MATHEMATICS

Class-VIII

Topic-14

VISUALISING SOLID SHAPES

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CH-14

VISUALISING SOLID SHAPES

TERMINOLOGIES

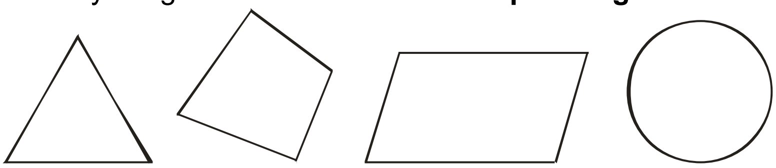
Plane figure, 2-dimensional figure, solid figures, 3-dimensional figures. pyramid, prism, polyhedron, convexpolyhedron, regular polyhedron, vertex, faces, euler 'sbformula, cylinder, cone, sphere, net pattern, triangular prism, rectangular prism, square prism, cube, pentagonal prism, triangular pyramid (tetrahedron), regular octahedron, pentagonal pyramid, edges, square pyramid.

INTRODUCTION

In previous classes, we have learnt about 2-dimensional and 3-dimensional geometric figures. In 2-D figures and 2 dimensions are known i.e. length and breadth for example triangle, square, rectangle etc. Where as 3-D figures have 3-dimensions ie., length, breadth and height for example cuboid, cube, prism etc. As we live in 3-d world, so in this chapter we will discuss more about 3-dimensional shapes.

14.1 VISUALISING SOLID SHAPES

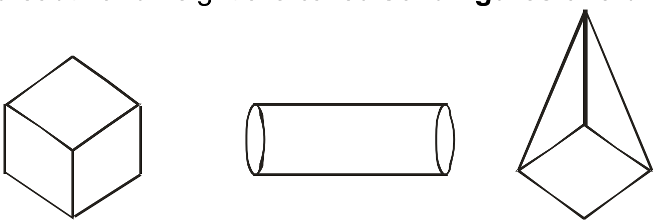
The figures such as triangles, rectangles, squares, circles etc., which have only two dimensions, namely length and breadth are called **plane figure** or **2- dimensional figure.**



Plane figure (2-dimensional figure)

Plane figure (2-dimensional figure)

The figures such as cube, cuboid, cylinder, pyramid etc., which have three dimensions, namely length, breadth and height are called **solid figures** or **3-dimensional figures.**



Solid figure (2-dimensional figure)

Solid figure (3-dimensional figure)

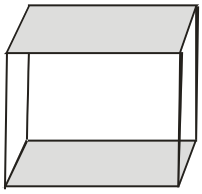
(a) Types of solid

(i) Polyhedron : A solid which is made up of polygonal regions (called faces) is called a polyhedron. Two adjoining faces of polyhedron meets at an edge, which is a line segment. Two adjoining edges of polyhedron meet at a vertex which is a point

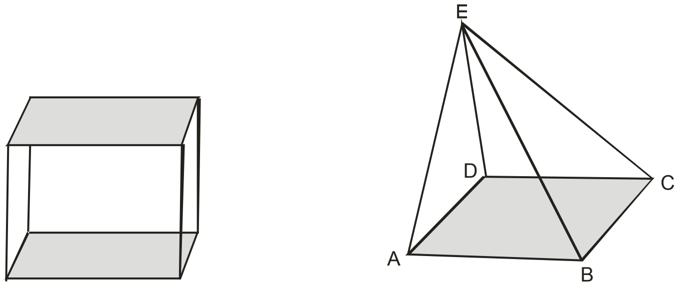
NOTE :

Cylinder, Cone, Sphere etc. are not polyhedron as their faces are not polygons.

(A) Convex Polyhedrons : The idea of convex polyhedrons comes from convex polygon. A convex polyhedron is one whose all faces are convex polygons.



(B) Regular Polyhedron : A polyhedron is regular if all its faces are regular polygons and same number of faces meet at each vertex.



(i) **(ii)**

In fig. (i) all faces are regular and at all vertex same number of faces meet (i.e 3 faces), so it is a regular polyhedron

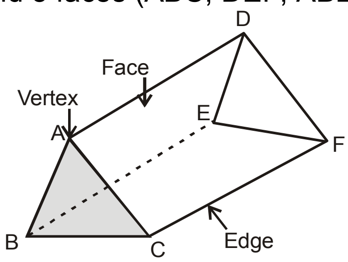
In fig. (ii) at vertex B, 3 adjoining faces meet where as at vertex E, 4 adjoining faces meet, (i.e. unequal no. of faces meet at vertex) so it is not a regular polyhedron.

