Basic Geometrical Ideas For Kids Includes Circle, Triangle and Quadrilateral

Rishikesh Biswas

Abstract- *Prepare to be astounded as we shatter the myth that geometry is a tedious and insurmountable mountain! This paper is not just a source of knowledge; it's a portal to a universe of captivating and mind-bending geometric wonders. Geometry, often dismissed as dry and challenging, is in reality an exhilarating field of mathematical marvels. Picture this: in today's educational landscape, it's not merely about studying "some figures"; it's a dynamic journey through the enchanting world of shapes.*

From the earliest stages in kindergarten to the developmental years of 1st and 2nd standard, students don't just learn shapes; they become architects of miniature worlds, crafting houses, cars, and more. And just when you think it can't get more intriguing, behold the evolution into polygons—closed masterpieces defined by straight lines, a symphony of mathematical elegance.

Fast forward to senior classes, where the complexity skyrockets. Students don't just acquire new properties; they feast on a banquet of formulas, unravelling the secrets of geometry. In essence, this paper promises not just learning but a revelation of countless new concepts, turning the supposedly mundane subject into an awe-inspiring journey of discovery. Brace yourselves for an exploration that transcends the ordinary and reshapes your perception of geometry!

I. INTRODUCTION

Hold onto your intellectual hats because in this groundbreaking paper, we're not just scratching the surface – we're diving headfirst into the vast, uncharted ocean of mind-bending geometric wonders!

Now, brace yourself for the revelation: geometry, the mystical realm within the grand kingdom of mathematics, is not merely about 'some figures.' No, no! It's an epic saga, a cosmic odyssey where we unravel the very fabric of shapes and their secrets.

Picture this: in the current educational landscape, geometry isn't just a subject; it's a rite of passage for our budding scholars. Think kindergarten, think 1st and 2nd standard – these pint-sized prodigies are already crafting the basic building blocks of the universe: shapes! And oh, it gets better. From constructing charming abodes to fashioning sleek automobiles, their artistic genius knows no bounds.

But wait, there's a twist! As they ascend the educational pyramid, the simplicity of shapes transforms into the enigmatic allure of polygons. Brace yourself for the official definition – a polygon is no ordinary figure; it's a closed masterpiece, a symphony of straight lines, a marvel of mathematical craftsmanship.

Fast forward to the senior classes, and our intrepid learners embark on a journey beyond imagination. They're not just digesting new properties; they're feasting on a banquet of formulas, each one more awe-inspiring than the last.

In the grand finale, this paper promises a rollercoaster ride through a galaxy of new concepts. Buckle up, knowledge seekers, for we're about to soar to heights hitherto unknown!

Ease of Use

- After reading this paper, you will build a strong fundamental understanding of geometry.
- We will discuss about circles, triangles, quadrilaterals, and more…
- And understand more unique concepts.

Conclusion

The primary goal of this paper is to immerse individuals in the exhilarating realm of mathematics, particularly the captivating field of Geometry. Picture this: Geometry isn't just another subject; it's an indispensable force shaping our entire universe. It's everywhere, woven into the fabric of geography itself. Those awe-inspiring monuments you admire? Their breathtaking beauty is a direct result of geometry's symmetrical magic.

Now, I get it—some folks might initially think geometry is as dull as watching paint dry. But fear not! After delving into the pages of this remarkable paper, I'm confident I can perform a mind-altering feat and transform your perception of geometry.

Get ready for a journey that not only educates but also entertains, as we unravel the enchanting secrets of geometry. In a nutshell, this paper serves as a treasure trove, exploring fundamental geometric shapes, uncovering their intriguing properties, and unveiling the mysteries behind their formulas.

I've poured my heart into this, aiming to provide a resource that not only educates but also sparks a newfound appreciation for the enchanting world of geometry. So, dive in, enjoy the ride, and if, by some cosmic chance, you spot a mistake, don't hesitate to reach out via the provided email. Thank you for embarking on this geometric adventure with me!

I. CIRCLE

Definition

A circle is a closed figure with no **sides** and **vertices (corners).**

This is not defined as a **polygon** because as we all know, a polygon is " a geometric figure in two-dimensional space characterized by a set of straight line segments connected end-to-end to form a closed boundary. The segments, called sides, do not intersect except at their endpoints, creating a planar shape with distinct vertices where adjacent sides meet."

