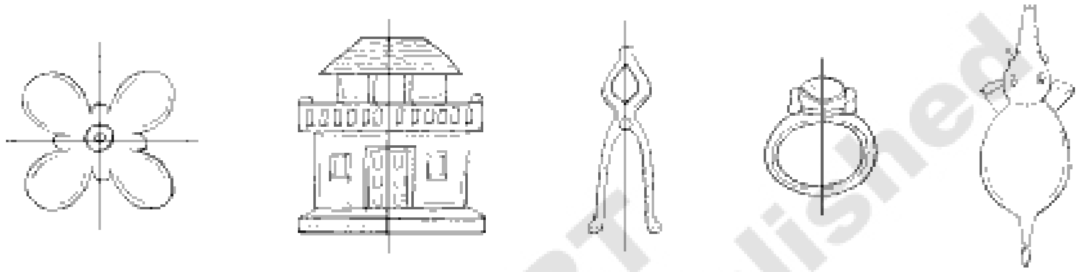
SYMMETRY 15

15.0 Introduction

Look around you. You will find that many objects around you are symmetrical. So are the objects that are drawn below.



All these objects are symmetrical as they can be divided in such a way that their two parts coincide with each other.

15.1 Line Symmetry

Let us take some more examples and understand what we mean. Trace the following figures on a tracing paper.

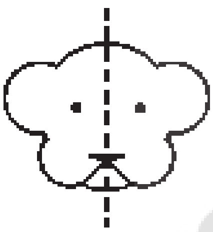


Figure 1

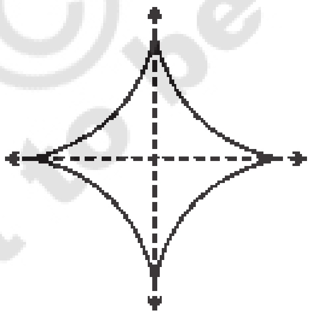


Figure 2

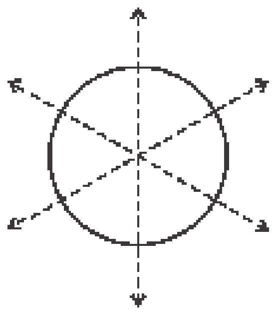


Figure 3

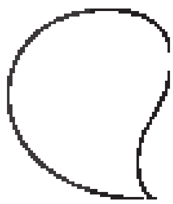


Figure 4

Fold Figure 1 along the dotted line. What do you observe?

You will find that the two parts coincide with each other. Is this true in Figure 2 and 3?

You will observe that in Figure 2, this is true along two lines and in Figure 3 along many lines. Can Figure 4 be divided in the same manner?

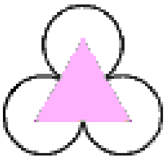
Figure 1, 2 and 3 have line symmetry as they can be divided in such a manner that two parts of the figure coincide with each other when they are folded along the line of symmetry. The dotted line which divides the figures into two equal parts is the line of symmetry or axis of symmetry. As you have seen, an object can have one or more than one lines of symmetry or axes of symmetry.

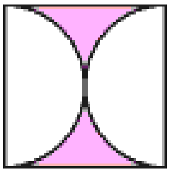
Try This

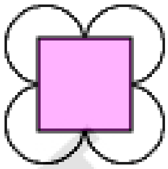
1. Name a few things in nature, that are symmetric.
2. Name 5 man-made things that are symmetric.

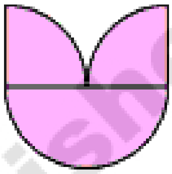
Exercise - 1

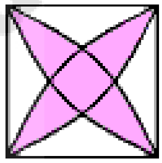
1. Given below are some fiugres. Which of them are symmetric? Draw the axes of symmetry for the symmetric figures.

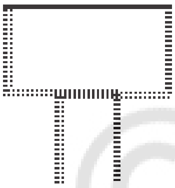

(i)

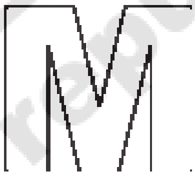

(ii)

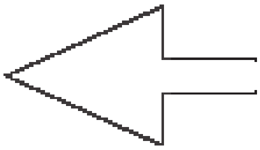

(iii)

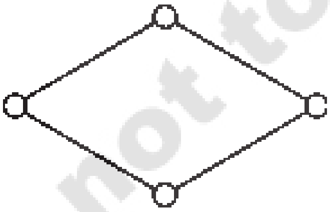

(iv)

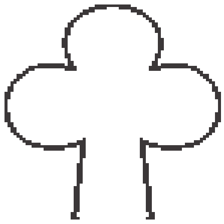

(v)


(vi)


(vii)

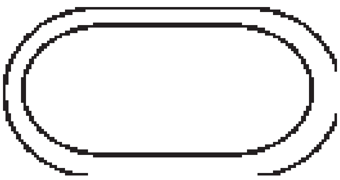

(viii)


(ix)


(x)

(xi)


(xii)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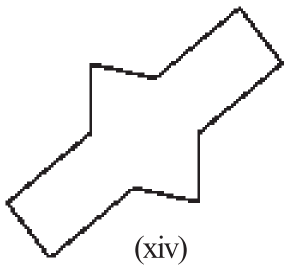
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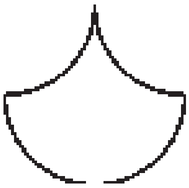

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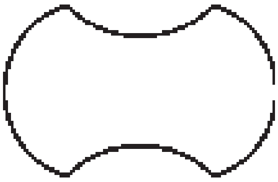

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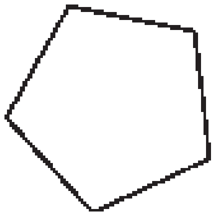

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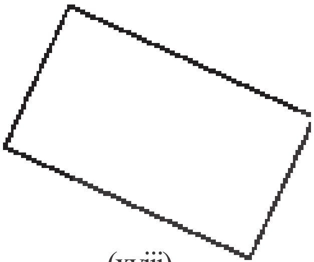

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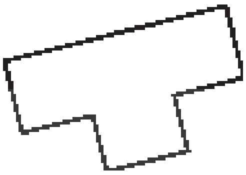
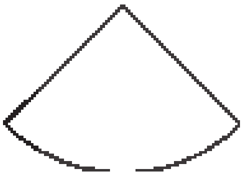


(xix)

(xx)



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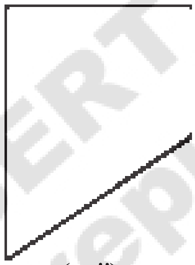
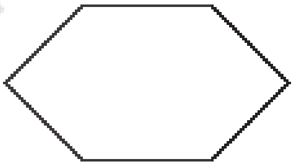


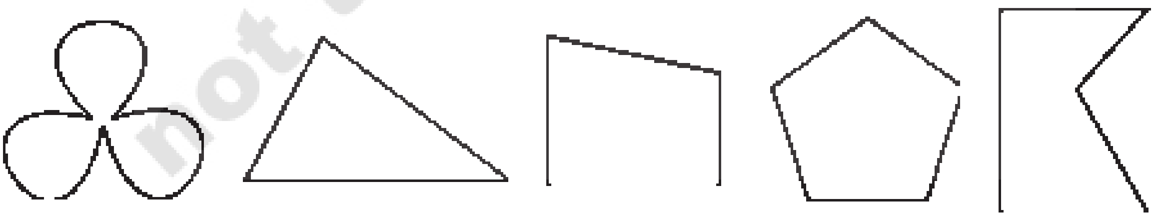
(xxii)



(xxiii)

15.1.1 Lines of symmetry for regular polygons

Look at the following closed figures.



A closed figure made from several line segments is called a 'Polygon'. Which of the above figures are polygons?

Try This

1. Can we make a polygon with less than three line segments?
2. What is the minimum number of sides of a polygon?

Observe the different triangles below.

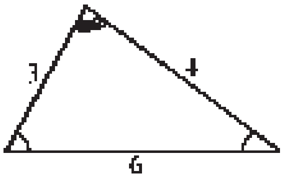


Figure 1

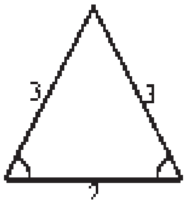


Figure 2

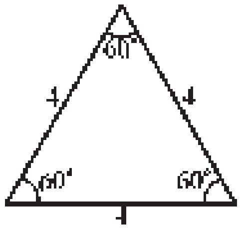
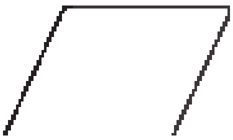


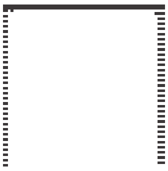
Figure 3

In Figure 3, the triangle has equal sides and congruent angles. It is thus called an regular polygon.

A polygon, with all sides and all angles equal is called a 'Regular Polygon'.

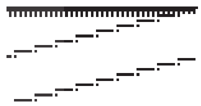
Which of the following polygons are regular polygons?


Parallelogram


Square

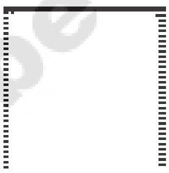

Trapezium

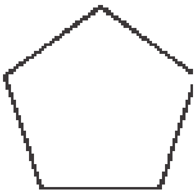

Equilateral triangle

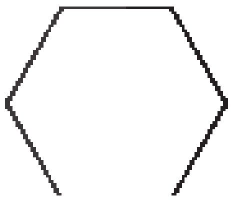

Rectangle

Now draw axes of symmetry for the following regular polygons.


Equilateral Triangle


Square


Regular Pentagon


Regular Hexagon

Write down your conclusions in the table below.

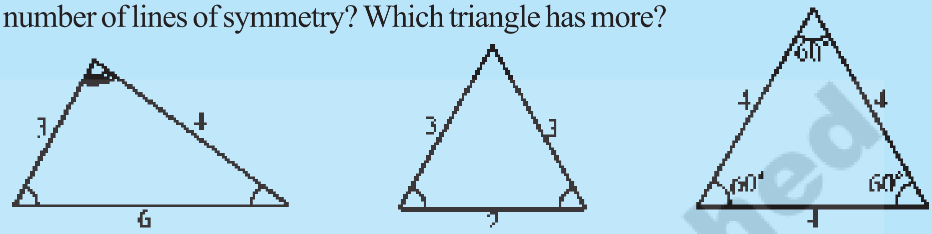
Regular Polygon	No. of sides	No. of axes of symmetry
Triangle	3	3
Square		
Pentagon		
Hexagon		

Did you find any relationship between the number of sides of a regular polygon and number of axes symmetry? You will find that the number of sides is equal to number of axes of symmetry.

