle PQR} = \frac{1}{2} b\,h$$
$$= \frac{1}{2} \times 5 \text{ cm} \times 4 \text{ cm}$$
$$= 10 \text{ sq.cm (or) cm}^2$$

(ii) Given: Base $= 7$cm, Height $= 6$cm

$$\text{Area of the triangle ABC} = \frac{1}{2} b\,h$$
$$= \frac{1}{2} \times 7\text{cm} \times 6\text{cm}$$
$$= 21 \text{ sq.cm (or) cm}^2$$

Example 2.11

Area of a triangular garden is 800 sq.m. The height of the garden is 40 m. Find the base length of the garden.

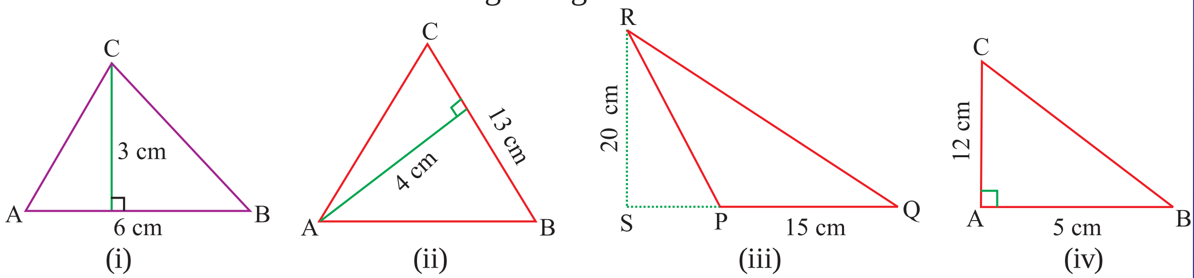
Solution

$$\text{Area of the triangular garden} = 800 \text{ sq.m. (given)}$$
$$\frac{1}{2} b\,h = 800$$
$$\frac{1}{2} \times b \times 40 = 800 \quad (\text{since } h = 40)$$
$$20\,b = 800$$
$$b = 40 \text{ m}$$

$\therefore$ Base of the garden is 40 m.

Exercise 2.2

1. Find the area of the following triangles:



2. Find the area of the triangle for the following measurements:
   (i) base = 6 cm, height = 8 cm
   (ii) base = 3 m, height = 2 m
   (iii) base = 4.2 m , height = 5 m

3. Find the base of the triangle whose area and height are given below:
   (i) area = 40 m^2 , height = 8 m
   (ii) area = 210 cm^2 , height = 21 cm
   (iii) area = 82.5 m^2 , height = 10 m

4. Find the height of the triangle whose area and the base are given below:
   (i) area = 180 m^2 , base = 20 m
   (ii) area = 62.5 m^2 , base = 25 m
   (iii) area = 20 cm^2 , base = 5 cm

5. A garden is in the form of a triangle. Its base is 26 m and height is 28 m. Find the cost of levelling the garden at ₹5 per m^2.

2.4 Area of the Quadrilateral

A quadrilateral is a closed figure bounded by four line segments such that no two line segments cross each other.

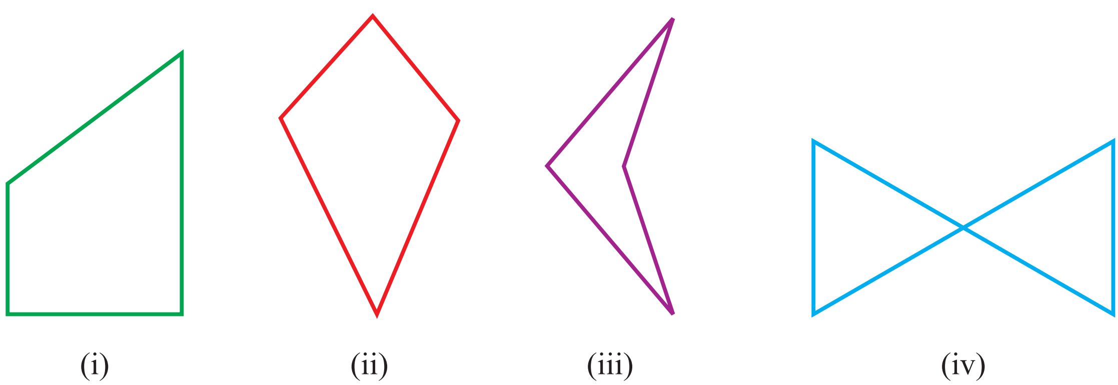


Fig. 2.20

In the above figure
fig (i), (ii), (iii) are quadrilaterals.
fig (iv) is not a quadrilateral.

Types of quadrilateral

The figure given below shows the different types of quadrilateral.

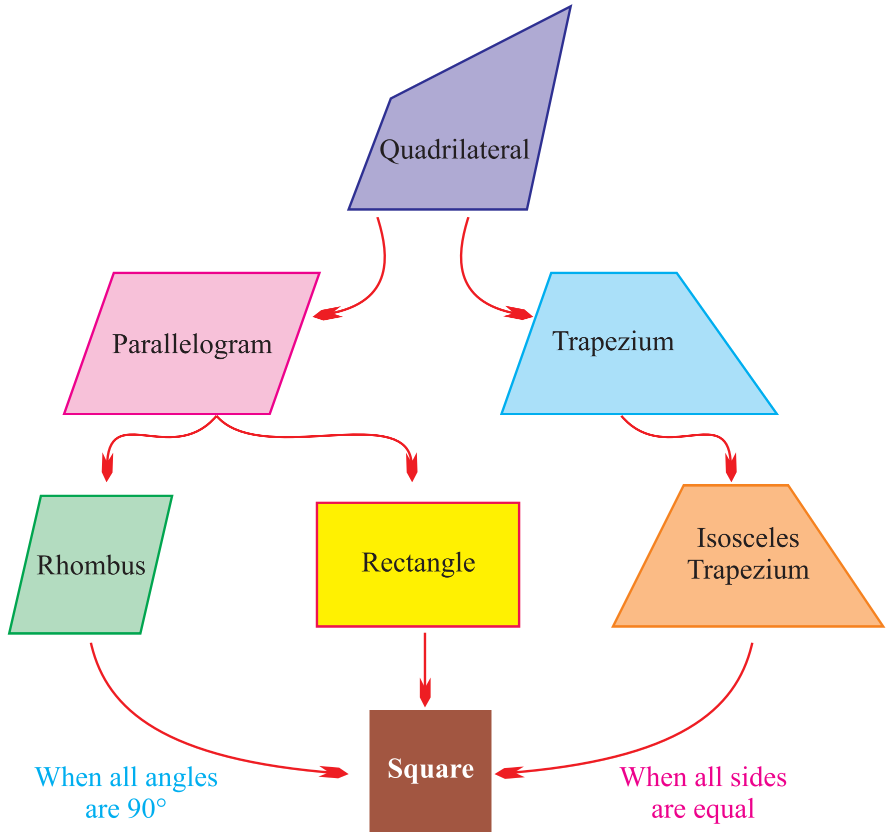


Fig. 2.21

Area of the quadrilateral

In a quadrilateral ABCD, draw the diagonal AC. It divides the quadrilateral into two triangles ABC and ADC. Draw altitudes BE and DF to the common base AC.

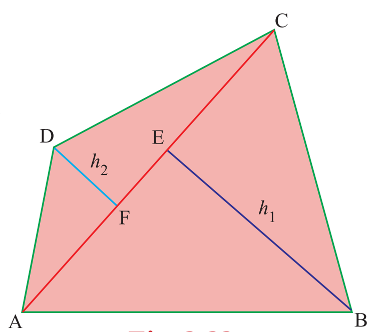


Fig. 2.22

Area of the quadrilateral ABCD

$$= \text{Area of } \triangle ABC + \text{Area of } \triangle ADC$$

$$= [\frac{1}{2} \times AC \times h_1] + [\frac{1}{2} \times AC \times h_2]$$

$$= \frac{1}{2} \times AC \times (h_1 + h_2)$$

$$= \frac{1}{2} \times d \times (h_1 + h_2) \text{ sq. units}$$

where d is the length of the diagonal AC and h_1 and h_2 are perpendiculars drawn to the diagonal from the opposite vertices.

$\therefore$ Area of the quadrilateral $= \frac{1}{2} \times d \times (h_1 + h_2)$ sq.units.

Example 2.12

Calculate the area of a quadrilateral PQRS shown in the figure

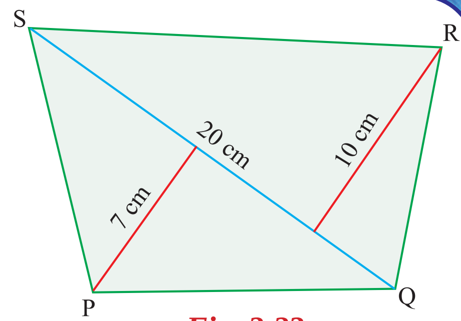


Fig. 2.23

Solution

Given: $d = 20\text{cm}$, $h_1 = 7\text{cm}$, $h_2 = 10\text{cm}$.