(C) Special Types of Polyhedron :

(i) Prism

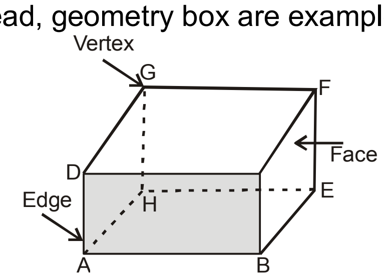
(1) Triangular prism : A prism which has a uniform triangular cross section is called a triangular prism.

In figure triangular prism has 6 vertices (A, B, C, D, E and F); 9 edges (AB, BC, AC, AD, BE, CF, DE, EF, and DF) and 5 faces (ABC, DEF, ABED, BCFE and ACFD).

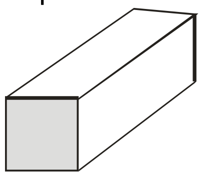


(2) Rectangular prism (cuboid) : A prism which has a uniform rectangular cross section is called a rectangle prism. A rectangular prism has 8 vertices, 12 edges and 6 faces.

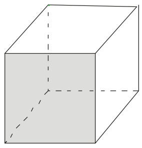
Match boxes. Loaf of a bread, geometry box are examples of cuboid.



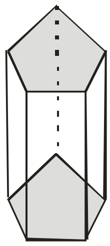
(3) Square prism : A prism which has a uniform squared cross section is called a square prism, like rectangular prism, square prism also has 8 vertices, 12 edges and 6 faces.



(4) Cube : A square prism whose all faces are squares is called a cube.
A sugar lump, die etc., are examples of a cube.

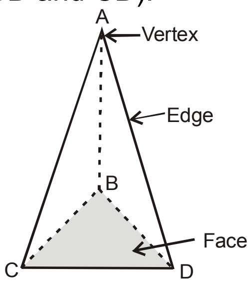


(5) Pentagonal Prism : A prism which has uniform pentagonal cross section is called pentagonal prism. A pentagonal prism has 10 vertices, 7 faces and 15 edges.



(ii) Pyramid

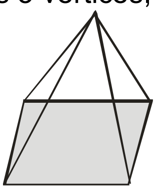
(1) Triangular Pyramid : A pyramid whose base is triangle is called a triangular pyramid. In figure triangular pyramid has 4 vertices (A, B, C and D); 4 faces (ABC, ABD, ACD, BCD) and 6 edges (AB, AD, AC, BC, BD and CD).



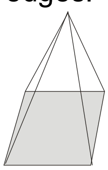
NOTE :

A triangular pyramid is also called a tetrahedron. (tetra = four and hedron = face)

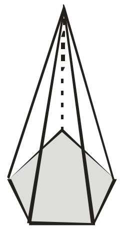
(2) Rectangular Pyramid : A pyramid whose base is rectangle is called **Rectangular Pyramid**. A rectangular pyramid has 5 vertices, 8 edges and 5 faces.



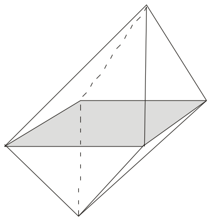
(3) Square Pyramid : A pyramid whose base is a square called square pyramid. A square pyramid has 5 vertices, 5 faces and 8 edges.



(4) Pentagonal Pyramid : A pyramid whose base is a pentagon is called a pentagonal pyramid. A pentagonal pyramid has 6 vertices, 6 faces and 10 edges.



(5) Regular octahedron : It is a combination of two square pyramids whose faces are equilateral triangle: A regular octahedron has 6 vertices, 12 edges and 8 faces.



NOTE :

(i) All the side faces of a pyramid (triangular, rectangular, squares, pentagonal etc.) are triangular.

(ii) A pyramid is named according to the shape of its non-triangular face. If all the faces are triangular, then it is called a triangular pyramid or tetrahedron.

(iv) **Euler's Formula :**
The number of faces, edges and vertices of prism and pyramids are connected by the formula V + F – E = 2, where V, F and E stand for number of vertex , face and edge. This formula is known as **Euler's formula.**

Illustration 14.1

A polyhedron has 30 edges and 20 vertices. How many faces does the polyhedron have?