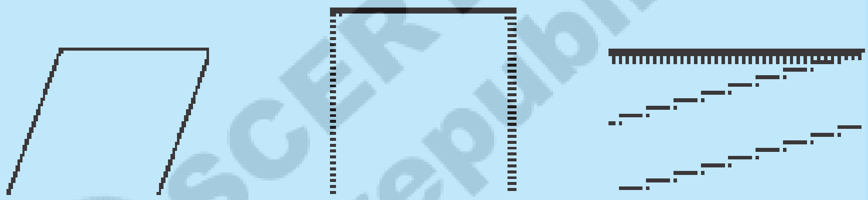
You can verify your results by tracing out all the four figures on a paper, cuting them out and actually folding each figure to find the axes of symmetry.

Try This

1. Given below are three types of triangles. Do all the triangles have the same number of lines of symmetry? Which triangle has more?



2. Given below are different types of quadrilaterals. Do all of them have the same number of lines of symmetry? Which quadrilateral has the most?



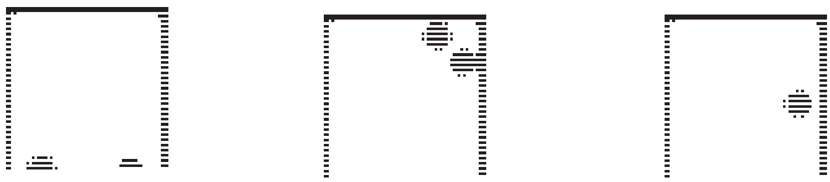
Rhombus Square Rectangle

Hint: You can trace the triangles and quadrilaterals on a tracing paper and actually fold each figure to find the axes of symmetry.

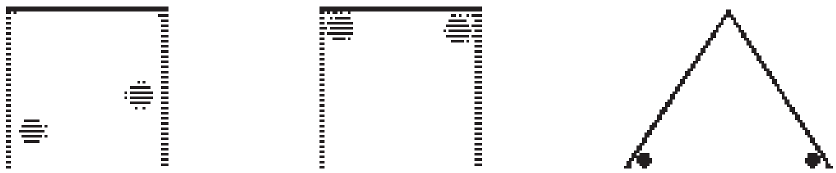
On the basis of (i) and (ii) can we say that a regular polygon has the maximum number of axes of symmetry.

Exercise - 2

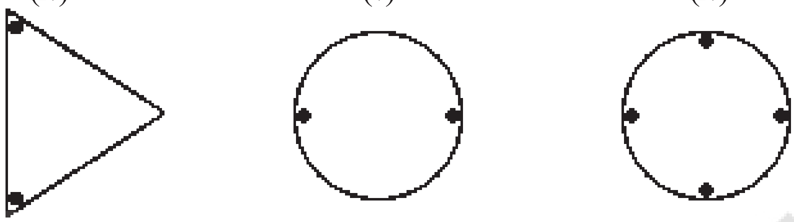
1. In the figures given below find the axes of symmetry such that on folding along the axis the two dots fall on each other.



(i) (ii) (iii)



(iv) (v) (iv)

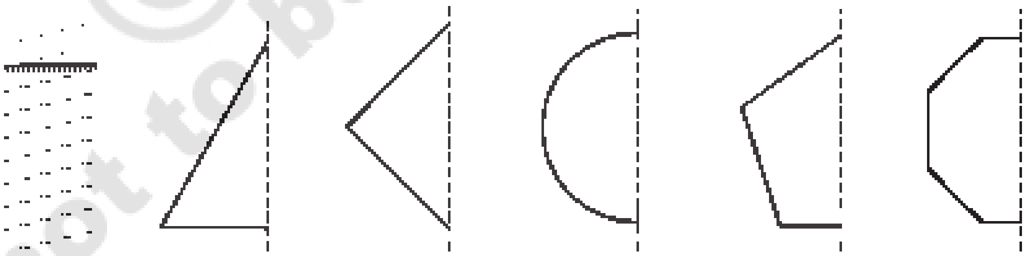


(vii) (viii) (ix)

2. Given the line of symmetry, find the other dot.

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

3. In the following incomplete figures, the mirror line (i.e. the line of symmetry) is given as a dotted line. Complete each figure, performing reflection on the dotted (mirror) line. (You might perhaps place a mirror along the dotted line and look into the mirror for the image). Are you able to recall the name of the figure you complete?



(i) (ii) (iii) (iv) (v) (vi)

4. State whether the following statements are true or false.

(i) Every closed figure has an axis of symmetry. ( )

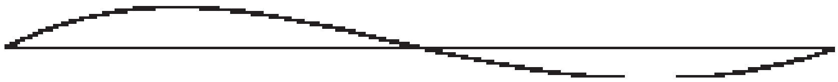
(ii) A figure with at least one axis of symmetry is called a symmetric figure. ( )

(iii) A regular polygon of 10 sides will have 12 axes of symmetry. ( )

5. Draw a square and construct all its axes of symmetry. Measure the angles between each pair of successive axes of symmetry. What do you notice? Does the same rule apply for other regular polygons?

15.2 Rotational Symmetry

Activity 1 : Trace the following diagram onto a tracing paper.



Try to fold the diagram so that its two parts coincide. Is this diagram symmetric?

Now, let us try to match the different positions of the diagram in another way. Draw the above diagram on a piece of paper. Mark a point 'o'at the centre and name the four edges of the paper A,B,C,D as shown in Figure 1.

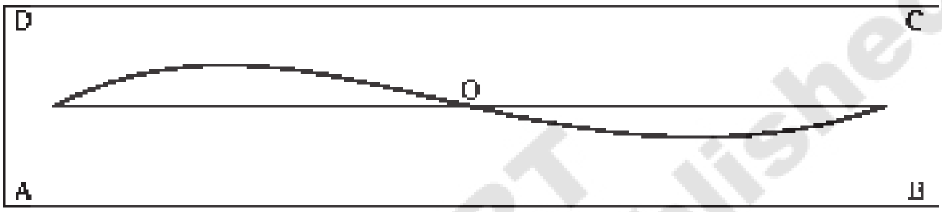


Figure 1

Rotate the paper around the marked point for 180^o.

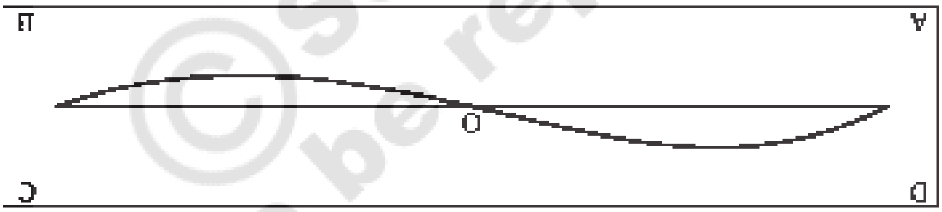


Figure 2

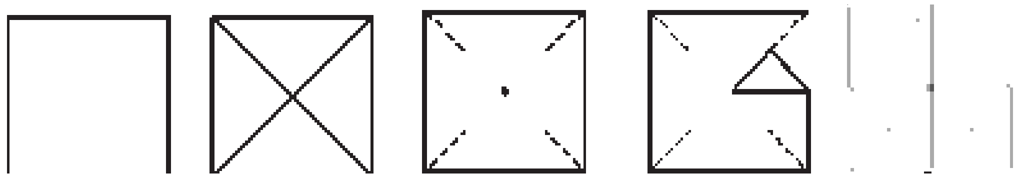
What do you notice? Does this diagram look different from the previous one?

Due to the rotation, the points A,B,C,D have changed position however the diagram seems to be unchanged. This is because the diagram has rotational symmetry.

Activity 2 : Lets make a wind wheel

- Take a paper and cut it into the shape of a square.
- Fold it along the diagonals.
- Starting from one corner, cut the paper along the diagonals towards the centre, up to one fourth of the length of the diagonal. Do the same from the remaining corners.
- Fold the alternate corners towards the centre.
- Fix the mid point to a stick with a pin so that the paper rotates freely.

- Face it in the opposite direction of the wind. You will find it rotates



Now, let us rotate the wind-wheel by 90º. After each rotation you will see that the wind-wheel looks exactly the same. The wind-wheel has rotational symmetry.

Thus, if we rotate a figure, about a fixed point by a certain angle and the figure looks exactly the same as before, we say that the figure has rotational symmetry.

15.2.1 Angle of Rotational Symmetry

We know that the square has line symmetry and 4 axes of symmetry. Now, let us see if the square has rotational symmetry.

Consider a square as in Figure (i) with P as one of its corners.

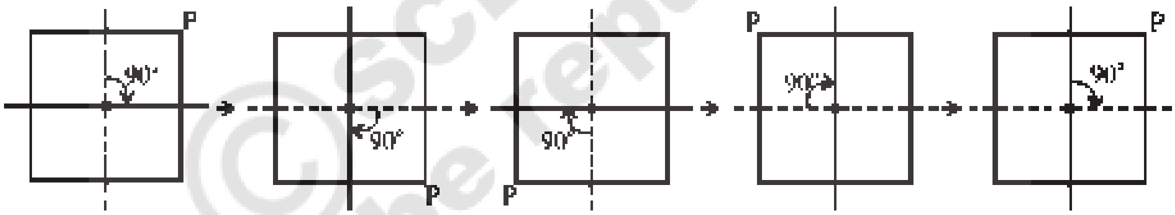


Figure 1 Figure 2 Figure 3 Figure 4 Figure 5

Figure 1 represent the initial position of square.

Rotate the square by 90 degrees about the centre. This quarter turn will lead to Figure 2. Note the position of P. In this way, rotate the square again through 90 degrees and you get Figure 3. When we complete four quarter turns, the square reaches its original position. After each turn, the square looks exactly like it did in its original position. This can also be seen with the help of the position taken by P.

In the above activcity all the positions in figure 2, figure 3, figure 4 and figure 5 obtained by the rotation of the first figure trhough 90^0 , 180^0, 270^0 and 360^0 look exactly like the original figure 1. Minimum of these i.e., 90^0 is called the angle of rotational symmetry.

The minimum angle rotation of a figure to get exactly the same figure as original is called the "angle of rotational symmetry" or "angle of rotation".

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Do This

1. What is the angle of rotational symmetry of a square?
2. What is the angle of rotational symmetry of a parallelogram?
3. What is the angle of rotational symmetry of a circle?

15.2.2 Order of rotational symmetry

In the above activity, the angle of rotational symmetry of square is 90^0 and the figure is turned through angle of rotational symmetry for 4 times before it comes to original position. Now we say that the square as rotational symmetry of order 4.