Area of a quadrilateral PQRS

$$= \frac{1}{2} \times d \times (h_1 + h_2)$$
$$= \frac{1}{2} \times 20 \times (7 + 10)$$
$$= 10 \times 17$$
$$= 170 \text{ cm}^2$$

$\therefore$ Area of the quadrilateral PQRS = 170 cm^2.

Example 2.13

A plot of land is in the form of a quadrilateral, where one of its diagonals is 200 m long. The two vertices on either side of this diagonals are 60 m and 50 m away from the diagonal. What is the area of the plot of land ?

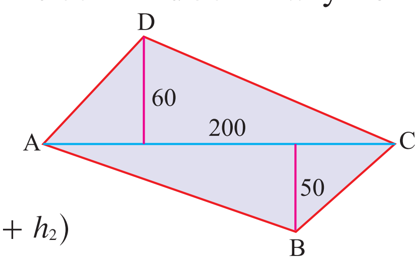


Fig. 2.24

Solution

Given: $d = 200$ m, $h_1 = 50$ m, $h_2 = 60$ m

$$\text{Area of the quadrilateral ABCD} = \frac{1}{2} \times d \times (h_1 + h_2)$$
$$= \frac{1}{2} \times 200 \times (50 + 60)$$
$$= 100 \times 110$$
$$\therefore \text{Area of the quadrilateral} = 11000 \text{ m}^2$$

Example 2.14

The area of a quadrilateral is 525 sq. m. The perpendiculars from two vertices to the diagonal are 15 m and 20 m. What is the length of this diagonal ?

Solution

Given: Area = 525 sq. m, $h_1 = 15$ m, $h_2 = 20$ m.

Now, we have

$$\text{Area of the quadrilateral} = 525 \text{ sq.m.}$$
$$\frac{1}{2} \times d \times (h_1 + h_2) = 525$$

$$\frac{1}{2} \times d \times (15 + 20) = 525$$

$$\frac{1}{2} \times d \times 35 = 525$$

$$d = \frac{525 \times 2}{35} = \frac{1050}{35} = 30 \text{ m}$$

$\therefore$ The length of the diagonal = 30 m.

Example 2.15

The area of a quadrilateral PQRS is 400 cm^2. Find the length of the perpendicular drawn from S to PR, if PR = 25 cm and the length of the perpendicular from Q to PR is 15 cm.

Solution

Given: $d = 25$ cm, $h_1 = 15$ cm, Area = 400 cm^2

Area of a quadrilateral PQRS= 400 cm^2

$$\frac{1}{2} \times d \times (SL + QM) = 400 \text{ where } SL = h_1,\ QM = h_2$$

(i.e.) $$\frac{1}{2} \times d \times (h_1 + h_2) = 400$$

$$\frac{1}{2} \times 25 \times (15 + h_2) = 400$$

$$15 + h_2 = \frac{400 \times 2}{25} = 16 \times 2 = 32$$

$$h_2 = 32 - 15 = 17$$

$\therefore$ The length of the perpendicular from S to PR is 17 cm.

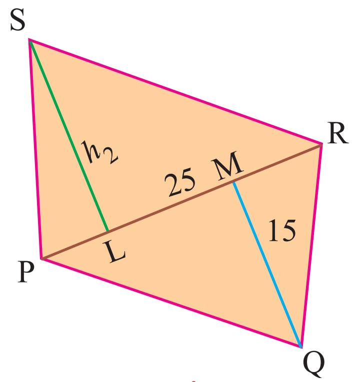
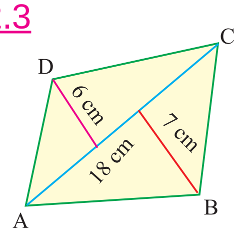


Fig. 2.25

Excercise 2.3

1. From the figure,
   find the area of the quadrilateral ABCD.



2. Find the area of the quadrilateral whose diagonal and heights are:
   (i) $d = 15$ cm, $h_1 = 5$ cm, $h_2 = 4$ cm
   (ii) $d = 10$ cm, $h_1 = 8.4$ cm, $h_2 = 6.2$ cm
   (iii) $d = 7.2$ cm, $h_1 = 6$ cm, $h_2 = 8$ cm
3. A diagonal of a quadrilateral is 25 cm, and perpendicular on it from the opposite vertices are 5 cm and 7 cm. Find the area of the quadrilateral.
4. The area of a quadrilateral is 54 cm^2. The perpendicualrs from two opposite vertices to the diagonal are 4 cm and 5 cm. What is the length of this diagonal?
5. A plot of land is in the form of a quadrilateral, where one of its diagonals is 250 m long. The two vertices on either side of the diagonal are 70 m and 80 m away. What is the area of the plot of the land?

2.5 Area of a Parallelogram

In our daily life, we have seen many plane figures other than square, rectangle and triangle. Do you know the other plane figures?

Parallelogram is one of the other plane figures.

In this section we will discuss about the parallelogram and further we are going to discuss the following:

How to find the area of a field which is in the shape of a parallelogram?

Can a parallelogram be converted to a rectangle of equal area ?

Can a parallelogram be converted into two triangles of equal area ?

Definition of Parallelogram

Take four broom sticks. Using cycle valve tube rubber, join them and form a rectangle (see Fig. 2.26 (i))

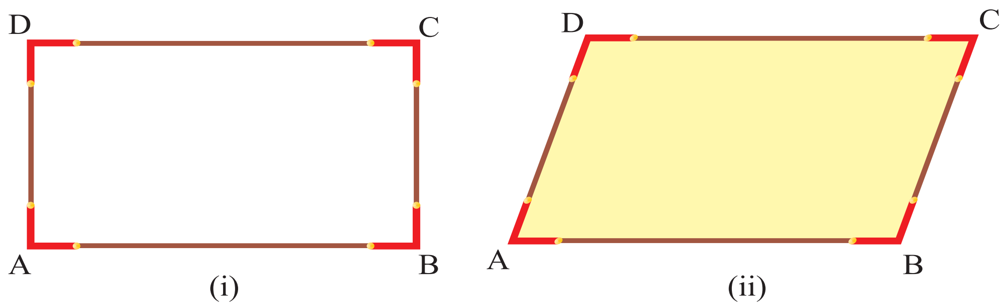


Fig. 2.26

Keeping the base AB fixed and slightly push the corner D to its right, you will get the shape as shown in Fig. 2.26 (ii).

Now answer the following:

Do the shape has parallel sides ? Which are the sides parallel to each other?

Here the sides AB and DC are parallel and AD and BC are parallel. We use the symbol '||' which denotes "is parallel to" i.e., AB || DC and AD || BC. (Read it as AB is parallel to DC and AD is parallel to BC).

In a quadrilateral, if both the pair of opposite sides are parallel then it is called a parallelogram. Fig.2.27.

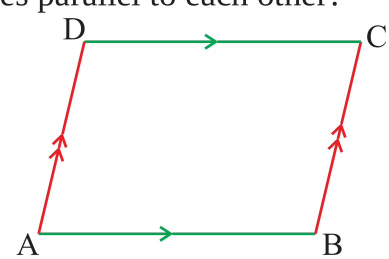


Fig. 2.27

Area of the parallelogram

Draw a parallelogram on a graph paper as shown in Fig. 2.28 (i)

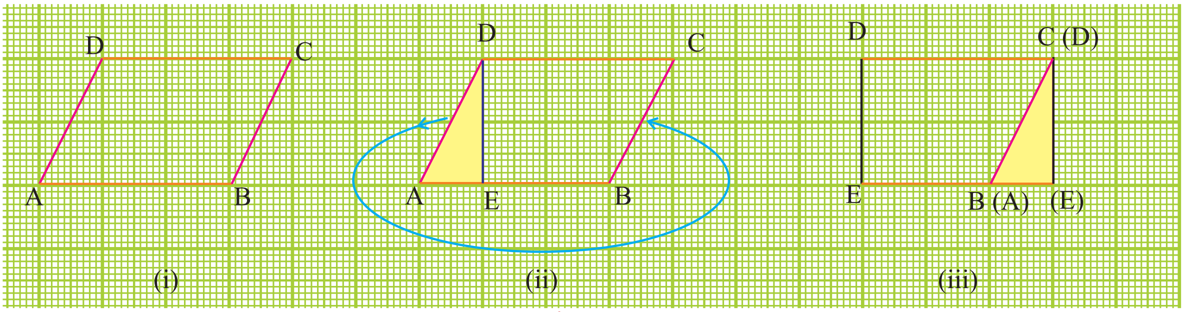


Fig. 2.28

Draw a perpendicular line from the vertex D to meet the base AB at E.

Now, cut the triangle AED and place the triangle AED as shown in fig.2.8(iii) with side AD coincide with side BC.

What shape do you get? Is it a rectangle?

Is the area of the parallelogram equal to the area of the rectangle formed?