Sol. Here, E = 30, V = 20

$\Rightarrow$ V + F – E = 2

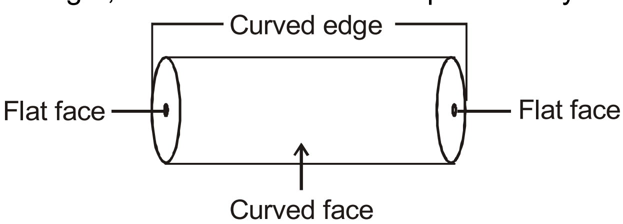
$\Rightarrow$ 20 + F – 30 = 2

$\Rightarrow$ F= 2 – 20 + 30 = 12

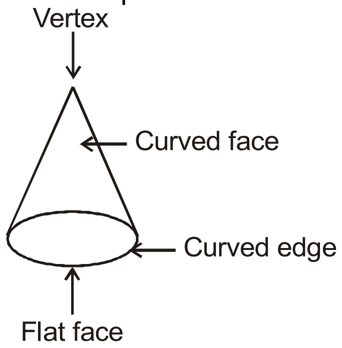
Hence , the polyhedron has 12 faces.

(b) Some other solid's

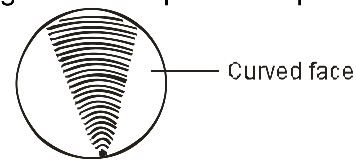
Cylinder : A cylinder has 3 faces, 1 curved face and 2 flat faces. It has 2 curved edges. It has no vertex. A tube light, tin containers are examples of a cylinder.



Cone : A cone has 1 vertex, 1 curved edge and 2 faces 1 curved and 1 flat face. Icecream cones, joker's cap are examples of a cone.



Sphere : A sphere has 1 curved face. It has no vertex and no edge. A football, marbles, an orange are examples of a sphere.



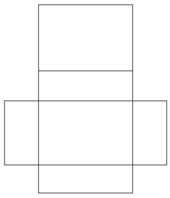
The following table gives the summary of all the above observations :

Solid	No. of faces	No. of vertices	No. of edges
Cube	6	8	12
Cuboid	6	8	12
Cylinder	3	–	2
Cone	2	1	1
Sphere	1	–	–
Triangular prism	5	6	9
Triangular pyramid	4	4	6
Square pyramid	5	5	8
Rectangular pyramid	5	5	8

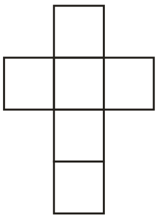
(c) Nets

In order to understand dimensional objects more closely, we try to form these objects from their nets. A net for a three dimensional shape is nothing but a sort of skeleton-outline in 2-dimension which, when folded, results in three dimensional shape.
Following are net patterns for different three dimensional shapes :

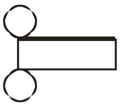
(i) Net pattern for a cuboid



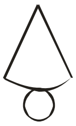
(ii) Net pattern for cube



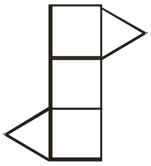
(iii) Net pattern for a cylinder



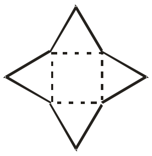
(iv) Net pattern for a cone



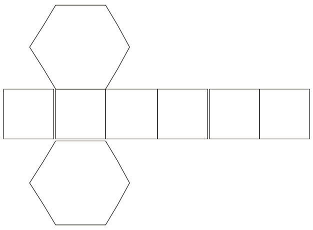
(v) Net pattern for a triangular prism



(vi) Net pattern for a square pyramid

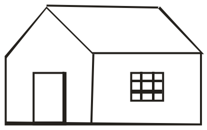


(vii) Net pattern for a hexagonal prism.

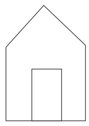


(d) View of 3D-Shapes

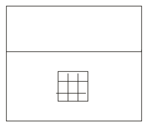
As we know that a 3-dimensional object can look differently from different positions so they can be drawn from different perspectives. For example, a given hut can have the following views.



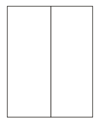
Object



Front view (from right)

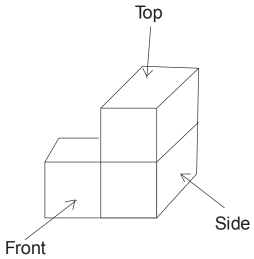


Side view

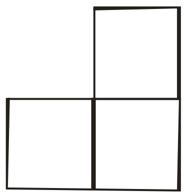


Top view

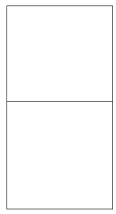
We can also get different views of figures made by joining cubes. For example an object made of three cubes.