Consider an equilateral triangle. Its angle of rotational symmetry is 120^0. That means it has to be rotated about its centre for 3 times to get exactly the same position as the original one. So the order of rotational symmetry of a equilateral triangle is 3.

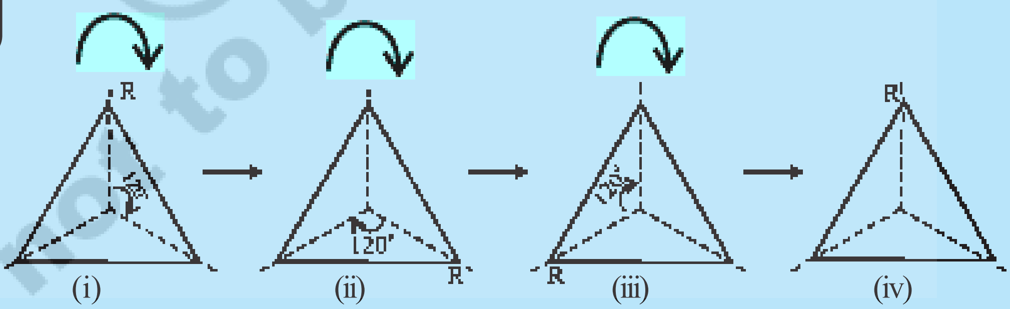
By these examples we conclude that the number of times a figure, rotated through its angle of rotational symmetry before it comes to original postion is called order of rotational symmetry.

Let us conclude from the above examples

- The centre of rotational symmetry of a square is its intersection point of its diagonals.
- The angle of rotational symmetry for a square is 90^0.
- The order of rotational symmetry for a sqaure is 4.

Try This

1. (i) Can you now tell the order of rotational symmetry for an equilateral triangle.



(ii) How many lines of semetry?

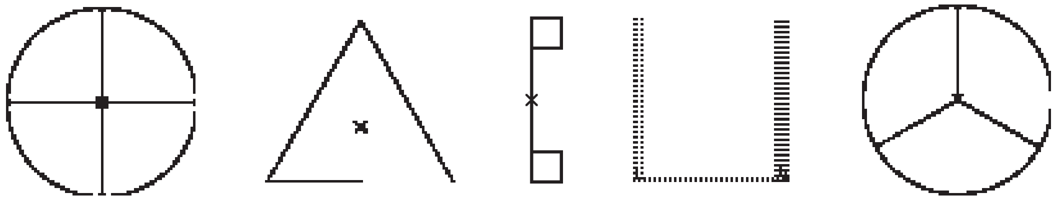
(iii) What is the angle between every adjacent axes?

2. Look around you. Which objects have rotational symmetry (i.e. rotational symmetry of order more than 1).

Note: It is important to understand that all figures have rotational symmetry of order 1, as can be rotated completely through 360° to come back to its original position. So we say that an object has rotational symmetry, only when the order of symmetry is more than 1.

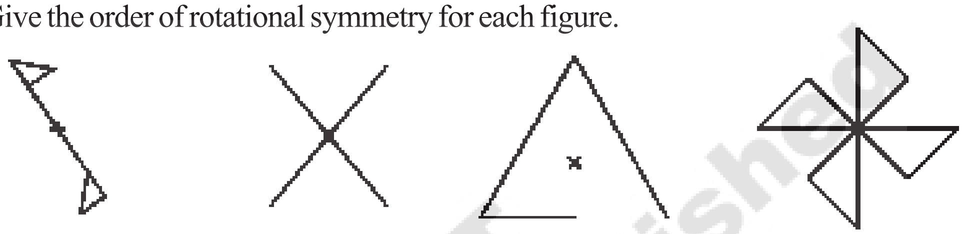
Exercise - 3

1. Which of the following figures have rotational symmetry of order more than 1?

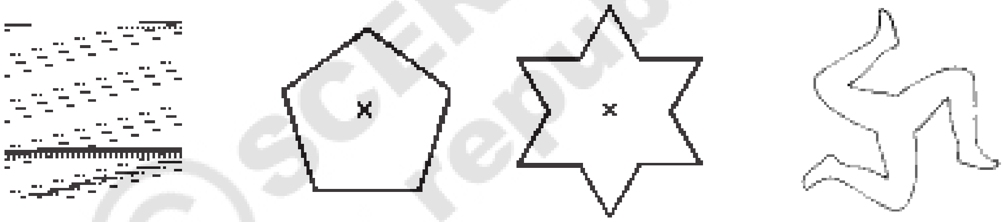


(i) (ii) (iii) (iv) (v)

2. Give the order of rotational symmetry for each figure.



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



(v) (vi) (vii) (viii)

3. Draw each of the shapes given below and fill in the blanks.

Shape	Centre of Rotation (intersection of diagonals/ Intersection of axes of symmetry)	Angle of Rotation	Order of Rota -tion
Square			
Rectangle			
Rhombus			
Equilateral Triangle			
Regular Hexagon			
Circle			
Semi-circle			

15.3 Line symmetry and rotational symmetry

By now you must have realised that some shapes only have line symmetry and some have only rotational symmetry (of order more than 1) and some have both. Squares and equilateral triangles have both line and rotational symmetry. The circle is the most perfect symmetrical figure, because it can be rotated about its centre through any angle and it will look the same. A circle also has unlimited lines of symmetry.

Example 1 : Which of the following shapes have line symmetry? Which have rotational symmetry?

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

Figure	Line symmetry	Rotational symmetry
1.	Yes	No
2.	No	Yes
3.	Yes	Yes
4.	No	Yes

Activity 3 :

- Take a square shaped paper.
- Fold it vertically first, then horizontally.
- Then fold along a diagnal such that the paper takes a triangular shape (Figure 4).
- Cut the folded edges as shown in the figure or as you wish (Figure 5).
- Now open the piece of paper.

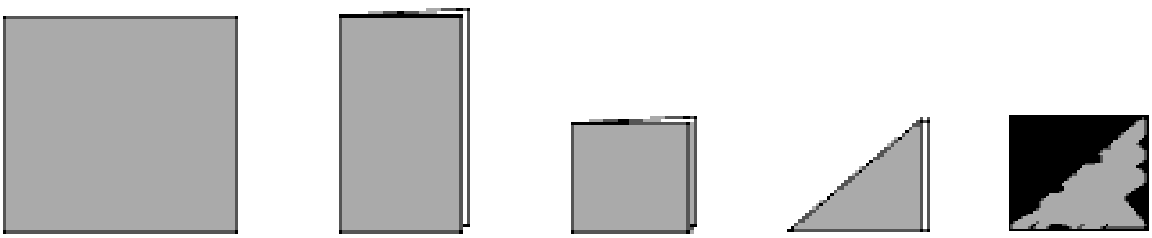
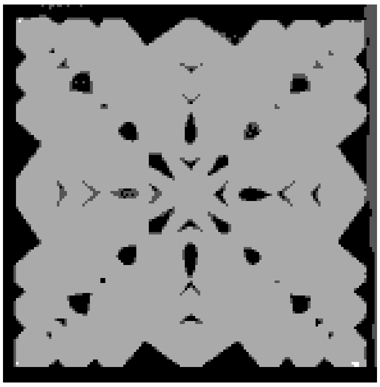


Figure 1 Figure 2 Figure 3 Figure 4 Figure 5



(i) Does the paper have line symmetry?

(ii) Does the paper have rotational symmetry?

Exercise - 4

1. Some english alphabets have fascinating symmetrical structures. Which capital letters have only one line of symmetry (like E))? Which capital letters have rotational symmetry of order 2 (like I)?

Fill the following table, thinking along such lines.

Alphabets	Line symmetry	Number of lines symmetry	Rotational symmetry	Order of rotational symmetry
Z	No	0	Yes	2
S				
H				
O				
E	Yes	1	No	-
N				
C				

Home Project

Collect pictures of symmetrical figures from newspapers, magazines and advertisement pamphlets. Draw the axes of symmetry over them. Classify them.

Looking Back

- The line which divides a figure into two identical parts is called the line of symmetry or axis of symmetry.
- An object can have one or more than one lines of symmetry or axes of symmetry.
- If we rotate a figure, about a fixed point by a certain angle and the figure looks exactly the same as before, we say that the figure has rotational symmetry.
- The angle of turning during rotation is called the angle of rotation.
- All figures have rotational symmetry of order 1, as can be rotated completely through 360º to come back to their original position. So we say that an object has rotational symmetry only when the order of symmetry is more than 1.
- Some shapes only have line symmetry and some have only rotational symmetry and some have both. Squares, equilateral triangles and circles have both line and rotational symmetry.

ANSWERS

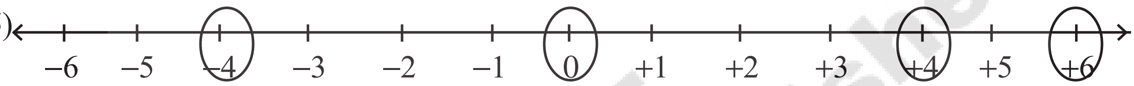
01- Integers

Exercise - 1 (page - 2)

(2) (i) −9, −8, −7, −6 ; biggest number = −6 ; smallest number = −9
(ii) −1, 0 +1, +2, ; biggest number = +2 ; smallest number = −1
(iii) −7, −6, −5, −4, −3, −2, −1, 0, 1, 2, 3, 4
b) biggest number = +4 ; smallest number = −7

(3) (i) −8, −5, 1, 2 (ii) −5, −4, −3, 2 (iii) −15, −10, −7

(4) (i) −2, −3, −5 (ii) −1, −2, −8 (iii) 8, 5, −2

(5)


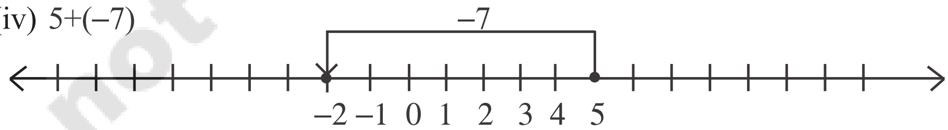
6. −8, −7, −6, −4, −3, −2, −1, 1, 2, 3, 5, 7, 9

(7) i)

No.	Name of the City	Temperature
1	Bangalore	20°C
2	Ooty	15°C
3	Nainital	−3°C
4	Manali	−7°C
5	Kasauli	−9°C

(ii) Bangalore (20°C) (iii) Kasauli (−9°C)
(iv) Nainital (−3°C) Manali (−7°C) Kasauli (−9°C) (v) Ooty (15°C) Bangalore (20°C)

Exercise - 2 (page - 4)

(1) (iv) 5+(−7)


(2) (i) 11 (ii) 5 (iii) 14 (iv) 8 (v) 2 (vi) 4 (vii) −2
(viii) 0 (ix) 8 (x) 20 (xi) 80