Yes, Area of the parallelogram = Area of the rectangle formed

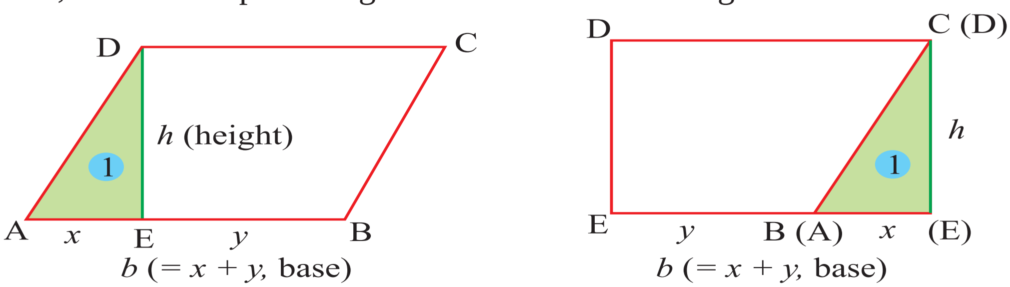


Fig. 2.29

We find that the length of rectangle formed is equal to the base of the parallelogram and breadth of rectangle is equal to the height of the parallelogram. (see Fig. 2.29)

∴ Area of parallelogram = Area of rectangle

= (length × breadth) sq. Units

= (base × height) sq. Units

Area of parallelogram = bh sq. Units

Where b is the base and h is the height of the parallelogram.

∴ area of the parallelogram is the product of the base (b) and its corresponding height (h).

Note: Any side of a parallelogram can be chosen as base of the parallelogram. The perpendicular dropped on that side from the opposite vertex is the corresponding height (altitude).

Do you know?

In a parallelogram

- the opposite sides are parallel.
- the opposite angles are equal.
- the opposite sides are equal.
- the diagonals are not equal.
- the diagonals bisect each other.

Example 2.16

Using the data given in the figure,

(i) find the area of the parallelogram with base AB.

(ii) find the area of the parallelogram with base AD.

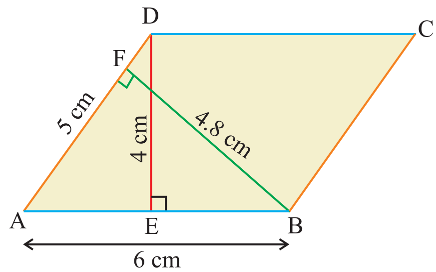


Fig. 2.30

Solution

The area of the parallelogram = base × height

(i) Area of parallelogram with base AB = base AB × height DE

$= 6 \text{ cm} \times 4 \text{ cm}$

$= 24 \text{ cm}^2$

(ii) Area of parallelogram with base AD = base AD × height FB

$= 5 \text{ cm} \times 4.8 \text{ cm}$

$= 24 \text{ cm}^2$

Note: Here, area of parallelogram with base AB is equal to the area of parallelogram with base AD.

∴ we conclude that the area of a parallelogram can be found choosing any of the side as its base with its corresponding height.

Try these

Find the relationship between the area of the parallelogram and the triangles using Fig. 2.31.

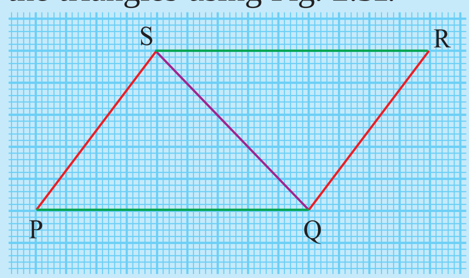


Fig. 2.31

Example 2.17

Find the area of a parallelogram whose base is 9 cm and the altitude (height) is 5 cm.

Solution

Given: $b = 9$ cm, $h = 5$ cm

Area of the parallelogram $= b \times h$

$= 9 \text{ cm} \times 5 \text{ cm}$

∴ Area of the parallelogram $= 45 \text{ cm}^2$

Example 2.18

Find the height of a parallelogram whose area is 480 cm^2 and base is 24 cm.

Solution

Given: Area = 480 cm^2, base b = 24 cm

$$\text{Area of the parallelogram} = 480$$
$$b \times h = 480$$
$$24 \times h = 480$$
$$h = \frac{480}{24} = 20 \text{ cm}$$

$\therefore$ height of a parallelogram = 20 cm.

Example 2.19

The area of the parallelogram is 56 cm^2. Find the base if its height is 7 cm.

Solution

Given: Area = 56 cm^2, height h = 7 cm

$$\text{Area of the parallelogram} = 56$$
$$b \times h = 56$$
$$b \times 7 = 56$$
$$b = \frac{56}{7} = 8 \text{ cm.}$$

$\therefore$ base of a parallelogram = 8 cm.

Example 2.20

Two sides of the parallelogram PQRS are 9 cm and 5 cm. The height corresponding to the base PQ is 4 cm (see figure). Find

(i) area of the parallelogram

(ii) the height corresponding to the base PS

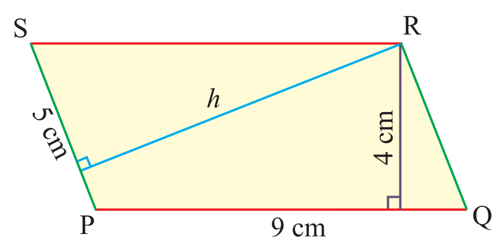


Fig. 2.32

Solution

(i) Area of the parallelogram $= b \times h$

$= 9 \text{ cm} \times 4 \text{ cm}$

$= 36 \text{ cm}^2$

(ii) If the base PS (b) = 5 cm, then

$$\text{Area} = 36$$
$$b \times h = 36$$
$$5 \times h = 36$$
$$h = \frac{36}{5} = 7.2 \text{ cm.}$$

$\therefore$ height corresponding to the base PS is 7.2 cm.

Think and Discuss:

- Draw different parallelograms with equal perimeters.
- Can you say that they have same area?

Excercise 2.4

1. Choose the correct answer.

i) The height of a parallelogram whose area is 300 cm^2 and base 15 cm is

(A) 10 cm (B) 15 cm (C) 20 cm (D) 30 cm

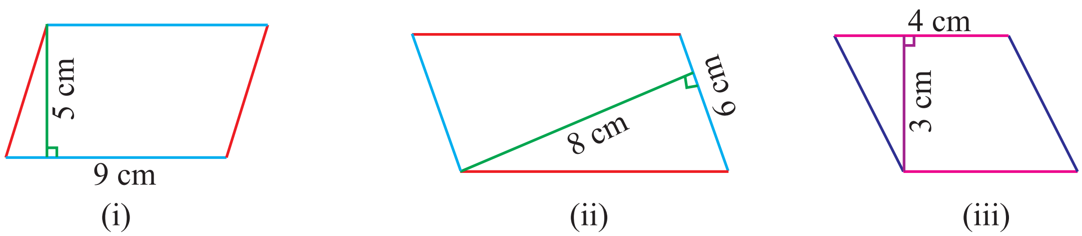
ii) The base of a parallelogram whose area is 800 cm^2 and the height 20 cm is

(A) 20 cm (B) 30 cm (C) 40 cm (D) 50 cm

iii) The area of a parallelogram whose base is 20 cm and height is 30 cm is

(A) 300 cm^2 (B) 400 cm^2 (C) 500 cm^2 (D) 600 cm^2

2. Find the area of each of the following parallelograms:



3. Find the area of the parallelogram whose base and height are :
   (i) b = 14 cm, h = 18 cm
   (ii) b = 15 cm, h = 12 cm
   (iii) b = 23 cm, h = 10.5 cm
   (iv) b = 8.3 cm, h = 7 cm
4. One of the sides and the corresponding height of a parallelogram are 14 cm and 8 cm respectively. Find the area of the parallelogram.
5. A ground is in the form of a parallelogram. Its base is 324 m and its height is 75 m. Find the area of the ground.
6. Find the height of the parallelogram which has an area of 324 sq. cm. and a base of 27 cm.

2.6 Rhombus

In a parallelogram if all the sides are equal then it is called rhombus.

Let the base of the rhombus be b units and its corresponding height be h units.

Since a rhombus is also a parallelogram we can use the same formula to find the area of the rhombus.

$\therefore$ The area of the rhombus = $b \times h$ sq. units.

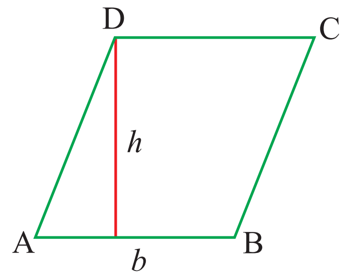


Fig. 2.33

Do you know?

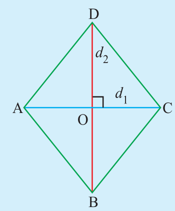
In a rhombus,

(i) all the sides are equal

(ii) opposite sides are parallel

(iii) diagonal divides the rhombus into two triangles of equal area.

(iv) the diagonal bisect each other at right angles.



Area of the rhombus in terms of its diagonals

In a rhombus ABCD , AB $\parallel$ DC and BC $\parallel$ AD

Also, AB = BC = CD = DA

Let the diagonals be d_1 (AC) and d_2 (BD)

Since, the diagonals bisect each other at right angles

AC $\perp$ BD and BD $\perp$ AC

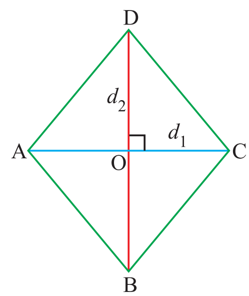


Fig. 2.34

Area of the rhombus ABCD

$$= \text{Area of } \Delta \text{ ABC} + \text{Area of } \Delta \text{ADC}$$

$$= \left[\frac{1}{2} \times AC \times OB\right] + \left[\frac{1}{2} \times AC \times OD\right]$$

$$= \frac{1}{2} \times AC \times (OB + OD)$$

$$= \frac{1}{2} \times AC \times BD$$

$$= \frac{1}{2} \times d_1 \times d_2 \text{ sq. units}$$

$\therefore$ Area of the rhombus $= \frac{1}{2}[d_1 \times d_2]$ sq. units

$= \frac{1}{2} \times$ (product of diagonals) sq. units

Think and Discuss

Square is a rhombus but a rhombus is not a square.