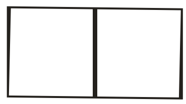
Object



Front view (from right)



Side view



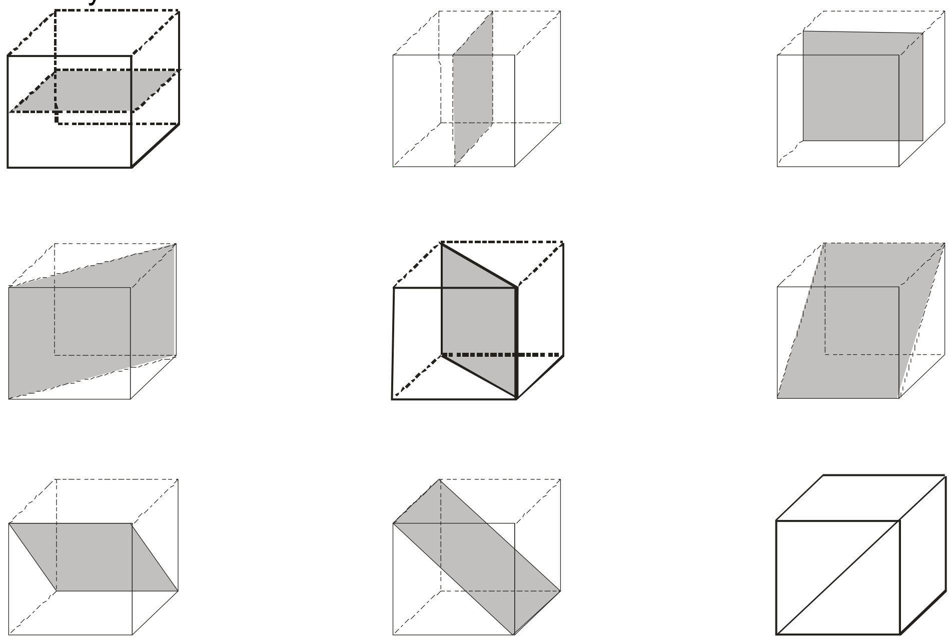
Top view

Ask yourself

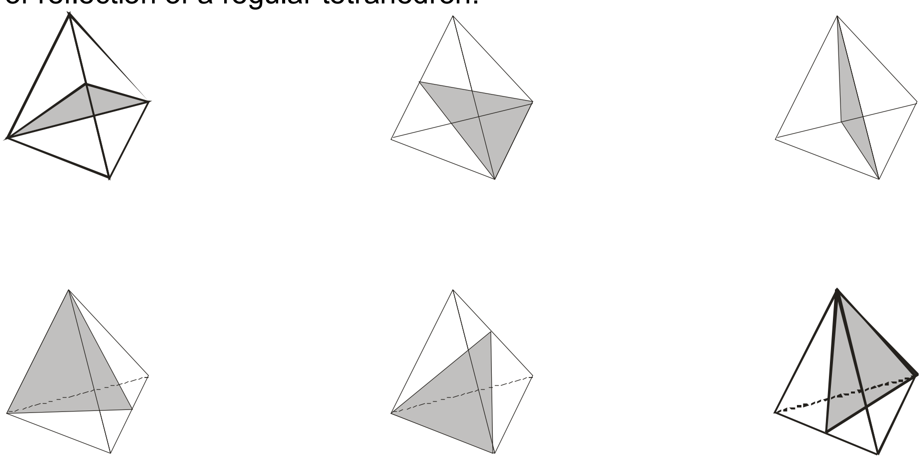
1. Can a polyhedron have 10 faces, 20 edges and 15 vertices ?
2. For the following figures verify the Euler's formula :
   (i) Cube
   (ii) Triangular Prism
   (iii) Hexagonal Pyramid.
3. Draw the net of open cylinder.
4. Draw the net of cone.