Exercise - 3 (page - 6)

(1) (i) 5 (ii) 15 (iii) 1 (iv) 13

(2) (i) 31 (ii) 21 (iii) 24 (iv) −13
(v) −8 (vi) 130 (vii) 75 (viii) 50

(3)

Sl.No	Negative integer	+	Whole No.	=	−6
1	(−6)	+	0	=	−6
2	(−7)	+	1	=	−6
3	(−8)	+	2	=	−6
4	(−9)	+	3	=	−6 etc.,

Exercise - 4 (page - 11)

(1) (i) +600 (ii) −1 (iii) −600 (iv) +200 (v) −45

(2) (i) −3 (ii) −225 (iii) 630 (iv) 316 (v) 0

(vi) 1320 (vii) 162 (viii) −360 (ix) −24 (x) 36

(3) −10° (4) (i) 10 (ii) 18 (iii) 5 (5) (i) ₹.5000 profit (ii) 3200

(6) (i) −9 (ii) −7 (iii) +7 (iv) −11

Exercise - 5 (page - 19)

(1) (i) True (72 = 126 − 54 = 72) (ii) True (210 = 84 + 126 = 210) (2) (i) −a (ii) −5

(3) (i) 480 (ii) −53,000 (iii) −15000 (iv) −4182

(v) −62500 (vi) 336 (vii) 493 (viii) 1140

Exercise - 6 (page - 22)

(1) (i) −1 (ii) −49 (iii) not defined (iv) 0

Exercise - 7 (page - 23 & 24)

(1) (i) 24 (ii) 20 (2) (i) Profit 33,000 (ii) 3000

(3) 9 PM ; Temperature at Midnight = −14°C

(4) (i) 8 questions (ii) 13 question (5) 1 hour

02- Fractions, Decimals and Rational Numbers

Exercise - 1 (page - 29)

(1) (i) $2\frac{3}{4}$ (ii) $1\frac{1}{9}$ (iii) $\frac{3}{7}$ (iv) $3\frac{1}{6}$ (v) $\frac{19}{24}$ (vi) $6\frac{1}{6}$

(2) (i) $\frac{1}{2}, \frac{5}{8}, \frac{5}{6}$ (ii) $\frac{3}{10}, \frac{1}{3}, \frac{2}{5}$

(3) Sum in row = $\frac{21}{13}$, Sum in column = $\frac{21}{13}$, Sum in diagonal = $\frac{21}{13}$ All the sums are equal.

(4) $17\frac{11}{15}$ cm (5) $1\frac{7}{8}$ (6) $\frac{7}{12}$

(7) Perimeter of Δ ABE $= 10\frac{1}{5}$ cm; BCDE perimeter $= 7\frac{11}{15}$ cm ;

Δ ABE is greater ; difference $= 2\frac{7}{15}$

Exercise - 2 (page - 34)

(1) (i) $5\frac{0}{6}$ or 5 (ii) $1\frac{1}{3}$ (iii) $1\ \frac{5}{7}$ (iv) $1\frac{1}{9}$ (v) $6\frac{0}{5}$ or 6

(2) (i) 6 (ii) 6 (iii) 9 (iv) 15

(3) (i) 4 (ii) 6

Exercise - 3 (page - 37)

(1) (i) $\frac{35}{66}$ (ii) $1\frac{1}{5}$ (iii) $7\frac{7}{15}$ (2) (i) $3\frac{7}{15}$ (ii) $\frac{2}{21}$ (iii) 3

(3) (i) $\frac{3}{8}$ (ii) Both are euqal (4) $17\frac{1}{2}$ hrs. (5) $85\frac{1}{3}$ km. (6) 1350 mm.

(7) (i) $\frac{10}{7}$ (ii) $\frac{3}{5}$, 35 or 3,7

Exercise - 4 (page - 43)

(1) (i) $\frac{8}{5}$ (ii) $\frac{7}{8}$ (iii) $\frac{7}{13}$ (iv) $\frac{4}{3}$ (2) (i) 24 (ii) $3\frac{3}{7}$ (iii) $1\frac{2}{7}$ (iv) $\frac{7}{5}$ (3)

(i) $\frac{2}{15}$ (ii) $\frac{7}{40}$ (iii) $\frac{5}{9}$ (4) $2\frac{1}{2}$ days

Exercise - 5 (pages- 45 & 46)

(1) (i) 0.7 (ii) 8.5 (iii) 1.51 (iv) 6 (2) (i) ₹. 0-09 (ii) ₹. 77-07 (iii) ₹. 2-35

(3) (i) 0.1 m, 0.0001 km (ii) 4.5 cm, 0.045 m, 0.000045 km.

(4) (i) 0.19 kg (ii) 0.247 kg (iii) 44.08 kg

(5) (i) $50+5+\frac{5}{10}$ (ii) $5+\frac{5}{10}+\frac{5}{100}$ (iii) $300+3+\frac{3}{100}$

(iv) $30+\frac{3}{10}+\frac{3}{1000}$ (v) $1000+200+30+4+\frac{5}{10}+\frac{6}{100}$

(6) (i) 3 (ii) 30 (iii) $\frac{3}{100}$ (iv) $\frac{3}{10}$ (v) $\frac{3}{100}$ (7) Radha ; 100 m. (8) 5.625 kg.

Exercise -6 (page- 50 & 51)

(1) (i) 1.8 (ii) 18.9 (iii) 13.55 (iv) 78.8 (v) 0.35
(vi) 1050.05 (vii) 1.72 (2) 24.8 cm^2

(3) (i) 213 (ii) 368 (iii) 537 (iv) 1680.7 (v) 13110

(vi) 15610 (vii) 362 (viii) 4307 (ix) 5 (x) 0.8

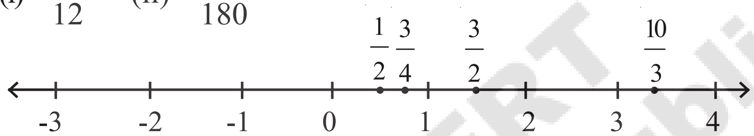
(xi) 90 (xii) 30 (4) 625 Km (5) (i) 0.45 (ii) 0.75
(iii) 42.16 (iv) 14.62 (v) 0.025 (vi) 0.112 (vii) 0.0214

(viii) 10.5525 (ix) 1.0101 (x) 77.011 (6) (i) 0.023 (ii) 0.09 (iii) 4.43
(iv) 0.1271 (v) 2 (vi) 590 (vii) 0.02 (7) 5 (8) 0.128 cm

Exercise -7 (page- 56)

(2) (i) $\frac{-5}{12}$ (ii) $\frac{-75}{180}$

(3)



(4) (i) false (ii) true (iii) true (iv) false (v) true

03 - Simple Equations

Exercise - 1 (page - 59)

(1) (i) LHS = 2x, RHS = 10 (ii) LHS = 2x–3, RHS = 9 (iii) LHS = 4z+1, RHS = 14 (iv) LHS = 5p+3, RHS = 2p+9

(v) LHS = 14, RHS = 27–y (vi) LHS = 2a–3, RHS = 5 (vii) LHS = 7m, RHS = 14 (iv) LHS = 8, RHS = 9s+5

(2) (i) y = 5 (ii) a = 8 (iii) m = 3 (iv) n = 7

Exercise - 2 (page - 63)

(1) (i) x = 4 (ii) y = 7 (iii) x = 5 (iv) z = 9 (v) x = 3 (vi) y = –20
(2) (i) y = 5 (ii) a = 4 (iii) q = 4 (iv) t = 4 (v) x = 13
(vi) x = 3 (vii) x = –5 (viii) x = –1 (ix) y = 4 (x) x = –2

Exercise - 3 (page - 67)

(1) 4 cm (2) 5 cm (3) 21 (4) 30 (5) 8 (6) 46, 49 (7) 7, 8, 9
(8) l = 34m, b = 2m (9) l=23m, b=19m (10) 5 years (11) 19, 44
(12) 40; 25, 15 (13) 2 (14) 40 (15) 30°, 60°, 90°
(16) 30

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04 - Lines and Angles

Exercise - 1 (page - 69)

(1) (i) Line segment AB (ii) Ray CD (iii) Line XY (iv) Point ‘P’

(2) (i) 

(ii) 

(iii) 

(iv) 

(3) $\overline{AB}$, $\overline{AC}$, $\overline{AD}$, $\overline{BC}$, $\overline{BD}$, $\overline{CD}$

(5) (i) acute (ii) obtuse (iii) Right (iv) acute (v) obtuse

(6) $\angle$AOF, $\angle$FOE, $\angle$EOD, $\angle$DOC, $\angle$COB, $\angle$FOD, $\angle$EOC, $\angle$DOB - Acute angles.

$\angle$AOE, $\angle$EOB, $\angle$FOC - Right angles ; $\angle$AOD, $\angle$AOC, $\angle$FOB - Obtuse angles.

$\angle$AOB - straight angle (7) (i) and (iv) are parallel ; (ii) and (iii) non parallel

(8) i, ii and iv are intersecting lines and iii non-intersecting lines.

Exercise - 2 (page - 71)

(1) iii (2) (i) 65° (ii) 50° (iii) 1° (iv) 35° (3) 45°, 45°

(4) Yes. Because the sum of the angles must be 90°

Exercise - 3 (page - 73)

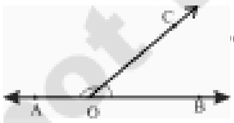
(1) (i), (ii) (2) (i) 75° (ii) 85° (iii) 30° (iv) 160°

(3) The sum of two acute angles is always less than 180° (4) 90°, 90°

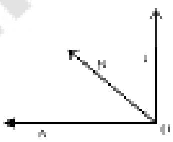
Exercise - 4 (page - 74)

(1) (i) a, b (ii) c, d (2) (i) $\angle$AOD, $\angle$DOB (ii) $\angle$DOB, $\angle$BOC

(iii) $\angle$BOC, $\angle$COA (iv) $\angle$COA, $\angle$AOD

(3) Yes. 

ecause $\angle$AOC + $\angle$COB = 180°

(4) Yes . 
because $\angle$AOB + $\angle$BOC = 90°

Exercise - 5 (page - 75)

(1) i, ii (2) No. Because there is no common arm.