Example 2.21

Find the area of a rhombus whose side is 15 cm and the altitude (height) is 10cm.

Solution

Given: base = 15 cm, height = 10 cm

$$\text{Area of the rhombus} = \text{base} \times \text{height}$$
$$= 15 \text{ cm} \times 10 \text{ cm}$$
$$\therefore \text{Area of the rhombus} = 150 \text{ cm}^2$$

Example 2.22

A flower garden is in the shape of a rhombus. The length of its diagonals are 18 m and 25 m. Find the area of the flower garden.

Solution

Given: $d_1 = 18$ m, $d_2 = 25$ m

$$\text{Area of the rhombus} = \frac{1}{2} \times d_1 \times d_2$$
$$= \frac{1}{2} \times 18 \times 25$$
$$\therefore \text{Area of the flower garden} = 225 \text{ m}^2$$

Example 2.23

Area of a rhombus is 150 sq. cm. One of its diagonal is 20 cm. Find the length of the other diagonal.

Solution

Given: Area = 150 sq. cm, diagonal $d_1 = 20$ cm

$$\text{Area of the rhombus} = 150$$
$$\frac{1}{2} \times d_1 \times d_2 = 150$$
$$\frac{1}{2} \times 20 \times d_2 = 150$$
$$10 \times d_2 = 150$$
$$d_2 = 15 \text{ cm}$$

$\therefore$ The length of the other diagonal = 15 cm.

Example 2.24

A field is in the form of a rhombus. The diagonals of the fields are 50 m and 60 m. Find the cost of levelling it at the rate of ₹2 per sq. m.

Solution

Given: $d_1 = 50$ m, $d_2 = 60$ m

$$\text{Area} = \frac{1}{2} \times d_1 \times d_2$$

$$= \frac{1}{2} \times 50 \times 60 \text{ sq. m}$$

$$= 1500 \text{ sq. m}$$

Cost of levelling 1 sq. m = ₹2

$\therefore$ cost of levelling 1500 sq. m = ₹2 × 1500

= ₹3000

Try these

Take a rectangular sheet. Mark the midpoints of the sides and join them as shown in the Fig. 2.35.

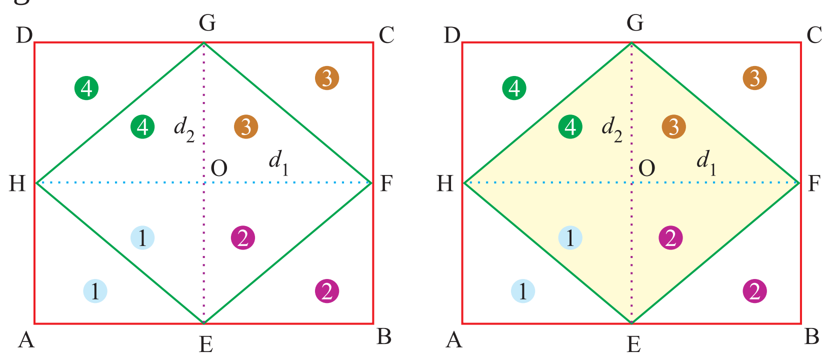


Fig. 2.35

The shaded figure EFGH is a rhombus. Cut the light shaded triangles and join them to form a rhombus. The new rhombus is identical to the original rhombus EFGH see Fig.2.36.

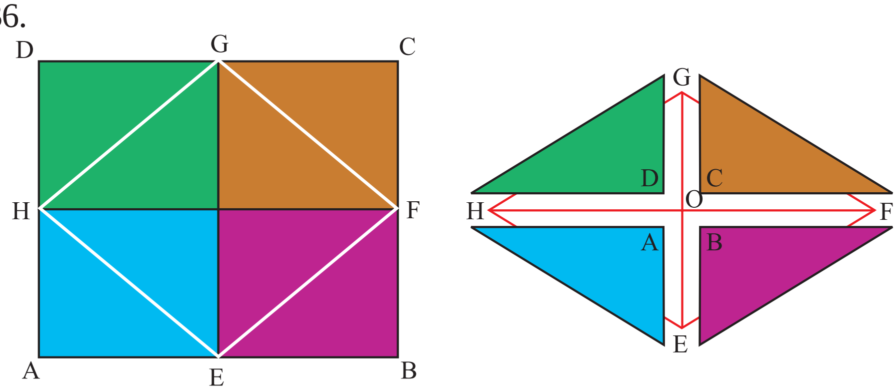


Fig. 2.36

$\therefore$ The area of rectangle = Twice the area of rhombus

$$\text{Area of a rhombus} = \frac{1}{2}\text{ [area of rectangle]}$$

$$= \frac{1}{2}[AB \times BC]$$

$$= \frac{1}{2}[HF \times EG] \text{ [see Fig. 4.35]}$$

$$\text{Area of a rhombus} = \frac{1}{2}(d_1 \times d_2) \text{ sq. units.}$$

Exercise 2.5

1. Choose the correct answer.

i) The area of a rhombus

(A) $d_1 \times d_2$ (B) $\frac{3}{4}(d_1 \times d_2)$ (C) $\frac{1}{2}(d_1 \times d_2)$ (D) $\frac{1}{4}(d_1 \times d_2)$

ii) The diagonals of a rhombus bisect each other at

(A) 30° (B) 45° (C) 60° (D) 90°

iii) The area of a rhombus whose diagonals are 10 cm and 12 cm is

(A) 30 cm^2 (B) 60 cm^2 (C) 120 cm^2 (D) 240 cm^2

2. Find the area of a rhombus whose diagonals are

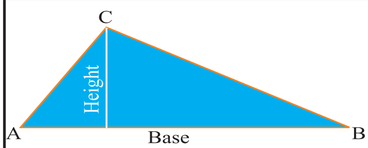
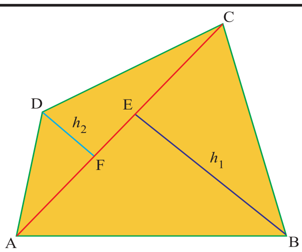
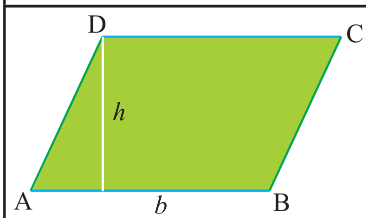
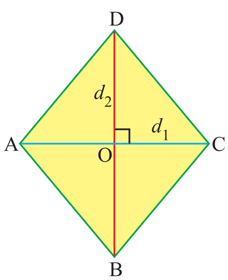
i) 15 cm, 12 cm ii) 13 cm, 18.2 cm
iii) 74 cm, 14.5 cm iv) 20 cm, 12 cm

3. One side of a rhombus is 8 cm and the altitude (height) is 12 cm. Find the area of the rhombus.

4. Area of a rhombus is 4000 sq. m. The length of one diagonal is100 m. Find the other diagonal.

5. A field is in the form of a rhombus. The diagonals of the field are 70 m and 80 m. Find the cost of levelling it at the rate of ₹3 per sq. m.

Points to Remember

Figure	Area	Formula
 Triangle	$\frac{1}{2} \times$ base $\times$ height	$\frac{1}{2} \times b \times h$ sq. units.
 Quadrilateral	$\frac{1}{2} \times$ diagonal $\times$ (sum of the perpendicular distances drawn to the diagonal from the opposite vertices)	$\frac{1}{2} \times d \times (h_1 + h_2)$ sq. units
 Parallelogram	base $\times$ corresponding altitude	bh sq. units
 Rhombus	$\frac{1}{2} \times$ product of diagonals	$\frac{1}{2} \times d_1 \times d_2$ sq. units

3 GEOMETRY

3.1 Parallel Lines

Look at the table.

The top of the table ABCD is a flat surface. Are you able to see some points and line segment on the top? Yes.

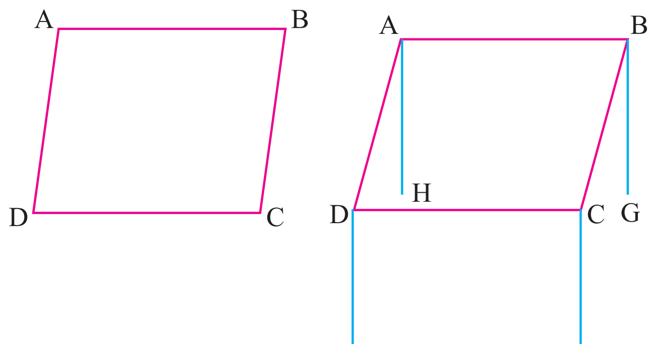
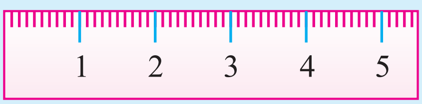


Fig. 3.1

The line segment AB and BC intersects at B. which line segment intersects at A, C and D? Do the line segment AD and CD intersect? Do the line segment AD and BC intersect?