Add your knowledge

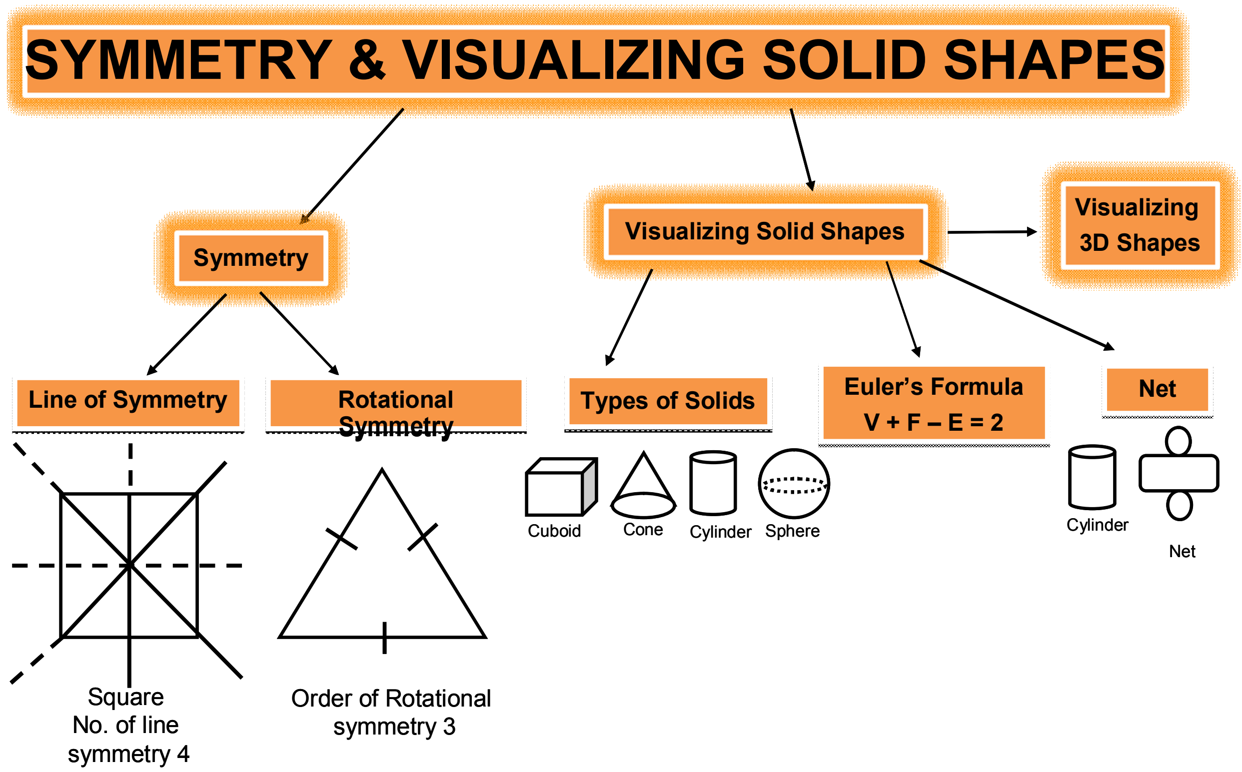
1. The 9 plane symmetries of the cube.



2 Planes of reflection of a regular tetrahedron.



Concept Map



Summary

1. A solid which is made up of polygonal regions is called polyhedron.

2. Cylinder, cone, sphere etc are not polyhedrons as their faces are not polygons.

3. There are 2 types of polyhedrons convex polyhedron and regular polyhedron.

4. A triangular pyramid is also called a tetrahedron.

5. All the side faces of a pyramid are triangular.

6. Pyramid is named according to the shape of its bottom face.

7. Euler's formula,

$$V + F - E = 2$$

where V = number of vertex
F = number of faces
E = number of edges.

Exercise-1

SECTION -A (FIXED RESPONSE TYPE)

MULTIPLE CHOICE QUESTIONS

1. A line where two faces of a solid meet is called :
(A) Edge (B) Vertex (C) Surface (D) Curved face

2. The corner where three faces of a solid meet is called :
(A) Edge (B) Vertex (C) Surface (D) Curved face

3. A rectangular prism is also called :
(A) Square (B) Cube (C) Cuboid (D) Rectangle

4. A tetrahedron is also called :
(A) Triangular pyramid (B) Triangular prism
(C) Square pyramid (D) Rectangular pyramid

5. A triangular pyramid has :
(A) 3 faces (B) 4 faces (C) 5 faces (D) 6 faces

6. A cube has :
(A) 12 edges, 8 vertices (B) 10 edges, 8 vertices
(C) 12 edges, 6 vertices (D) 10 edges, 6 vertices

7. A square pyramid has :
(A) 4 triangular faces (B) 3 triangular faces (C) 5 triangular faces (D) 1 triangular faces

8. A rectangular pyramid has :
(A) 8 edges, 5 vertices (B) 10 edges, 5 vertices
(C) 12 edges, 6 vertices (D) 8 edges, 4 vertices

9. A cylinder has :
(A) 2 curved faces (B) 3 curved faces (C) 5 curved faces (D) 1 curved face

10. A sphere has :
(A) 2 curved faces (B) 3 curved faces (C) 5 curved faces (D) 1 curved face

FILL IN THE BLANKS

1. Solid whose base is polygon and side faces are triangles, is ______________

2. Triangular prism has __________ vertices.

3. Cone has ____________ faces.

4. V + F – E = 2 is known as __________

5. Cube has _________ edges.

6. Square pyramid has base as __________

7. Cylinder has __________ faces.

8. All the side faces of a pyramid are ________

9. Cuboid has ____________ edges.

TRUE / FALSE

1. In prism, base and top are different polygon.

2. In pyramid, side faces are triangles.

3. Sphere has 1 curved face, no vertex, no edge.

4. Pyramid is named according to the shape of its non-trianglular face.

5. In Sphere there is no edges.

MATCH THE COLUMN

1.