Exercise - 6 (page - 76)

(1) (i) $\angle$AOD, $\angle$BOC (ii) $\angle$AOC, $\angle$BOD

(2) y = 160° (Vertically opposite angles) $x + 160° = 180°$ $\therefore\ x = 20°$

$\angle x = \angle z$ Vertically opposite angles $\therefore\ z = 20°$

Exercise - 7 (page - 85)

(1) (i) Transversal (ii) Parallel (iii) Parallel (iv) one
(2) (i) $100°$ (ii) $45°$ (iii) $90°$ (iv) $100°$

(3) $\angle x = 180 - (75+45) = 60°$; $\angle y = 75°$; $z = 45°$

(4) $b + 50° = 180°$ $\therefore b = 130°$

$b + c = 180° \Rightarrow 130° + c = 180° \Rightarrow c = 50°$
$d + 50° = 180° \Rightarrow d = 130°$

(5) $l \parallel m$

(6) $\angle a = 50°$ (Alternate angles)

$\angle b = 50°$ (Alternate angles)

$\angle c = \angle d = \angle e = 50°$

(all are Alternate angles)

05 - Triangle and its Properties

Exercise - 1 (page - 93)

(1) (i) Possible (ii) Possible (iii) Not possible (iv) Possible (v) Not possible

Exercise - 2 (page - 94)

(1) (i) Median (ii) Altitude (Height) (2) Right angle triangle (3) Yes

(4) No, in some cases it lies in the exterior of the triangel (5) (i) XZ (ii) $\angle P$ (iii) B

Exercise - 3 (page - 100)

(1) (i) $70°$ (ii) $60°$ (iii) $40°$ (2) (i) $x = 70°$; $y = 60°$ (ii) $x = 80°$; $y = 50°$
(iii) $x = 110°$; $y = 70°$ (iv) $x = 60°$; $y = 90°$ (v) $x = 45°$; $y = 90°$ (iv) $x = 60°$

(3) (i) $40°$ (ii) $34°$ (iii) $60°$ (4) $60°$ (5) (i) False (ii) True (iii) False (iv) False

(6) (i) $30°$; $60°$; $90°$ (7) $x = 100°$; $y = 50°$; $z = 100°$ (8) $72°$

(9) $\angle P = 80°$; $\angle Q = 40°$; $\angle R = 60°$ (10) $18°$; $72°$; $90°$ (11) $36°, 54°$

(12) $\angle LPM = 40°$; $\angle PML = 50°$; $\angle PRQ = 50°$ (13) $540°$

Exercise - 4 (page - 107)

(1) Interior angles : $\angle ABC, \angle ACB, \angle BAC$; Exterior angles : $\angle CBX, \angle ACZ, \angle BAY$

(2) $\angle ACD = 111°$ (3) $x = 115°$; $y = 35°$ (4) (i) $x = 50°$ (ii) $x = 33°$; $y = 82°$

(5) $\angle CDB = 76°$; $\angle DBC = 39°$; $\angle ABC = 58°$

(6) (i) $x = 55°$ (ii) $x = 100°$ (iii) $x = 75°$ (iv) $y = 70°$(v) $x = 60°$; $y = 150°$;

(vi) $x = 50°$; $y = 130°$ (7) 50° ; 75° ; 55° (8) $\angle P$ 35° (9) 70°

(10) 30° ; 75° ; 75° (11) $x = 135°$; $y = 80°$

06 - Ratio - Applications

Exercise - 1 (page - 111)

(1) 100 : 10 , 10:1 (2) ₹.15 (i) 15 : 5 or 3 : 1 (Radha : Sudha)

(ii) 5 : 15 or 1 : 3 (Sudha : Radha) (3) Raju's Share = 40 ; Ravi's Share = 56

(4) $\overline{AX} = 18$ cm ; $\overline{XB} = 20$ cm. (5) ₹.60,000 (6) 8 liters

(7) 40 : 20 or 2: 1 (8) 1:2400 or 0.05 : 120

(9) (i) count No. boys and girls in your class and write inthe form of ratio. If boys or girls will be zero, can you write in the form and ratio? We can not compare such ratios.

(ii) Count of doors and number of windows of your classroom and number write in the form of ratios.

(iii) Count all textbooks and note books with you and write in ratio form.

Exercise - 2 (page - 114)

(1) (i) 8, 8 (ii) 450, 450 (iii) 96, 96 (iv) 6, 30 (v) 24, 72

(2) (i) False (ii) True (iii) True (iv) True (v) False

(3) ₹.90 (4) 10 kg (5) a) 45 b) 26 (6) i) 540° ii) 21°

Exercise - 3 (page - 120)

(1) 0.0001 cm ; 2cm (2) (i) Yes (ii) No (iii) No. (3) 4 cm

(4)
- Draw 5 different squares, measure their lengths and fill the table.
- 4 times of side will be perimeter of square find and fill the table.
- Square the side of each and fill the table.

(i) Yes, lenght of side is in direct proportion to perimeters of the squares.

(ii) Yes, length of side is in director proportion to area of the square.

Exercise - 4 (page - 125)

(1) School Y (2) 20% decrease (3) Mangoes = 35% (4) 16%

(5) Abscent $= 16\frac{2}{3}\%$ or 16.66% Present $= 83\frac{1}{3}\%$ or 83.33% (6) 7200

(7) 15 (8) gold 70% ; silver 25% ; Copper 5% (9) 2000

Exercise - 5 (page - 136)

(1) $12\frac{1}{2}\%$ or 12.5% (2) 6% (3) ₹. 2,00,000 (4) ₹. 875

(5) loss = 1200 (2.44%) (6) 561 (7) 202.5 (8) 800 (9) 1100

Exercise - 6 (page - 140)

(1) 2 years 8 months or $\frac{8}{3}$ years or $2\frac{2}{3}$ years (2) 12%

(3) ₹. 450 (4) ₹. 12958 (5) $1\frac{1}{2}$ years

07 - Data Handling

Exercise 1 (page - 147)

(1) (i) 33 ^{0}C (ii)30 ^{0}C (2) 15.9 kg

(3) (i) Ground nuts ₹:7500 ; Jawar ₹:4000 ; Millets ₹:5250 (ii) Ground nuts

(4) 42 (5) (i) 23 (ii) 21 (iii) 16.5 (iv) Lekhya

(6) (i) ₹:18 (ii) ₹:54 (iii) Boportional (7) 5.5 (8) 5.6 (9) 107

Exercise 2 (page - 152)

(1) 155 cm, 140cm (2) (i) Mean = 28, Mode = 27 (ii) 2 players of age 25 years each.

(3) 25 (4) (i) Mode (ii) Mean (iii) Mean (iv) Mode

Exercise 3 (page - 155)

(1) (i) F (ii) T (iii) F (iv) F (2) (i) ₹:1400 (ii) ₹:1500

(3) Mode is correct, but median is wrong. (4) three 1, 7, 10 ; 2, 7, 9 ; 3, 7, 8 (5) 11

Exercise 4 (page - 160)

(5) (i) Education (ii) Food (iii)₹:2250 (iv) ₹:1500

08 - Congurencey of Triangles

Exercise - 1 (Page. 169)

(1) (i) True (ii) False

(2) (i) $\angle P = \angle R$ (ii) $\angle ROS = \angle POQ$

$\angle TQP = \angle SQR$ $\angle R = \angle Q$ or $\angle R = \angle P$

$\angle T = \angle S$ $\angle S = \angle P$ or $\angle S = \angle Q$

(3) (ii) Correct (4) Yes (S.S.S. Congruency)

Exercise - 2 (Page. 171)

(1) It is to be given that GH = TR and HJ = TS (2) AP = 4 km ($\therefore$ AP = BQ c.p.c.t.)

(3) (i) $\Delta ABC \cong \Delta STR$
AB = ST also BC = TR
$\angle A = \angle S$ $\angle B = \angle T$
AC = SR $\angle C = \angle R$

(ii) $\Delta POQ \cong \Delta ROS$
PO = RO also PQ = RS
OQ = OS $\angle P = \angle R$
$\angle POQ = \angle POS$ $\angle Q = \angle S$

(iii) $\Delta DRO \cong \Delta OWD$ DR = OW also DO = OD
RO = WD $\angle ODR = \angle DOW$
$\angle R = \angle W$ $\angle DOR = \angle ODW$
in the fig $\square$ WORD
$\angle R = 90°$
WD = OR and WO = DR
$\therefore$ $\square$ WORD is a rectangle
$\therefore$ $\Delta WSD \cong \Delta RSO$
$\Delta WSO \cong \Delta RSD$
also $\Delta ORW \cong \Delta DWR$

(iv) ΔABC and ΔCBA not congruent

(4) (i) In ΔABC adn ΔRQP we need to know that AB = RQ.
(ii) In ΔABC and ΔADC we need to know that AB = AD.

Exercise - 3 (Page. 175)

(1) (i) By A.A.S. $\Delta ABC \cong \Delta RPQ$ (ii) By A.S.A. or A.A.A. $\Delta ABD \cong \Delta CDB$
(iii) By A.A.A. or A.A.S. $\Delta AOB \cong \Delta DOC$ (iv) not congruent

(2) (i) $\Delta ABC \cong \Delta DCB$ (A.A.S)
(ii) from AB = CD (c.p.c.t.) (Corresponding Parts of Congruent Triangles)
$\therefore$ $\Delta AOB \cong \Delta DOC$
otherwise ΔAOB and ΔDOC are similar by A.A.A.
in congruent triangles corresponding parts are equal.

Exercise - 4 (Page. 178)

(1) (i) S.S.S. (ii) S.A.S. (iii) A.S.A. (iv) R.H.S. (2) (i) a) AR = PE b) RT = EN
c) AT = PN (ii) a) RT = EN b) PN = AT (iii) a) $\angle A = \angle P$ b) $\angle T = \angle N$

(3) (i) Side (ii) Angle (iii) Common side (iv) S.A.S.

(4) We can't say $\Delta ABC \cong \Delta PQR$ when the corresponding angles are equal, but can say that the triangles are simlar.

(5) $\Delta RAT \cong \Delta WON$ (6) $\Delta ABC \cong \Delta ABT$ and $\Delta QRS \cong \Delta TPQ$

(7) (i) Draw two triangles with same measures. (ii) Draw two triangles of different measures.
(8) BC = QR (A.S.A.) or AB = PQ (A.A.S.) or AC = PR (A.A.S.)
(9) $\angle B = \angle E$; $\angle A = \angle F$ by A.A.S. $\Delta ABC \cong \Delta FED$ are congruent ; BC = ED

10- Algebraic Expressions

Exercise - 1 (page - 192)

(1) (i) $3n$ (ii) $2n$

(2) (i) • In fig. 4 number of coloured tiles will be 4 on each side.
• In fig. 5 number of coloured tiles will be 5 on each side.
(ii) Algebraic expression for the pattern = 4n ; 4, 8, 12, 16, 20 . . . . . expression = 4n
(iii) Algebraic expression for the pattern = 4n + 1 ; 9, 13, 17, 21 . . .. expression = 4n + 1

(3) (i) $p + 6$ (ii) $x - 4$ (iii) $y - 8$ (iv) $-5q$ (v) $y \div 4$ or $\frac{y}{4}$

(vi) $\frac{1}{4}$ of pq or $\frac{pq}{4}$ (vii) $3z+5$ (viii) $10+5x$ (ix) $2y - 5$ (x) $10y + 13$

(4) (i) ' 3 more than x' or 3 is added to x (ii) '7 is less than y' or 7 is substracted from 'y'
(iii) l is multiplied by 10. (iv) x is divided by 5
(v) m is multiplied by 3 and added to 11
(vi) y is multiplied by 2 and subtracted 5 or 5 is subtracted from 2 times of y.

