

SHAPE AND STRUCTURE

**An explanation of
Mathematical terminology**

2005

POINT

- A dot
- Dots join to make lines

LINE

- A line is 1 dimensional (length)
- A line is a series of points touching each other and extending infinitely in both directions
- A line can be straight (this is the shortest distance between two points) or curved (a line in which no part is straight)
- A curved line may be open (not joining) or closed (joining).
- A Line segment is a part of a straight line.
- Line segments can be joined to make shapes.

TWO DIMENSIONAL SHAPES

- When curved or straight lines join they make a two dimensional shape
- Its sides may be straight or curved lines.
- They may be convex or concave
- They may have one or more lines of symmetry and they may also have rotational symmetry
- The two dimensions are length and width
- Two dimensional shapes are also called plane shapes
- They can be drawn on a plane (flat) surface
- They may also be called figures.

TWO DIMENSIONAL SHAPES WITH CURVED SIDES

- Circle
 - A closed curved shape with all points of the shape equal distance from the centre point
 - The perimeter (boundary) of a circle is called the circumference
 - A line segment that passes from one side of the circle through the centre to the other side is called the diameter of a circle
 - A line segment that passes from the centre of the circle to the circumference is called the radius of the circle. It is half of the diameter.
- Semicircle
 - Half a circle.
- Ellipse or Oval
 - An egg shaped closed curve with one line of symmetry.

TWO DIMENSIONAL SHAPES WITH STRAIGHT SIDES

Polygons

- A polygon is a plane shape consisting of three or more straight line segments that have joined to make a closed shape.
- There are many different types of polygons
- Polygons are classified according to the number of sides they have
- If a polygon has all equal sides and all equal angles it is a **regular** polygon.
- If not all sides or angles are equal the polygon is **irregular**.
- Polygons may be congruent (exactly the same shape and size) or similar (same shape but different size)

Triangles are polygons.

- A triangle is a plane shape with three straight sides and three angles
- The angles inside a triangle always add up to 180 degrees
- Triangles are classified according to their properties*.
 - Equilateral triangles have three equal sides and three 60 degree angles. They are regular
 - Isosceles triangles have two equal sides and two equal angles. They are irregular.
 - Scalene triangles have three different length sides and three different angles. They are irregular.
 - A Right angled triangle is a triangle with one right angle
 - If all angles are smaller than a right angle, the triangle can also be known as an acute triangle
 - If one angle is larger than a right angle the triangle can also be known as an obtuse triangle

Quadrilaterals are polygons

- A quadrilateral is a plane shape with four straight sides and four angles
- The angles inside a quadrilateral always add up to 360 degrees
- Quadrilaterals are classified according to their properties*.
 - Most are convex shapes

Parallelograms are quadrilaterals with two pairs of parallel sides

- a rectangle is a special type of parallelogram . It has two sets of opposite sides that are equal in length and all angles 90 degrees.
- a rhombus is a special type of parallelogram. It has four equal sides and opposite angles which are equal.
- a square is a special type of rectangle because it has four equal sides and four right angles. It is regular.
- a trapezium or trapezoid has one pair of parallel sides.
- an isosceles trapezoid has one pair of opposite sides that are congruent (equal)
- a kite has two pairs of adjacent sides equal in length, with the shorter pair pointing away from the longer pair.
 - One is concave
- an arrowhead has two pairs of adjacent sides equal in length, with the shorter pair pointing towards the larger pair

Polygons with more than four sides also have special names. They can be regular or irregular.

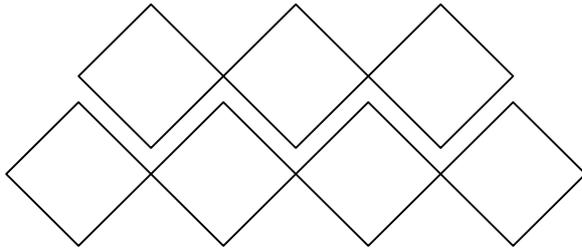
◆ five sides	pentagon
◆ six sides	hexagon
◆ seven sides	heptagon
◆ eight sides	octagon
◆ nine sides	nonagon
◆ ten sides	decagon
◆ eleven sides	hendecagon
◆ twelve sides	dodecagon
◆ twenty sides	icosagon