Column – I		Column – II	
(A)	Vertices of cone	(p)	V + F – E = 2
(B)	No. of edges of trianglular pyramid	(q)	9
(C)	Faces of cylinder	(r)	1
(D)	edges of triangular prism	(s)	3
(E)	Euler's formula	(t)	6

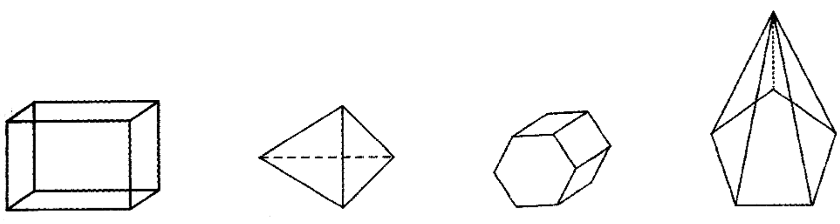
SECTION -B (FREE RESPONSE TYPE)

VERY SHORT ANSWER TYPE

1. Which of the following are plane figures and which are solid figures ?
Rhombus, hexagon, cylinder, trapezium, circle, sphere, squares prism, pyramid, octagon.

2. Base of a pyramid is Hexagonal and all other faces are triangular. Name the pyramid.

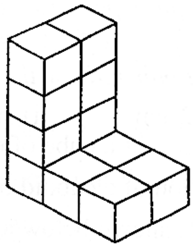
3. Name the following solid shapes :



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

4. Give two real life examples of each of the following shapes :
(i) cube **(ii)** cuboid **(iii)** cylinder
(iv) cone **(v)** sphere **(vi)** triangular prism

5. How many cubes are there in the figure :



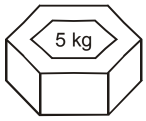
SHORT ANSWER TYPE

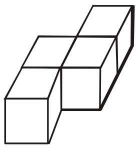
6. A polyhedron has 8 faces and 12 vertices. How many edges does this polyhedron have?

7. Is a square prism same as a cube ? Explain.

8. Can a polyhedron have for its faces.
(i) 3 triangles? **(ii)** 4 triangles?

9. Draw the front, side and top view for the given object.

(i) 

(ii) 

LONG ANSWER TYPE

10. Write down the number of vertices in each of the following solids:
(i) Cube **(ii)** Cone **(iii)** Tetrahedron **(iv)** Triangular prism
(v) Rectangular pyramid

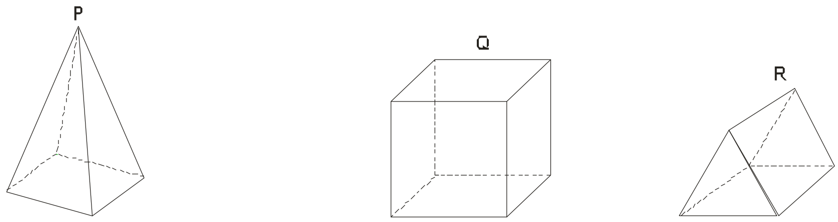
11. Give the geometrical name for each of the following :
(i) book **(ii)** die **(iii)** fridge **(iv)** football
(v) unsharpened pencil

Exercise-2

SECTION -A (COMPETITIVE EXAMINATION QUESTION)

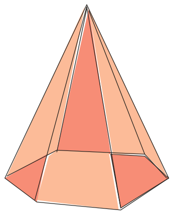
MULTIPLE CHOICE QUESTIONS

1. Identify P, Q and R.



	P	Q	R
(A)	Rectangular prism	Square prism	Triangular pyramid
(B)	Rectangular pyramid	Square Prism	Triangular prism
(C)	Rectangular pyramid	Square Prism	Cuboid
(D)	Square prism	Rectangular Prism	Triangular pyramid

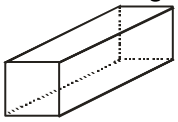
2. The given figure has

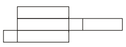
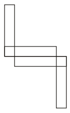
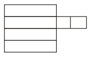
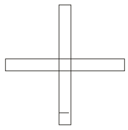


(i) Faces : _______________
(ii) Edges : _______________
(iii) Corners : _______________

(A) 8, 12, 7 (B) 6, 11, 6 (C) 7, 12, 7 (D) 5, 11, 7

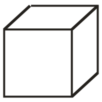
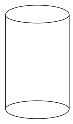
3. The figure shows a solid. Which of the following options is NOT a net of the solid ?