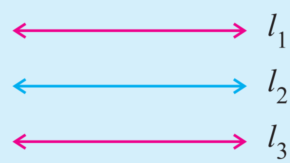
The line segment AB and CD will not meet however they are extended such lines are called parallel lines. AD and BC form one such pair. AB and CD form another pair.

Do you know? The following are the examples of parallel lines



The opposite edges of ruler

The cross bars of this window



l_1, l_2 are parallel to l_3

If the two lines AB and CD are parallel. We write AB || CD.

Two straight lines are said to be parallel to each other if they do not intersect at any point.

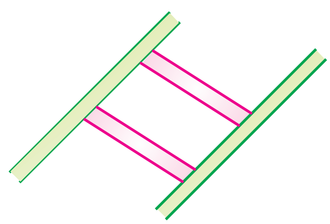


Fig. 3.2

In the given figure, the perpendicular distance between the two parallel lines is the same everywhere.

3.2 Transversal

A straight line intersects two or more given lines at distinct points is called a transversal to the given lines. The given lines may or may not be parallel.

Names of angles formed by a transversal.

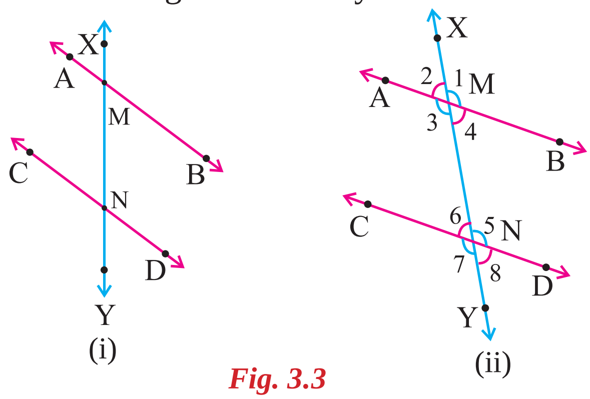
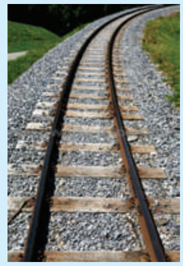


Fig. 3.3

Do you know?



The above figure give an idea of a transversal. You have seen a railway line crossing several lines.

In Fig. 3.3 (i), a pair of lines AB and CD, are cut by a transversal XY, intersecting the two lines at points M and N respectively. The points M and N are called points of intersection.

Fig. 3.3 (ii) when a transversal intersects two lines the eight angles marked 1 to 8 have their special names. Let us see what those angles are

1. Interior angles

All the angles which have the line segment MN as one ray in Fig. 3.3 (ii) are known as interior angles as they lie between the two lines AB and CD. In Fig. 3.3 (ii), $\angle$ 3, $\angle$ 4, $\angle$ 5, $\angle$ 6 are interior angles.

2. Interior alternate angles

When a transversal intersects two lines four interior angles are formed. Of the interior angles, the angles that are on opposite sides of the transversal and lie in separate linear pairs are known as interior alternate angles. $\angle 3$ and $\angle 5$, $\angle 4$ and $\angle 6$ are interior alternate angles in Fig. 3.3 (ii).

3. Exterior angles

All the angles which do not have the line segment MN as one ray, are known as exterior angles. $\angle 1$, $\angle 2$, $\angle 7$, $\angle 8$ are exterior angles in Fig. 3.3 (ii).

4. Exterior alternate angles

When a transversal intersects two lines four exterior angles are formed. Of the exterior angles, the angles that are on opposite sides of the transversal and lie in separate linear pairs are known as exterior alternate angles.

In Fig. 3.3 (ii), $\angle 1$ and $\angle 7$, $\angle 2$ and $\angle 8$ are exterior alternate angles.

5. Corresponding angles

The pair of angles on one side of the transversal, one of which is an exterior angle while the other is an interior angle but together do not form a linear pair, are known as corresponding angles.

The pairs of corresponding angles in Fig. 3.3 (ii) are $\angle 1$ and $\angle 5$, $\angle 2$ and $\angle 6$, $\angle 3$ and $\angle 7$, $\angle 4$ and $\angle 8$.

Notice that although both $\angle 6$ and $\angle 7$ lie on the same side of the transversal and $\angle 6$ is an interior angle while $\angle 7$ is an exterior angle but $\angle 6$ and $\angle 7$ are not corresponding angles as together they form a linear pair. Now we tabulate the angles.

a	Interior angles	$\angle 3, \angle 4, \angle 5, \angle 6$
b	Exterior angles	$\angle 1, \angle 2, \angle 7, \angle 8$
c	Pairs of corresponding angles	$\angle 1$ and $\angle 5$; $\angle 2$ and $\angle 6$ $\angle 3$ and $\angle 7$; $\angle 4$ and $\angle 8$
d	Pairs of alternate interior angles	$\angle 3$ and $\angle 5$; $\angle 4$ and $\angle 6$
e	Pairs of alternate exterior angles	$\angle 1$ and $\angle 7$; $\angle 2$ and $\angle 8$
f	Pairs of interior angles on the same side of the transversal.	$\angle 3$ and $\angle 6$; $\angle 4$ and $\angle 5$

Try these

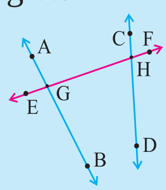
Name the following angles:

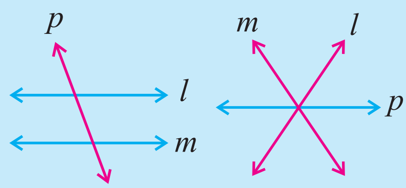
a) Any two interior angles ____ and _____

b) Any two exterior angles ____ and _____

c) A pair of interior angles _____and _____

d) A pair of corresponding angles _____and _____.





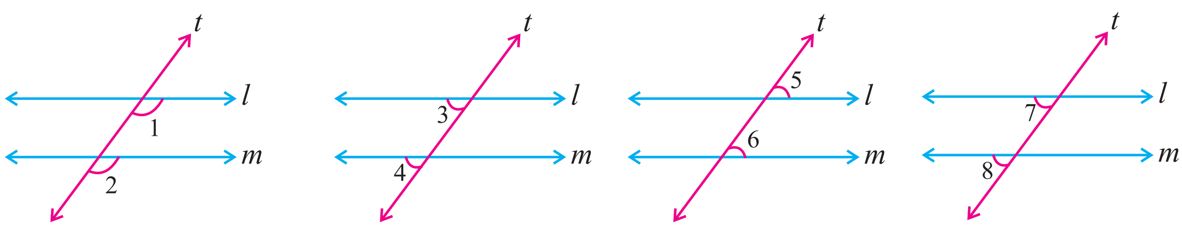
(i) (ii)

In Fig. (i) p is a transversal to the lines l and m. In Fig. (ii) the line p is not a transversal, although it cuts two lines l and 'm' can you say why?

Properties of parallel lines cut by a transversal

Activity 1:

Take a sheet of white paper. Draw (in thick colour) two parallel lines 'l' and 'm'. Draw a transversal 't' to the lines 'l' and 'm' . Label $\angle 1$ and $\angle 2$ as shown in Fig 3.4.



(i) (ii) (iii) (iv)

Fig. 3.4

Place a trace paper over the figure drawn. Trace the lines '*l*', '*m*' and '*t*'. Slide the trace paper along '*t*' until '*l*' coincides with '*m*'.

You find that $\angle 1$ on the traced figure coincides with $\angle 2$ of the original figure. In fact, you can see all the following results by similar tracing and sliding activity.

(i) $\angle 1 = \angle 2$ (ii) $\angle 3 = \angle 4$ (iii) $\angle 5 = \angle 6$ (iv) $\angle 7 = \angle 8$

From this you observe that.

When two parallel lines are cut by a transversal,

(a) each pair of corresponding angles are equal

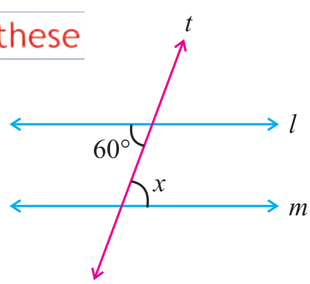
(b) each pair of alternate angles are equal

(c) each pair of interior angles on the same side of the transversal are supplementary (i.e 180^0)

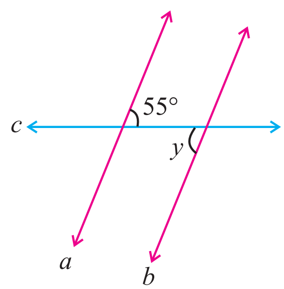
Try these

Draw parallel lines cut by a transversal. Verify the above three statements by actually measuring the angles.