***PROPERTIES OF TWO DIMENSIONAL SHAPES**

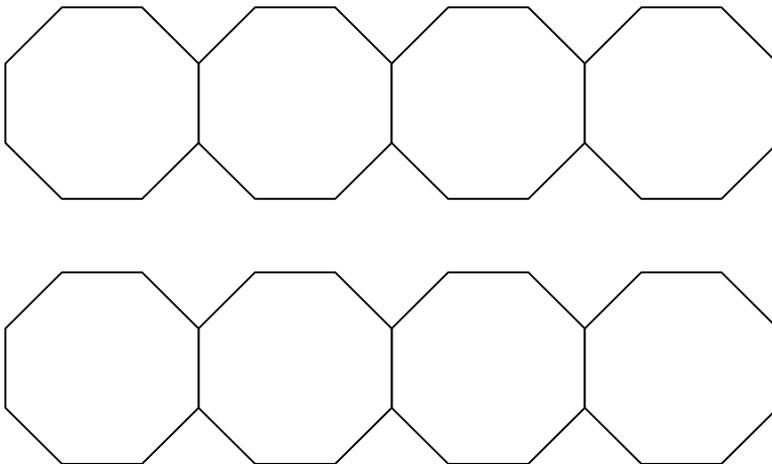
- Sides
 - a line segment between two corners on a polygon
- Angle
 - an angle measures the degree of turn between two line segments joined at a common point
 - interior and exterior angles can be measured
- Diagonals
 - a line joining two corners which are not next to each other in a polygon
- Concave- a shape with a “dent” in it
- Convex – a shape with no “dents”
- Symmetry
 - Mirror symmetry – a shape has mirror symmetry or is symmetrical if one half can fit exactly onto the other half
 - If a whole shape is flipped over, it will be symmetrical with the shape in the original position
 - Rotational symmetry – a shape has rotational symmetry if you turn it about a point and as you turn it fits exactly over the original shape.

- Tessellations

- Shapes tessellate if they fit together without leaving any gaps and without overlapping.
- A tessellating design uses one or more plane shapes in a repeating pattern
- A **regular tessellation** is made of a single tile that is a regular polygon (all sides and angles congruent)



- A **semi-regular tessellation** is made of two or more tiles, each of which is a regular polygon



- **Escher-type tessellations** - Escher took a simple shape like a triangle or a square and performed transformations on each side

THREE DIMENSIONAL SHAPES

- When plane figures join, they make three dimensional shapes
- The three dimensions are length, width and height
- Three dimensional shapes are also called objects, or solids, or polyhedra (polyhedron)
- They may be open or closed
- Their surfaces may be curved or flat. Flat surfaces are called faces
- If all the surfaces of an object are flat (faces), all of the edges will be straight lines
- Faces may or may not be parallel
- They may be regular or irregular
- Three dimensional shapes are classified by their properties*

CLASSIFICATIONS OF THREE DIMENSIONAL SHAPES

- **Spheres and other “rounded” shapes**
 - A sphere is a perfectly round object (like a ball) with all points on the surface equal distance from the centre. Spheres have one curved surface, no edges and no corners
 - Some shapes have curved surfaces with edges but no vertices eg a flying saucer
 - Some shapes have vertices but no edges eg a football
 - An egg shaped object is called an ovoid
- **Cylinders**
 - an object with two congruent parallel faces called bases. The lines joining corresponding points on the two bases are always parallel. These lines are called elements of the cylinder
 - in a right cylinder the elements are perpendicular to the bases. If the elements are not perpendicular to the bases it is called an oblique cylinder.
 - the cylinders we are most familiar with have circles as its bases

-**PRISMS** are a special type of cylinder. They have polygons as their bases. The shapes joining the bases is always a rectangle.

-Prisms are named according to their base, eg

- Triangular prisms
- Square prisms
- Rectangular prisms
- Pentagonal prisms
- Hexagonal prisms etc

- a **CUBE** is a special type of cylinder and prism, having 6 congruent square faces

- rectangular prisms are sometimes called **cuboids**

- **Cones**

-a three dimensional object with exactly one face and a vertex that is not on the face. Straight lines (elements) can be drawn from any point on the edge of the base to the vertex. The base can be any shape. The vertex need not be directly over the base.

-a **circular CONE** has a circular base (these are the cones we are most familiar with)

-**PYRAMIDS** are a special type of cone. They have a polygon as a base and all faces joining the base and the vertex are triangles

- Pyramids are named according to the shape of the base eg

- Triangular based pyramid
- Square based Pyramid
- Pentagonal based pyramid
- hexagonal based pyramid etc

-Pyramids where the vertex is not directly over the centre of the base are called oblique pyramids

***PROPERTIES OF THREE DIMENSIONAL SHAPES**

Surfaces

- The surface of a three dimensional shape may be curved or flat

Faces

- The face of a three dimensional shape is a flat surface

Edges

- The lines where two surfaces (or faces) meet
- If all the surfaces of a three dimensional shape are flat the edges will be straight lines

Vertices

- The corner where two or more lines meet

Three dimensional shapes may:

- Tessellate (stack and pack)
- Be symmetrical
- Be regular – all faces are congruent eg
Tetrahedron, cube, octahedron, icosahedron, dodecahedron

OR

- Irregular