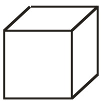
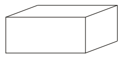


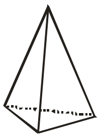
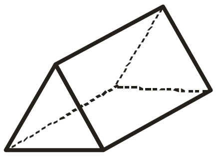
(A)  (B)  (C)  (D) 

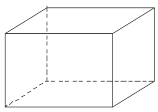
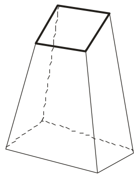
4. Which of the following figures satisfy the given conditions ?

Figure :(i) **Faces : 4** **Figure** **(ii)** **Faces : 5**
Edges : 6 **Edges : 9**
Vertices : 4 **Vertices : 6**

(A) (i)  (ii) 

(B) (i)  (ii) 

(C) (i)  (ii) 

(D) (i)  (ii) 

5. In a solid F=V=5 then determined the which type of solid it is
(A) square pyramid (B) triangular pyramid
(C) triangular prism (D) cuboid

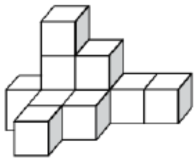
6. Which of the following canot be true for a polyhedron?
(A) V = 6, F = 4, E = 8 (B) V = 4, F = 4, E = 6
(C) V = 4, F = 4, E = 4 (D) V = 8, F = 6, E = 12

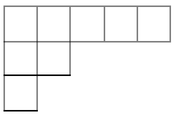
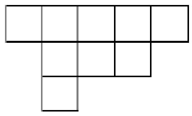
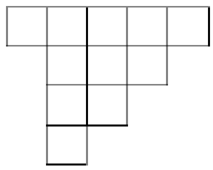
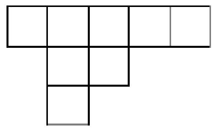
7. In a blueprint of a room, an architect has shown the height of the room as 33 cm. if the actual height of the room is 330 cm, then the scale used by her is
(A) 1:11 (B) 1:10 (C)1:100 (D) 1:318

8. Which of the following is a regular polyhedron?
(A) cuboid (B) triangular prism (C)cube (D) square prism

Direction:(For Q.no. 9 and 10)

9. The diagram given shows a three-dimensional object made of 11 identical cubes.
Which of the following best represents the top view of this three-dimensional object?



(A)  (B)  (C)  (D) 

10. Find the no of the cubes
(A) 8 (B) 9 (C)10 (D) 11

SECTION -B (TECHIE STUFF)

11. How many plane symmetry does a regular hexagonal prism ?
(A) 6 (B) 9 (C)12 (D) 18

12. How many plane symmetry does a regular tetrahedron have ?
(A) 3 (B) 4 (C) 6 (D) 9

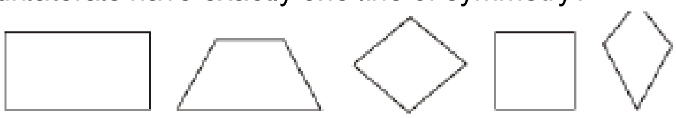
Exercise-3

(PREVIOUS YEAR EXAMINATION QUESTIONS)

1. The shapes formed by rotating a right triangle about its height is **[NSTSE - 2009]**
(A) Cuboid (B) Cone (C) Cylinder (D) Sphere

2. Which of the following does not have a vertex ? **[NSTSE - 2010]**
(A) Cube (B) Pyramid (C) Cylinder (D) Cone

3. Which two quadrilaterals have exactly one line of symmetry? **[IMO - 2010]**

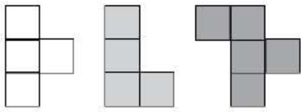


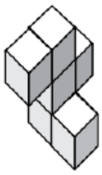
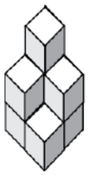
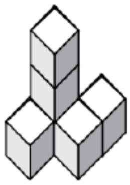
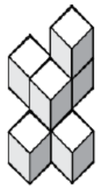
(1) (2) (3) (4) (5)