(5) (i) Constant (ii) Variable (iii) Constant (iv) Variable

Exercise - 2 (page -199)

(1) (i) (a^2, $-2a^2$) (ii) ($-yz$, 2zy) (iii) ($-2xy^2$, $5y^2x$) (iv) ($7p, -2p, 3p$) and ($8pq, -5pq$)
(2) Algebaric expression : Problem Numbers : i, ii, iv, vi, vii,ix, xi
Numerical expression : Problem Numbers : iii, v, viii, x
(3) Mononomial i, iv, vi ; binomial : ii, v, vii ; trinomial : iii, viii, ix multinomial : x
(4) (i) 1 (ii) 3 (iii) 5 (iv) 4 (v) 2 (vi) 3 (5) (i) 1 (ii) 2 (iii) 4 (iv) 3
(v) 4 (vi) 2 (6) $xy + yz$ $2x^2 + 3x + 5$

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Exercise - 3 (page - 204)

(1) 3a + 2a = 5a (2) (i) $13x$ (ii) $10x$ (3) (i) $3x$ (ii) $-6p$ (iii) $11m^2$ (4) (i) -1

(ii) 4 (iii) -2 (5) -9 (6) $2x^2 + 11x - 9, -23$ (7) (i) 3 (ii) 5 (iii) -1

(8) 54 cm × cm = 54 cm^2 (9) ₹. 90

(10) $s = \frac{d}{t} = \frac{135\,mt}{10\,\text{sec}} = \frac{27}{2} mt./Sec.$, or $13\frac{1}{2} mt./Sec.$, or $13.5\,mt./Sec.$,

Exercise - 4 (page - 209)

(1) (i) $-5x^2 + xy + 8y^2$ (ii) $10a^2 + 7b^2 + 4ab$ (iii) $7x + 8y - 7z$ (iv) $-4x^2 - 5x$

(2) $7x + 9$ (3) $18x - 2y$ (4) $5a + 2b$

(5) (i) a+2b (ii) $(2x+3y+4z)$ (iii) $(-4ab - 8b^2)$ (iv) $4pq - 15p^2 - 2q^2$

(v) $-5x^2+3x+10$ (vi) $2x^2 - 2xy - 9y^2$ (vii) $3m^3 + 4m^2 + 7m - 1$

(6) $7x^2 + xy - 6y^2$ (7) $42x^2 - 3x - z$ (8) $4x^2 - 3y^2 - xy$ (9) $2a^2 + 14a + 5$

(10) (i) $22x^2 + 12y^2 + 8xy$ (ii) $-14x^2 - 10y^2 - 20xy$ or $-(14x^2 + 10y^2 + 20xy)$

11 - Exponents

Exercise - 1 (page - 214)

1. (i) $3 \times 3 \times 3 \times 3$ (ii) $7 \times x \times 7 \times x$ (iii) $5 \times 5 \times 5 \times a \times a \times a \times b \times b \times b$

(iv) $4 \times 4 \times 4 \times 4 \times 4 \times y \times y \times y \times y \times y$ 2. (i) 7^5 (ii) $3^3 \times 5^4$ (iii) $2^3 \times 3^4 \times 5^3$

3. (i) $2^5 \times 3^2$ (ii) 2×5^4 (iii) $2 \times 3^2 \times 5^3$ (iv) $2^4 \times 3^2 \times 5^2$ (v) $2^5 \times 3 \times 5^2$

4. (i) 3^2 (ii) 3^5 (iii) 2^8 5. (1) 17 (ii) 31 (iii) 25 (iv) 1

Exercise - 2 (page - 225)

(1) (i) 2^{14} (ii) 3^{10} (iii) 5^5 (iv) 9^{30} (v) $\left(\frac{3}{5}\right)^{15}$ (vi) 3^{20}

(vii) 3^4 (viii) 6^4 (ix) 2^{9a} (x) 10^6 (xi) $\left(\frac{-5}{6}\right)^{10} = \frac{(-5)^{10}}{6^{10}} = \frac{5^{10}}{6^{10}}$

(xii) 2^{10a+10} (xiii) $\frac{2^5}{3^5}$ (xiv) 15^3 (xv) $(-4)^3$ (xvi) $\frac{1}{9^8}$ (xvii) $\frac{1}{(-6)^4}$ (xviii) $(-7)^{15}$

(xix) $(-6)^{16}$ (xix) a^{x+y+z} (2) 3^{10} (3) 2 (4) 2 (5) 1

(6) (i) true (2+11=13) (ii) false (iii) true (iv) true (v) false (vi) fasle (vii) true

Exercise - 3 (page - 226)

(i) $3.84 \times 10^8 m$ (ii) 1.2×10^{10} (iii) $3 \times 10^{20} m$ (iv) $1.353 \times 10^9 km^3$

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12 - Quadrilaterlals

Exercise - 1 (page - 232)

(1) (i) Sides: $\overline{PQ}$, $\overline{QR}$, $\overline{RS}$, $\overline{RP}$ Angles: $\angle QPS$, $\angle PSR$, $\angle SRQ$, $\angle RQP$

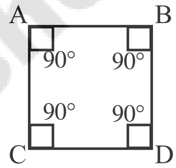
Vertices: P, Q, R, S Diagnoals: $\overline{PR}$, $\overline{QS}$

(ii) Pairs of adjacent sides $\overline{PQ}, \overline{QR}$; $\overline{QR}, \overline{RS}$; $\overline{RS}, \overline{SP}$ and $\overline{SP}, \overline{PQ}$

Pairs of adjacent angles: $\angle QPS$, $\angle PSR$; $\angle PSR$, $\angle SRQ$; $\angle SRQ$, $\angle RQP$ and $\angle RQP$, $\angle QPS$

Pairs of opposite sides : $\overline{PS}$, $\overline{QR}$ and $\overline{QP}$, $\overline{RS}$

Pairs of opposite angles: $\angle QPS$, $\angle SRQ$ and $\angle PSR$, $\angle RQP$



(2) 100° (3) 48°, 72°, 96°, 144° (4) 90°, 90°, 90°, 90°

(5) 75°, 85°, 95°, 105°

(6) Angle of the quaderleteral cannot be 180°

Exercise - 2 (page - 242)

(1) (i) false (ii) true (iii) true (iv) false (v) false (vi) true (vii) true (viii) true

(2) (i) Since it has 4 sides (ii) Since opposite sides in a square are parallel

(iii) Since diagonals of a square are perpendicular bisectors

(iv) Since opposite sides of a square are of equal length.

(3) $\angle BAC = 140°$, $\angle DCA = 140°$, $\angle CDA = 40°$ (4) 50°, 130°, 50°, 130°

(5) It has 4 sides and one pair of parallel sides; $\overline{EA}$, $\overline{DR}$ (6) 1

(7) Opposite angles are not equal. (8) 15 cm, 9cm, 15cm, 9cm

(9) No Rhomsun should have equal length of sides (10) $\angle C = 150^{\circ}$, $\angle D = 150^{\circ}$

(11) (i) Rhombus (ii) Squrare (iii) 180° - x°

(iv) equal/congruent (v) 10 (vi) 90°

(vii) 0 (viii) 10 (ix) 45

13 - Area and Perimeter

Exercise - 1 (page - 245)

(1) $2(l+b)$; a^2 (2) 60 cm; 22cm; 484 cm^2 (3) 280cm^2; 68cm; 18cm; 216cm^2; 10cm; 50cm

Exercise - 2 (page - 249)

(1) (i) 28cm^2 (ii) 15cm^2 (iii) 38.76cm^2 (iv) 24cm^2 (2) (i) 91.2cm^2 (ii) 11.4cm
(3) 42cm ; 30cm (4) 8cm ; 24cm (5) 30m, 12m (6) 80m

Exercise - 3 (page - 252)

(1) (i) 20cm^2 (ii) 12cm^2 (iii) 20.25cm^2 (iv) 12cm (2) (i) 12cm^2 (ii) 3cm

(3) 30cm^2 ; 4.62 cm (4) 27cm^2 ; 7.2 cm

(5) 64cm^2 ; Yes ; ΔBEC, ΔBAE and ΔCDE are three triangles drawn between the two parallel lines BC and AD, BC = AE+AD

(6) Ramu in ΔPQR, PR is the base, because QS$\perp$PR. (7) 40 cm (8) 20 cm ; 40cm
(9) 20 cm (10) 800cm^2 (11) 220cm^2 (12) 192cm^2 (13) 18 cm ; 12cm

Exercise - 4 (page - 257)

(1) (i) 20cm^2 (ii) 24cm^2 (2) 96cm^2 ; 150 mm : 691.2m^2 (3) 18cm (4) 5062.5

Exercise - 5 (page - 260)

(1) (i) 220cm (ii) 26.4cm (iii) 96.8 cm (2) (i) 55m (ii) 17.6 m (iii) 15.4m

(3) (i) (a) 50.24 cm (b) 942 cm (c) 1256 cm(ii) 7 cm (4) 42 cm

(5) 10.5 cm (6) 3 times (7) 3 : 2 (8) 1.75cm (9) 94.20 cm (10) 39.25 cm

Exercise - 6 (page - 263)

(1) 475m^2 (2) 195.5m^2 (3) 304 m^2 (4) 68 m^2 (5) 9900 m^2; 200100m^2

14 - Understanding 3D and 2D Shapes

Exercise - 1 (Page - 265)

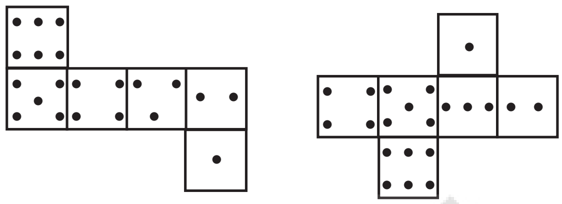
(1) Sphere: Foot ball, Cricket ball, Laddu
Cylinder: Battery, Biscuit pack, Log, Candle
Pyramid: Pyramid ; Cuboid: Match box, Sharpner, Biscuit pack
Cone : Ice-cream, Flower pot ; Cube: Dice, Carton

(2) (i) Cone: Ice-cream, upper part of a funnel (ii) Cube: Dice, Carton
(iii) Cuboid: Duster, Brick (iv) Sphere: Ball, Marble (v) Cylinder: Pencil, Pype.