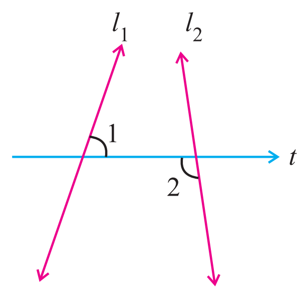
Try these



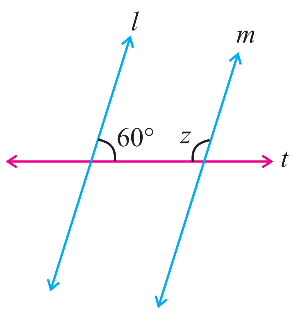
Lines $l \parallel m$, t is a transversal, $\angle x$ = ?



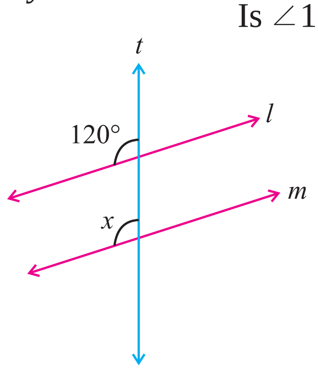
Lines $a \parallel b$, c is a transversal, $\angle y$ = ?



l_1, l_2 be two lines and t is a transversal. Is $\angle 1 = \angle 2$?



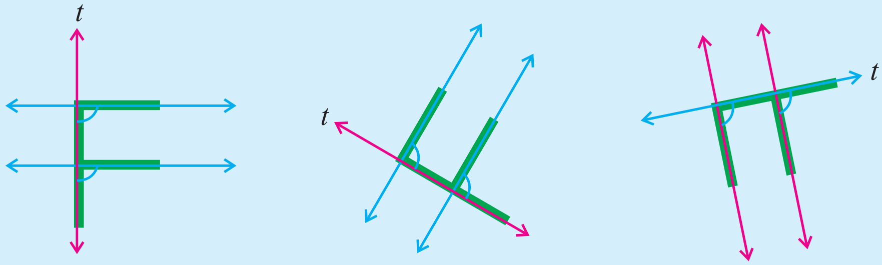
Lines $l \parallel m$, t is a transversal, $\angle z$ = ?



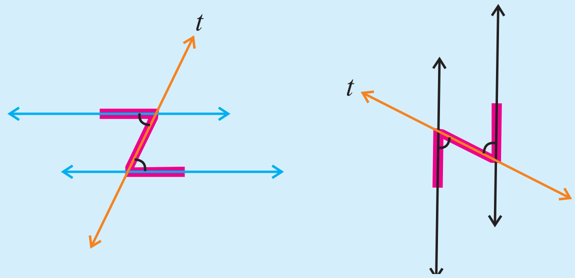
Lines $l \parallel m$, t is a transversal, $\angle x$ = ?

Do you know?

The F - shape stands for corresponding angles.



The Z - shape stands for alternate angles.

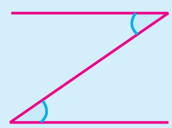


Try these

Fold a sheet of paper so as to get a pair of parallel lines. Again fold the paper across so that a transversal is obtained. Press the edges of folded paper and open it. You will see a pair of parallel lines with the transversal. Measure the angles and verify the properties of parallel lines when cut by a transversal.

Do you know?

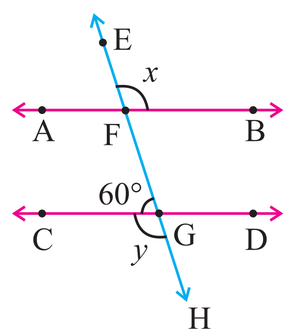
Checking for Parallel Lines: Look at the letter z.



The horizontal segments are parallel, because the alternate angles are equal.

Example 3.1

In the figure, find $\angle CGH$ and $\angle BFE$.



Solution

In the figure, AB || CD and EH is a transversal.

$\angle FGC = 60°$ (given)

$y = \angle CGH = 180° - \angle FGC$ ($\angle CGH$ and $\angle FGC$ are adjacent angles on a line)

$$= 180° – 60°$$
$$= 120°$$
$\angle FGC = \angle EFA = 60°$ (Corresponding angles)

$\angle EFA + \angle BFE = 180°$ (Sum of the adjacent angles on a line is 180°)

$60° + x = 180°$

$x = 180° – 60°$

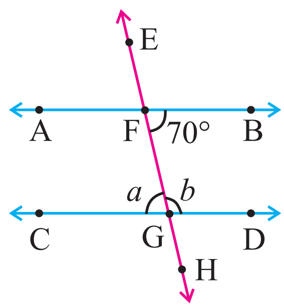
$= 120°$

$\therefore\ x = \angle BFE = 120°$

$y = \angle CGH = 120°$

Example 3.2

In the given figure, find $\angle CGF$ and $\angle DGF$.



Solution

In the figure AB || CD and EH is a transversal.

$\angle GFB = 70°$ (given)

$\angle FGC = a = 70°$ (Alternate interior angles $\angle GFB$ and $\angle CGF$ are equal)

$\angle CGF + \angle DGF = 180°$ (Sum of the adjacent angle on a line is 180°)

$a + b = 180°$

$70 + b = 180°$

$b = 180° – 70°$

$= 110°$

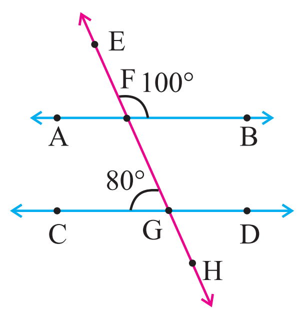
$\angle CGF = a = 70°$

$\angle DGF = b = 110°$

Example 3.3

In the given figure, $\angle BFE = 100°$ and $\angle CGF = 80°$.

Find i) $\angle EFA$, ii) $\angle DGF$, iii) $\angle GFB$, iv) $\angle AFG$, v) $\angle HGD$.



Solution

$\angle BFE = 100°$ and $\angle CGF = 80°$ (given)

i) $\angle EFA = \angle CGF = 80°$ (Corresponding angles)

ii) $\angle DGF = \angle BFE = 100°$ (Corresponding angles)

iii) $\angle GFB = \angle CGF = 80°$ (Alternate interior angles)

iv) $\angle AFG = \angle BFE = 100°$ (Vertically opposite angles)

v) $\angle HGD = \angle CGF = 80°$ (Vertically opposite angles)

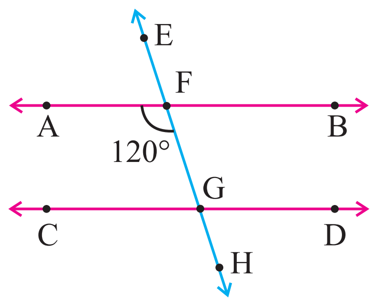
Example 3.4

In the figure, AB || CD, $\angle AFG = 120°$ Find

(i) $\angle DGF$

(ii) $\angle GFB$

(iii) $\angle CGF$



Solution

In the figure, AB || CD and EH is a transversal

(i) $\angle AFG = 120°$ (Given)

$\angle DGF = \angle AFG = 120°$ (Alternate interior angles)

$\therefore \angle DGF = 120°$

(ii) $\angle AFG + \angle GFB = 180°$ (Sum of the adjacent angle on a line is 180°)

$120° + \angle GFB = 180°$

$\angle GFB = 180° - 120°$

$= 60°$

(iii) $\angle AFG + \angle CGF = 180°$

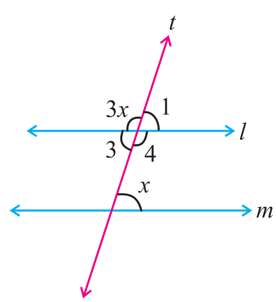
$120° + \angle CGF = 180°$ (Sum of the adjacent angles on a line is 180°)

$\angle CGF = 180° - 120°$

$= 60°$

Example 3.5

Find the measure of x in the figure, given $l \parallel m$.



Solution

In the figure, $l \parallel m$

$$\angle 3 = x \quad \text{(Alternate interior angles are equal)}$$

$$3x + x = 180° \quad \text{(Sum of the adjacent angles on a line is 180°)}$$

$$4x = 180°$$

$$x = \frac{180^0}{4}$$

$$= 45°$$

Exercise 3.1

1. Choose the correct answer

i) If a transversal intersect two lines, the number of angles formed are

(A) 4 (B) 6 (C) 8 (D) 12

ii) If a transversal intersect any two lines the two lines

(A) are parallel (B) are not parallel
(C) may or may not be parallel (D) are perpendicular

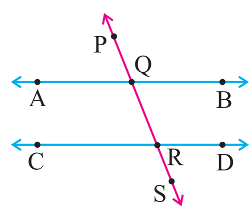
iii) When two parallel lines are cut by a transversal, the sum of the interior angles on the same side of the transversal is

(A) 90° (B) 180° (C) 270° (D) 360°

iv) In the given figure

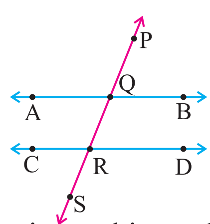
$\angle$BQR and $\angle$QRC are a pair of

(A) vertically apposite angles
(B) exterior angles
(C) alternate interior angles
(D) corresponding angles



v) In the given figure $\angle$SRD = 110° then the value of $\angle$BQP will be

(A) 110° (B) 100°
(C) 80° (D) 70°

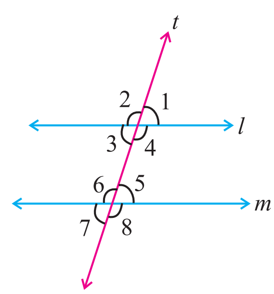


2. In the given figure, state the property that is used in each of the following statement.

(i) If $l \parallel m$ then $\angle 1 = \angle 5$.