(A) (1) and (5) (B) (2) and (3) (C) (1) and (4) (D) (2) and (5)

4. A polyhedron has 11 faces and 18 vertices. Find the number of edges ? **[NSTSE - 2012]**
(A) 15 (B) 27 (C) 33 (D) 21

5. The adjoining Figure shows 3 different views of a three-dimensional figure constructed from cubes. Which could be the correct option? **[IMO - 2012]**

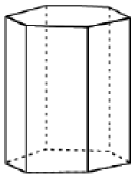


(A)  (B)  (C)  (D) 

6. Which of the following pictures appears to have rotational symmetry? **[IMO - 2012]**

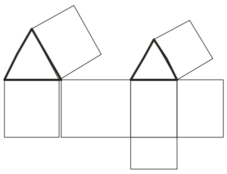
(A)  (B)  (C)  (D) None of these

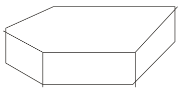
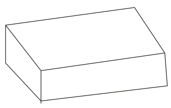
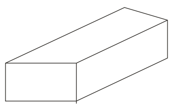
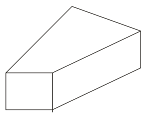
7. The number of edges of the given figure is **[IMO - 2012]**



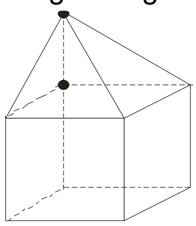
(A) 18 (B) 12 (C) 14 (D) 16

8. Which of the following solids can be formed from the net in the given figure ? **[NSTSE - 2013]**



(A)  (B)  (C)  (D) 

9. How many faces does the solid in the given figure have ? **[NSTSE - 2013]**



(A) 5 (B) 7 (C) 8 (D) 9

Answer Key

Exercise-1

SECTION -A (FIXED RESPONSE TYPE)

MULTIPLE CHOICE QUESTIONS

Ques.	1	2	3	4	5	6	7	8	9	10
Ans.	A	B	C	A	B	A	A	A	D	D

FILL IN THE BLANKS

1. Pyramid **2.** 6 **3.** 2 **4.** Euler's Formula

5. 12 **6.** A square **7.** 3 **8.** Triangle

9. 12

TRUE / FALSE

1. False **2.** True **3.** True **4.** True

5. True

MATCH THE COLUMN

1. (A) – r, (B) – t, (C) – s, (D) – q, (E) – p

SECTION -B (FREE RESPONSE TYPE)

VERY SHORT ANSWER TYPE

1. Plane figures $\rightarrow$ Rhombus, Hexagon, Trapezium, Circle, Octagon
Solid figures $\rightarrow$ Cylinder, Sphere, Square Prism, Pyramid, Cube.

2. Hexagonal pyramid

3. **(i)** Cuboid **(ii)** Triangular pyramid
(iii) Hexagonal prism **(iv)** Pentagonal pyramid.

4. **(i)** Dice, Rubik' Cube **(ii)** Bricks, Book **(iii)** Pipe, Cell
(iv) B'day cap, Softy ice cream **(v)** Ball, Lunch Box
(vi) Toblerone Chocolate rapper, Trekking tents

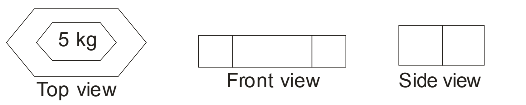
5. 12

SHORT ANSWER TYPE

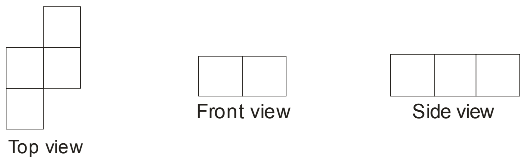
6. 18 **7.** No, it can be cuboid also.

8. **(i)** yes, triangular pyramid **(ii)** yes, square pyramid

9. **(i)**



(ii)



LONG ANSWER TYPE

10. **(i)** 8 **(ii)** 1 **(iii)** 4 **(iv)** 6
(v) 5

11. **(i)** cuboid **(ii)** cube **(iii)** cuboid **(iv)** sphere
(v) cylinder

Exercise-2

SECTION -A (COMPETITIVE EXAMINATION QUESTION)

MULTIPLE CHOICE QUESTIONS

Ques.	1	2	3	4	5	6	7	8	9	10	11	12
Ans.	B	C	C	C	A	C	B	C	D	D	C	C

Exercise-3

PREVIOUS YEAR EXAMINATION QUESTIONS

Ques.	1	2	3	4	5	6	7	8	9
Ans.	B	C	D	B	A	C	A	A	D