(3)	Cube	Cuboid	Pyramid
Faces	6	6	5
Edges	12	12	8
Vertices	8	8	5

Exercise - 2 (Page - 267)

(1) Do activity (2) i) C ii) a (3)



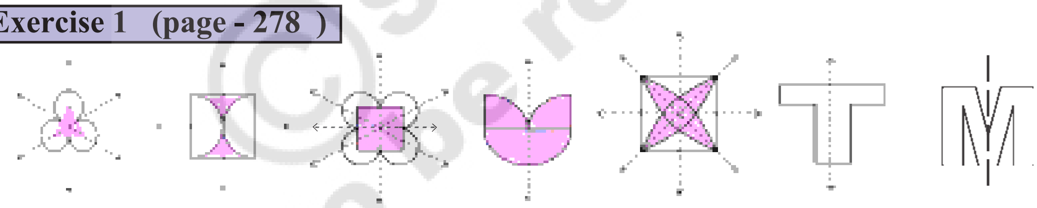
Exercise - 4 (Page - 276)

(1) A ball : a circle.
A Cylindrical pipe : a rectangle.
A book : a rectangle.

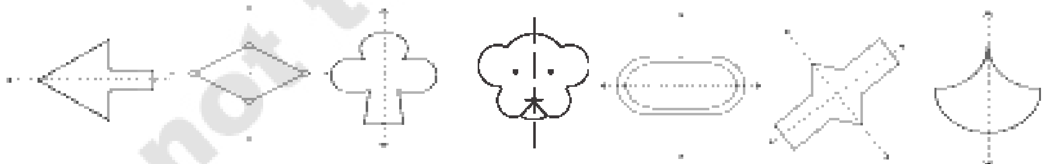
(2) (i) Spherical / Circular objects
(ii) Cube / Square sheets
(iii) Triangular shapes or Right prism with triangular base.
(iv) Cylinder / Rectangle sheets.

15 - Symmetry

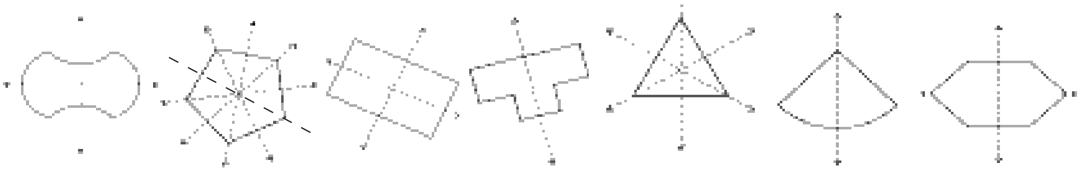
Exercise 1 (page - 278)



(i) (ii) (iii) (iv) (v) (vi) (vii)

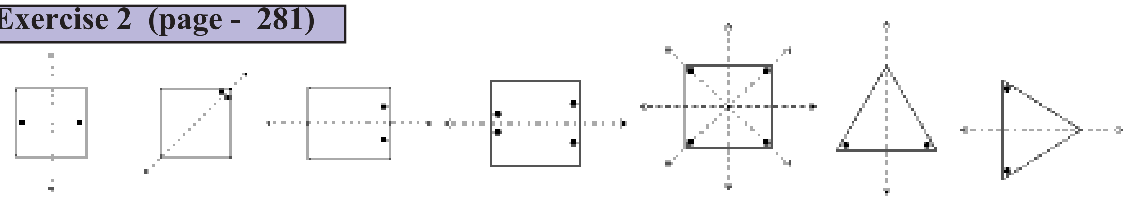


(viii) (ix) (x) (xii) (xiii) (xiv) (xv)

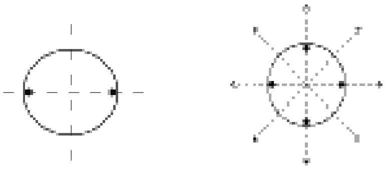


(xvi) (xvii) (xviii) (xix) (xx) (xxi) (xxiii)

Exercise 2 (page - 281)



(i) (ii) (iii) (iv) (v) (vi) (vii)

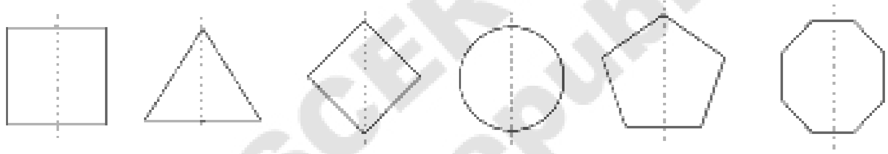


(viii) (ix)

(2)

(i) (ii) (iii) (ix)

(3)



(i) (ii) (iii) (iv) (v) (vi)

(4) (i) False (ii) True (iii) False

(5) Angle between successive axes = 360/2n =360/2x4 = 360/8 = 45^0
This is true for all regular polygons

Exercise 3 (page - 286)

1. Figures i, ii, iv and v have rotational symmetry.

2. (i) 2 (ii) 4 (iii) 3 (iv) 4 (v) 4 (vi) 5 (vii) 6 (viii) 3

3.

Square	yes	90^0	4
Rectangle	yes	180^0	2
Rhombus	yes	180^0	2
Equilateral Triangle	yes	120^0	3
Regular Hexagon	yes	60^0	6
Circle	yes	infinity	infinity
Semi-circle	No	-	-

Exercise 4 (page - 288)

1.

S	No	0	Yes	2
H	Yes	2	Yes	2
O	Yes	2	Yes	2
N	No	0	Yes	2
C	Yes	1	No	1

INSTRUCTIONS TO TEACHERS

Dear Teachers!!

Greetings and a hearty welcome to the newly developed textbook Mathematics for class VII.

- The present textbook is developed as per the syllabus and Academic standards conceived by the mathematics position paper prepared based on APSCF – 2011 and RTE – 2009 for Upper Primary stage of education.

- The new textbook constitutes 15 chapters with concepts from the main branches of mathematics like Arithemetics, Algebra, Geometry, Mensuration and Statistics.

- These chapters emphasize the prescribed academic standards in achieving the skills like Problem Solving, Reasoning-proof, Communication, Connectivity and representation. The staratagies in building a chapter are observation of patterns, making generalization through deductive, inductive and logical thinking, exploring different methods for problem solving, questioning, interaction and the utilization of the same in daily life.

- The situations, examples and activities given in the textbook are based on the competencies acquired by the child at Primary Stage. So the child participates actively in all the classroom interactions and enjoys learning of Mathematics.

- Primary objective of a teacher is to achieve the "Academic standards" by involving students in the discussions and activities suggested in the textbook and making them to learn the concepts.

- Mere completion of a chapter by the teacher doesn't make any sense. The exhibition of prescribed academic standards by the student only ensures the completion of the chapter.

- Students are to be encouraged to answer the questions given in the chapters. These questions help to improve logical, inductive and deductive thinking of the child.

- Understanding and generalization of properties are essential. Student first finds the need and then proceeds to understand, followed by solving similar problems on his own and then generalises the facts. The strategy in the presentation of concepts followed.

- Clear illustrations and suitable pictures are given wherever it was found connection and corrects the misconnection necessary.

- Exercises of 'Do This' and 'Try This' are given extensively after completion of each concept. Exercises given under 'Do This' are based on the concept taught. After teaching of two or three concepts some exercises are given based on them. Questions given under 'Try This' are intended to test the skills of generalization of facts, ensuring correctness of statements, questioning etc., 'Do This' exercise and other exercises given are supposed to be done by students on their own. This process helps the teacher to know how far the students can fare with the concepts they have learnt. Teacher may assist in solving problem given in 'Try This' sections.

- Students should be made to digest the concepts given in "looking back" completely. The next chapter is to be taken up by the teacher only after satisfactory performance by the students in accordance with the academic standards designated for them (given at the end).

- Teacher may prepare his own problems related to the concepts besides solving the problems given in the exercises. Moreover students should be encouraged to identify problems from day- to-day life or create their own.

- Above all the teacher should first study the textbook completely thoroughly and critically. All the given problems should be solved by the teacher well before the classroom teaching.

Happy Teaching.

Syllabus

<table>
<tr><td rowspan="2">Number System:
(50 hrs)
1. Integers
2. Fractions, Decimals & Rational Numbers</td><td>(i) Integers
• Multiplication and division of integers (through patterns).
• Properties of integers (including identities for addition & multiplication, (closure, commutative, associative, inverse, distributive) (through patterns). (examples from whole numbers as well). Expressing properties in a general form. Construction of counter examples, (eg. subtraction is not commutative).
• Word problems involvingintegers (all operations)</td></tr>
<tr><td>(ii) Fractions, Decimals and rationalnumbers:
• Multiplication of fractions
• Fraction as an operator “of”
• Reciprocal of a fraction and its use
• Division of fractions
• Word problems involving mixed fractions (related to daily life)
• Introduction to rational numbers (with representation on number line)
• Difference between fraction and rational numbers.
• Representation of rationalnumber as a decimal.
• Word problems on rationalnumbers (all operations)
• Multiplication and division of decimal fractions
• Conversion of units (length & mass)
• Word problems (including all operations)</td></tr>
<tr><td rowspan="3">Algebra
(20 hrs)
11. Exponents
10. Algebraic Expressions
3. Simple Equations</td><td>Exponents and powersIntroduction Meaning of x in a^x where a Ý Z
• Laws of exponents (throughobserving patterns to arrive at5 generalization.)whereM, n $\in$ N(i) a^m a^n = $a^{m?+n}$(ii)? $(a^m)^{?n}$ = a^{mn}(iii) a^m/a^n = a^{m-n}, where (m-n) $\in$ N(iv) $a^m.b^m$ = $(ab)^m$(v) number with exponent zerovi)Decimal number in exponential notation vii) Expressing large number in standard form (Scientific Notation)</td></tr>
<tr><td>ALGEBRAIC EXPRESSIONSIntroduction Generate algebraic expressions(simple) involving one or two variables
• Identifying constants, coefficient, powers
• Like and unlike terms, degree of expressions e.g., x^2y etc.(exponentd”?3, number of variables d”?2)
• Addition, subtraction of algebraic expressions (coefficients should be integers).</td></tr>
<tr><td>Simple equations
• Simple linear equations in one variable (in contextual problems) with two operations (integers as coefficients)</td></tr>
<tr><td>6. Ratio - Applications
(20 hrs)</td><td>• Ratio and proportion (revision)
• Unitary method continued,consolidation, generalexpression.
• Compound ratio : simple word problems
• Percentage- an introduction
• Understanding percentage as a fraction with denominator 100
• Converting fractions anddecimals into percentage andvice-versa.
• Application to profit and loss (single transaction only)
• Application to simple interest (time period in complete years).</td></tr>
</table>