(ii) If $\angle 4 = \angle 6$ then $l \parallel m$.

(iii) If $\angle 4 + \angle 5 = 180°$ then $l \parallel m$.



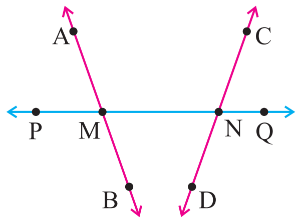
3. Name the required angles in the figure.

   (i) The angle vertically opposite to ∠AMN

   (ii) The angle alternate to ∠CNQ

   (iii) The angle corresponding to ∠ BMP

   (iv) The angle corresponding to ∠ BMN



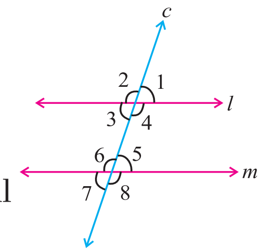
4. In the given figure identify

   (i) Pairs of corresponding angles

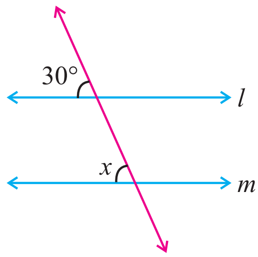
   (ii) Pairs of alternate interior angles.

   (iii) Pairs of interior angles on the same side of the transversal

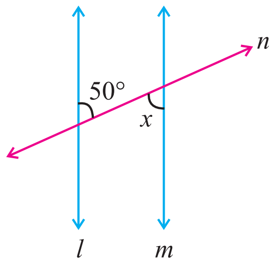
   (iv) Vertically opposite angles.



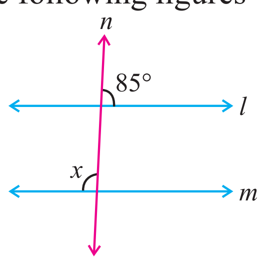
5. Given $l \parallel m$, find the measure of x in the following figures



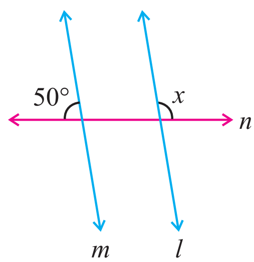
(i)



(ii)

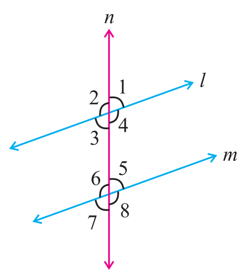


(iii)

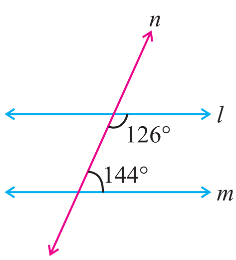


(iv)

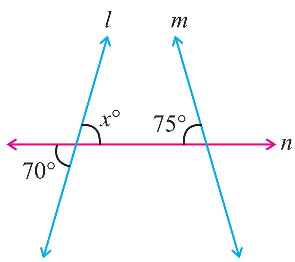
6. Given $l \parallel m$ and $\angle 1 = 70°$, find the measure of $\angle 2$, $\angle 3$, $\angle 4$, $\angle 5$, $\angle 6$, $\angle 7$ and $\angle 8$.



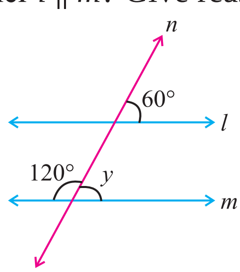
7. In the given figures below, decide whether $l \parallel m$? Give reasons.



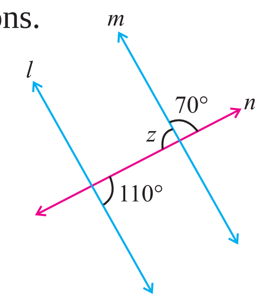
(i)



(ii)

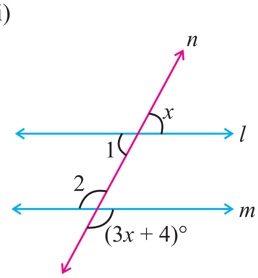


(iii)



(iv)

8. Given $l \parallel m$, find the measure of $\angle 1$ and $\angle 2$ in the figure shown.



Points to Remember

1. Two straight lines are said to be parallel to each other if they do not intersect at any point.
2. A straight line intersects two or more lines at distinct points is called a transversal to the given line.
3. When two parallel lines are cut by a transversal,

   (a) each pair of corresponding angles are equal.

   (b) each pair of alternate angles are equal.

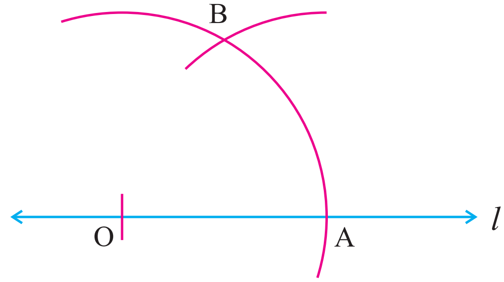
   (c) each pair of interior angles on the same side of the transversal are supplementary.

4 PRACTICAL GEOMETRY

4.1 To construct angles 60°, 30°, 120°, 90° using scale and compass.

(i) Construction of 60° angle

Step 1 : Draw a line 'l' and mark a point 'O' on it.

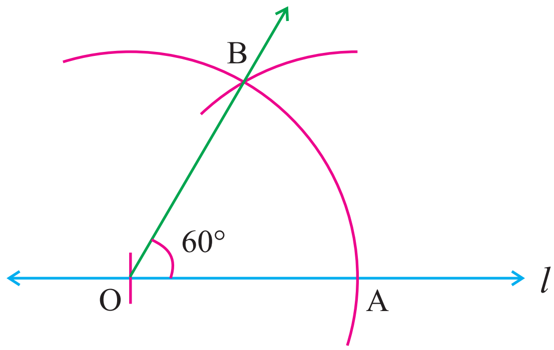


Step 2 : With 'O' as centre draw an arc of any radius to cut the line at A.

Step 3 : With the same radius and A as centre draw an arc to cut the previous arc at B.

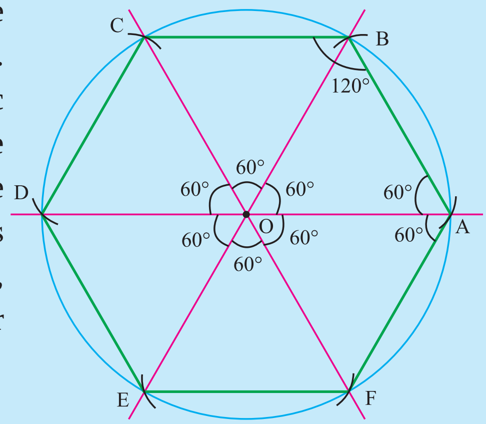
Step 4 : Join OB.

$\angle AOB = 60°$.



Try these

Draw a circle of any radius with centre 'O'. Take any point 'A' on the circumference. With 'A' as centre and OA as radius draw an arc to cut the circle at 'B'. Again with 'B' as centre draw the arc of same radius to cut the circle at 'C'. Proceed so on. The final arc will pass through the point 'A'. Join all such points A, B, C, D, E and F in order. ABCDEF is a regular Hexagon.



From the above figure we came to know

(i) The circumference of the circle is divided into six equal arc length subtending 60° each at the centre. In any circle a chord of length equal to its radius subtends 60° angle at the centre.

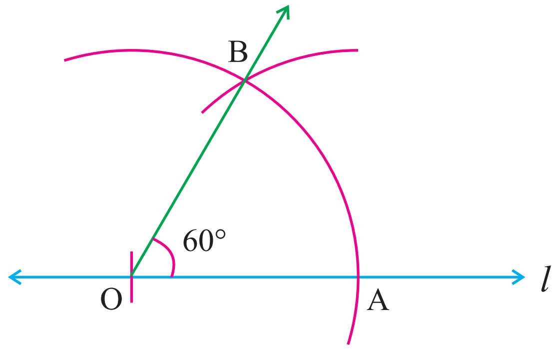
(ii) Total angle measuring around a point is 360°.

(iii) It consists of six equilateral triangles.

(ii) Construction of 30° angle

First you construct 60° angle and then bisect it to get 30° angle.

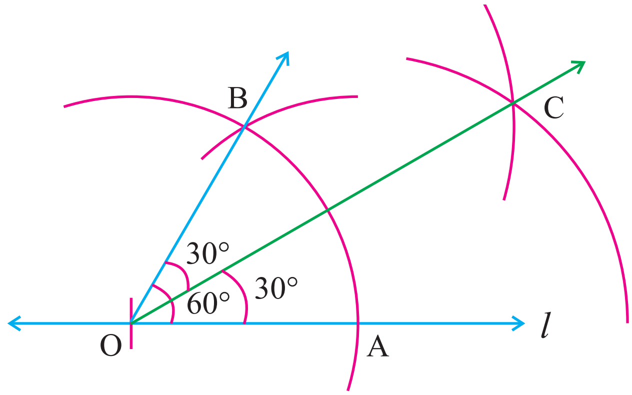
Step 1 : Construct 60° (as shown in the above construction (i))

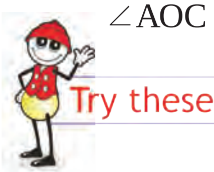


Step 2 : With 'A' as centre, draw an arc of radius more than half of AB in the interior of ∠AOB.