Understanding shapes / Geometry

4. Lines and Angles
5. Triangle and Its Properties
8.Congurencey of Triangles
9.Construction of Triangles
12.Quadrilaterals
15. Symmetry
14.Understand-ing 3D and 2D Shapes

(i) Lines and Angles:

- Pairs of angles (linear,supplementary, complementary,adjacent, vertically opposite)(verification and simple proofof vertically opposite angles)
- Properties of parallel lines withtransversal (alternate,corresponding, interior, exteriorangles)

(ii) Triangles:

- Definition of triangle.
- Types of triangles acc. To sides and angles
- Properties of triangles
- Sum of the sides, difference of two sides.
- Angle sum property (with notion of proof and verification through paper folding, proofs , using property of parallel lines , difference between proof and verification
- Exterior angle property of triangle

(iii) Congruence:

- congruence through superposition **ex**. Blades, stamps etc..
- Extend congruence to simple geometrical shapes ex. Triange , circles,
- criteria of congruence (by verification only)
- property of congruencies of triangles SAS, SSS, ASA, RHS Properties with figures•

(iv) Construction of triangles (all models)

- Constructing a triangles when the lengths of its 3 sides are known (SSS criterion)
- Constructing a triangle when the lengths of 2 sides and the measure of the angle between them are known (SAS criterion)
- Constructing a triangle when the measures of 2 of its angles and length of the side included between them is given (ASA criterion)
- Constructing a right angled triangle when the length of one leg and its hypotenuse are given (RHS criterion)

(v) Quadrilaterals Quadrilateral-definition.

- Quadrilateral, sides, angles, diagonals.
- Interior, exterior of quadrilateral
- Convex, concave quadrilateral differences with diagrams
- Sum angles property (By verification) , problems
- Types of quadrilaterals
- Properties of parallelogram, trapezium, rhombus, rectangle, square and kite.

(vi) Symmetry

- Recalling reflection symmetry
- Idea of rotational symmetry,observations of rotationalsymmetry of 2-D objects. (900,1200, 1800)
- Operation of rotation through900 and 1800 of simple figures.
- Examples of figures with bothrotation and reflection symmetry(both operations)
- Examples of figures that havereflection and rotation symmetryand viceversa

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	(vii) Understanding 3-D and 2-D Shapes: • Drawing 3-D figures in 2-Dshowing hidden faces. • Identification and counting ofvertices, edges, faces, nets (forcubes cuboids, and cylinders,cones). • Matching pictures with objects(Identifying names)
Mensuration *(15 hrs)* **13. Area and Perimeter**	**Area and Perimeter** • Revision of perimeter and Area of Rectangle, Square. • Idea of Circumference of Circle. • Area of a triangle, parallelogram, rhombus and rectangular paths.
7. Data Handling (15 hrs)	**Data Handling** • Collection and organisation ofdata • Mean, median and mode ofungrouped data – understandingwhat they represent.Reading bar-graphs • Constructing double bar graphs • Simple pie charts with reasonable data numbers

Academic Standards

CONTENT	ACADEMIC STANDARDS	
Number system 1. Integers	**Problem Solving:**	• Solves the problems involving four fundamental operations of integers • Solves the word problems involving the integers. • Used brackets for solving problems to simplify numerical statements.
	Reasoning Proof:	• Explains why the division by zero is meaning less. • Differentiates and compares the set of Natural numbers with integers. • Gives examples and counter examples to the number properties such as closure, Commutative, Associative etc.
	Communication:	• Expressing the number properties of integers in general form. • Uses the negative symbol in different contexts.
	Connections:	• Finds the usage of integers from their daily life situations • Understands the relation among N, W and Z.
	Representation:	• Represents the integers on number line. • Performs the operations of integers on the number line.
2. Fractions, Decimals and Rational numbers	**Problem Solving:**	• Solves the problems in all operation of fractions. • Solves the word problems of all operations of rational numbers. • Solves the problems of all operations of decimal fractions • Converts the small units into large units and vice versa.
	Reasoning : and Proof	• Differentiates rational numbers with fractions. • Justifies density property in rational numbers
	Communication:	• Expresses the need of set of rational numbers • Expresses the properties of rational numbers in general form
	Connections:	• Finds the usage of / inter relation among fractions, rational numbers, and decimal numbers.
	Representation:	• Represents rational numbers on the number line. • Represents the rational numbers in decimal form.
Algebra: 11. Exponents and powers	**Problem Solving:**	• Writes the large numbers in exponential form by using prime factorization
	Reasoning : and Proof	• Generalizes the exponential laws through the observation of patterns
	Communication:	• Understands the meaning of x in a^x where a € z. • Uses of exponential form when using large numbers

	Connections:	• Uses prime factorization in expression of large numbers in exponential form
	Representation:	• Expresses the large numbers in standard form
Algebra: 10. Algebraic Expression 3. Simple Equations	**Problem Solving**	• Finds the degree of algebraic expressions • Doing addition, subtraction of algebraic expressions (Co-efficient should be integers) • Solves the word problems involving two operations (Which can be expressed as simple equation and single variable)
	Reasoning and Proof	• Generates algebraic expressions involving one or two variables by using the patters
	Communication:	• Writes the standard form of first, second, third order expressions in one or two variables • Converts the daily life problems into simple equations. (Contains one variable only)
	Connections:	• Uses closure, commutative etc. properties in addition and subtraction of algebraic expressions. • Uses solving simple equations in daily life situations.
	Representation:	• Represents algebraic expressions in standard forms
6. Ratio - Applications	**Problem Solving**	• Finds the compound, inverse ratio of 2 ratios • Solves word problems involving unitary methods • Solves word problems involving percentage concept • Solves word problems to find simple interest (Time period in complete years)
	Reasoning and Proof	• Compares the decimals, converting into percentages and vice versa. • Formulates the general principles of ratios and proportions
	Communication:	• Expresses the fractions into percentages and decimal forms and their usage.
	Connections:	• Uses profit and loss concepts in daily life situations (Single transactions only) • Understands and uses the solutions for percentage problems in daily life.
	Representation:	• Converts fractions and decimals into percentage form and vice versa.

Understanding Shapes / Geometry **4. Lines and Angles**	**Problem Solving**	• Solves problems on angles made by transversal intersecting parallel line
	Reasoning and proof	• Differentiates the types of pair of angles from given angles • Verifies the parallel ness of the given lines with the use of properties of parallel lines. • Proofs and verifies the angle sum property through paper folding and using property of parallel lines.
	Communication:	• Gives examples of pairs of angles.
	Connections:	• Observes the parallelness in surroundings.
	Representation:	• Represents the notation of angle.
5. Triangle and Its Properties	**Problem Solving**	• Determines whether the given lengths of sides are shapes suitable to make triangle. • Finds the angle which is not given from exterior and other angles of triangle.
	Reasoning and proof	• Makes relationship between exterior angle to its opposite. • Classifies the given triangles on the basis of sides and angles. • Estimates the kind of triangle by observing the given triangle.
	Communication:	• Explains the different types of triangles according to sides and angles. • Explains the property of exterior angle of triangle.
	Connections:	• Uses the concept of triangle.
	Representation:	• ______________________
8. Congruency of Triangles	**Problem Solving**	• Identifies the congruent triangles from given triangles suitable to make triangle.
	Reasoning and proof	• __________________________
	Communication:	• Appreciates the congruency in 2-D figures.
	Connections:	• ______________________
	Representation:	• Represents the congruent triangles using symbols, notation.

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9. Construction of Triangles	**Problem Solving**	• Construct triangles using given measurements.
	Reasoning and proof	• ________________________________
	Communication:	• ________________________________
	Connections:	• ________________________________
	Representation:	• ________________________________
12. Quardilateral	**Problem Solving**	• ________________________________
	Reasoning and proof	• Differentiates the convex, concave quadrilaterals. • Verifies and justifies the sum angle property of quadrilaterals.
	Communication:	• Explains the inter relationship between triangle and quadrilateral. • Explains the different types quadrilaterals based on their properties.
	Connections:	• Tries to define the quadrilateral. • Classifies the given quadrilaterals using their properties and their inter relationship.
	Representation:	• ________________________________
15. Symmetry	**Problem Solving**	• Rotate the figure and find its angular symmetry.
	Reasoning and proof	• Can differentiate linear and reflection symmetry using objectives or figures.
	Communication:	• Gives examples that have reflection symmetry.
	Connections:	• ________________________________
	Representation:	• ________________________________

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14.Understanding 3-D and 2-D shapes	**Problem Solving**	• Identifying and counting of faces, Edges, Vertices, nets for 3D Fig (Cube, Cuboid, Cone, Cylender).
	Reasoning and proof	• Matches picture with 3-D objects and visualize fells the Faces, Edges, Vertices etc.
	Communication:	• ______________________________
	Connections:	• ______________________________
	Representation:	• Can draw simple 3-D shapes in to 2-D figures.
Mensuration 13. Area and Perimeter	**Problem Solving**	• Solves the problem of Area and perimeter for square, rectangle, parallelogram, triangle and Rhombus shapes of things.
	Reasoning and Proof	• Understands the relationship between square, Rectangle, Parallelogram with triangle shapes for finding the area of triangle. • Understands the Area of Rhombus by using area of triangles.
	Communication:	• Explains the concept of Measurement using a basic unit.
	Connections:	• Applies the concept of Area perimeter to find the daily life situation problems (Square, Rectangle, Parallelogram, Triangle, Rhombus and Circle) • Applies the concept of area of Rectangle, Circle. • Finds the area of the rectangular paths, Circular paths.
	Representation:	• Represent word problems as figures.
7. Data Handling	**Problem Solving**	• Organization of raw data into classified data. • Solves the problems for finding the Mean, Medium, Mode of ungrouped data
	Reasoning	• Understands the Mean, Mode and Medium of ungrouped data and what they represent.
	Communication:	• Explains the Mean, Mode and Medium for ungrouped data.
	Connections:	• Understands the usage of Mean, Mode and Medium in daily life situation problems. • Understands the usage of double graphs and pie graphs in daily life situation (Year wise population, Budget, Production of crops etc.)
	Representation:	• Representation of Mean, Medium and Mode for ungrouped data. • Representation of the data in to double bar graphs and pie graphs.