Step 3 : With the same radius and with B as centre draw an arc to cut the previous one at C. Join OC.

∠AOC is 30°.



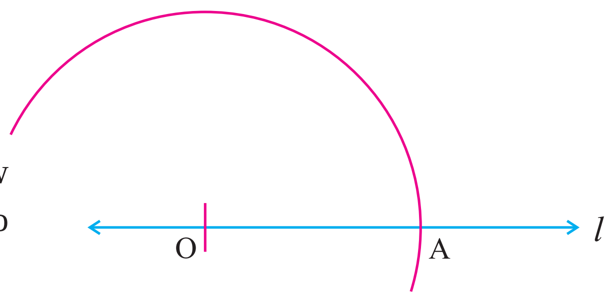


How will you construct 15° angle.

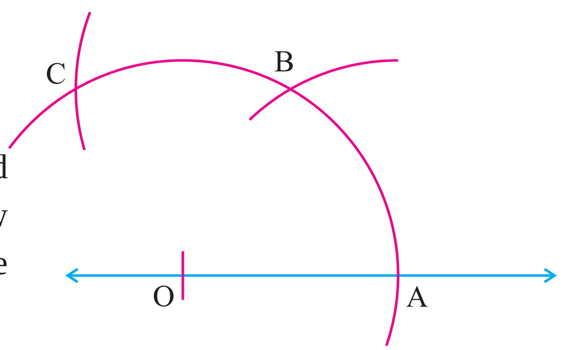
(iii) Construction of 120° angle

Step 1 : Mark a point 'O' on a line '*l*'.

Step 2 : With 'O' as centre draw an arc of any radius to cut the line *l* at A.



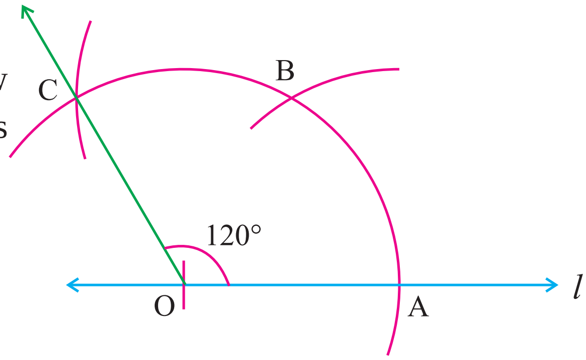
Step 3 : With same radius and with 'A' as centre draw another arc to cut the previous arc at 'B'.



Step 4 : With 'B' as centre draw another arc of same radius to cut the first arc at 'C'.

Step 5 : Join OC.

$\angle$AOC is 120°.

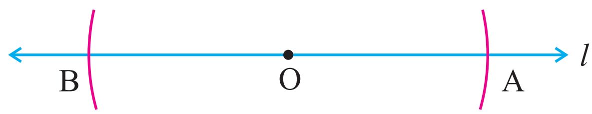


(iv) Construction of 90° angle

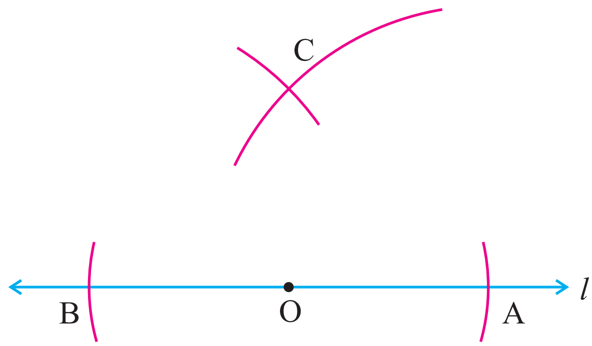
To construct 90° angle, we are going to bisect the straight angle 180°.

Step 1 : Mark a point 'O' on a straight line '*l*'.

Step 2 : With 'O' as centre draw arcs of any radius to cut the line *l* at A and B. Now $\angle$AOB = 180°.

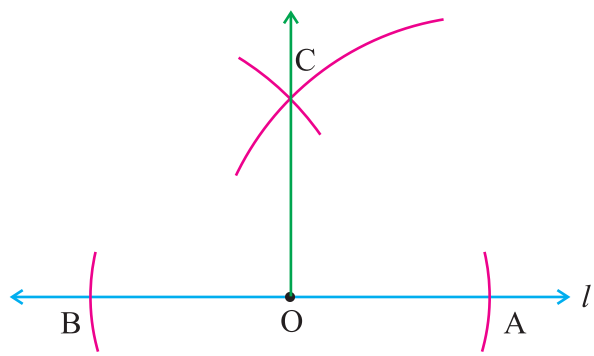


Step 3 : With A and B as centres and with the radius more than half of AB draw arcs above AB to instersect each other at 'C'.



Step 4 : Join OC.

$\angle$AOC = 90°.



Try these

1. Construct an angle of measure 60° and find the angle bisector of its complementary angle.
2. Trisect the right angle.
3. Construct the angles of following measures: 22½°, 75°, 105°, 135°, 150°

Do you know?

To construct a perpendicular for a given line at any point on it, you can adopt this method for the set-square method, as an alternate.

Exercise 4.1

1. Construct the angles of following measures with ruler and compass.

   (i) 60° (ii) 30° (iii) 120° (iv) 90°

ANSWERS

Unit 1

Exercise 1.1

1. (i) C (ii) A (iii) B (iv) A (v) D
2. 100 kg
3. 120 teachers
4. 80 km
5. 216 sq.m.
6. 26 kg
7. 7½ hours
8. 15 days
9. 156 soldiers
10. 105 pages
11. 40 days

Unit - 2

Exercise 2.1

1. (i) 175 cm^2 (ii) 365 cm^2 (iii) 750 cm^2 (iv) 106 cm^2
2. 40 tiles
3. triangular land
4. Mani benefited more.
5. Square has larger area.

Exercise 2.2

1. (i) 9 cm^2 (ii) 26 cm^2 (iii) 150 cm^2 (iv) 30 cm^2
2. (i) 24 cm^2 (ii) 3 m^2 (iii) 10.5 m^2
3. (i) 10 m (ii) 20 cm (iii) 16.5 m
4. (i) 18 m (ii) 5 m (iii) 8 cm
5. Cost ₹ 1,820

Exercise 2.3

1. 117 cm^2
2. (i) 67.5 cm^2 (ii) 73 cm^2 (iii) 50.4 cm^2
3. 150 cm^2 4. 12 cm 5. 18750 cm^2

Exercise 2.4

1. (i) C (ii) C (iii) D
2. (i) 45 cm^2 (ii) 48 cm^2 (iii) 12 cm^2
3. (i) 252 cm^2 (ii) 180 cm^2 (iii) 241.5 cm^2 (iv) 58.1 cm^2
4. 112 cm^2 5. 24300 m^2 6. 12 cm

Exercise 2.5

1. (i) C (ii) D (iii) B
2. (i) 90 cm^2 (ii) 118.3 cm^2 (iii) 536.5 cm^2 (iv) 120 cm^2
3. 96 cm^2 4. 80 cm 5. ₹ 8400

Unit - 3

Exercise 3.1

1. (i) C (ii) C (iii) B (iv) C (v) D
2. (i) corresponding angles (ii) alternate interior angle
   (iii) sum of the interior angles on the same side of the transversal.
3. (i) $\angle$PMB (ii) $\angle$PMB (iii) $\angle$DNM (iv) $\angle$DNQ
4. (i) $\angle 1, \angle 5; \angle 4, \angle 8; \angle 2, \angle 6; \angle 3, \angle 7$ (ii) $\angle 4, \angle 6; \angle 3, \angle 5$
   (iii) $\angle 3, \angle 6; \angle 4, \angle 5$ (iv) $\angle 1, \angle 3; \angle 2, \angle 4; \angle 5, \angle 7; \angle 6, \angle 8$
5. (i) 30° (ii) 50° (iii) 95° (iv) 130°
6. $\angle 1 = 70°, \angle 2 = 110°, \angle 3 = 70°, \angle 4 = 110°$
   $\angle 5 = 70°, \angle 6 = 110°, \angle 7 = 70°, \angle 8 = 110°$
7. (i) l is not parallel to m. (sum of the interior angles on the same side of the transversal is not 180°).
   (ii) l is not parallel to m. ($x = 75°$. Sum of the interior angles on the same side of the transversal is not 180°).
   (iii) l is parallel to m. ($y = 60°$. Corresponding angles are equal).
   (iv) l is parallel to m. ($z = 110°$. Alternate angles are equal).
8. $\angle 1 = 44°$, $\angle 2 = 136°$

'I can, I did'

Student's Activity Record

Subject :

Sl. No.	Date	Lesson No.	Topic of the Lesson	Activities	Remarks