We can see circles in many places. Such as clocks, signs, cameras, etc..

A circle is a very essential shape for us.
Let's know something more about it.

Parts of a Circle

Circumference: Just like in other polygons, a circle also have its perimeter. But here is a plot twist. Only **polygons have perimeter** as :

Perimeter = Sum of All Sides

But a circle does not have any sides. Thus it has a ***circumference***, its perimeter.

Thus a circumference is :

The encompassing boundary of a curved geometric shape, particularly a circle.

Arc: A segment of a curve, particularly a portion of the circumference of a circle.

Chord: A chord is the line segment joining two points on the circumference.

Diameter: The longest possible chord in a circle is the **diameter.** This line crosses the midpoint of the circle. When at least 2 diameters intersect, they intersect at the midpoint of the circle.

Radius: This can be defined as a half diameter. The radius is the length of the line from the centre to any point on its circumference.

Sector: A circular sector, also referred to as a circle sector or disk sector, is the segment of a disk that is defined by two radii and an arc. The smaller portion is termed the minor sector, while the larger one is designated as the major sector.

Segment: In geometry, a circular segment, also referred to as a disk segment, is an area of a disk that is isolated from the remainder of the disk by a secant or a chord.

Tangent: A tangent to a circle is a straight line which touches the circle at only one point.

Secant: The definition of a secant of a circle is as follows: A line intersecting a circle at precisely two points. Unlike a line segment, a secant can be extended on both sides. It is distinct from a chord, radius, diameter, and tangent.
It is different from a chord.

A secant intersects a circle at two points, while a tangent intersects it at just one point. Both a tangent and a secant can be extended, but a secant has portions inside and outside the circle, whereas a tangent is entirely external to the circle.

Some Basic Formulas

Circumference: $2\pi r$

(pi = 22/7 in fractional form)
Why we are using the **radii** and the **pi**?
There is some special relation between the **pi** and the **circle**.
The fractional form of **pi (22/7)** represents the perfect figure of a circle. Where 22 (numerator) is the circumference and 7 (denominator) is the diameter.

Hence, **pi is the ratio of a circle's circumference to its diameter, i.e. 22:7.**

Now, as we know, that
Circumference/diameter = pi
=> Circumference/diameter = 22/7
=>Circumference/Radius×2=22/7
=>C / 2 r = 22/7
(2 r represents **radius × 2** as we all know, radius is half of the diameter)
Now, we have c / 2r = 22/7.
Now, we will cross multiply and we will get 2πr=Circumference
Hence,

Circumference = 2πr

Area: πr^2

Now, to find the area, we already have the radius.
We can also write this as:
π× r × r
Which is
$\Pi \times r^2$
Here, if we take the 5cm radius of a circle, we can find the area, as 22/7 × 5 × 5
22/7 × 25
78.5…
Here, we get an approximate value of the area of the circle. Because the quantity of pi we are using is different from the actual pi.
The pi we are using is 22/7, but the actual first 5 digits of the pi are **3.14159.**
If we try to divide 22 by 7, we will ge**t 3.14185.**
Now, there are only some minor changes, hence we use 22/7 as an approximate fractional value of pi, and we will get an approximate answer.
Pi is an irrational number, which is non-terminating and non-repeating.

Diameter: As we all know, the diameter is twice the radius, we can assume that
Diameter = 2 × Radius
D = 2r

Now, this much understanding on the fundamental level is more than enough. Hence, we learn something new rather than the circle

Properties of Circle

1. Circles are considered congruent if they possess equal radii.
2. The diameter of a circle represents its longest chord.
3. The chords of a circle, when equal, create equal angles at the centre.
4. A radius drawn at a right angle to a chord bisects the chord.
5. Circles with varying radii are considered similar.
6. A circle can encompass a rectangle, trapezium, triangle, square, or kite.
7. A circle can be inscribed within a square, triangle, or kite.
8. Chords equidistant from the centre are of equal length.
9. The distance from the circle's centre to its longest chord (diameter) is zero.
10. The perpendicular distance from the circle's centre decreases as the chord length increases.
11. Tangents drawn at the ends of the diameter are parallel to each other.
12. An isosceles triangle forms when radii connect the ends of a chord to the circle's centre.

II. TRIANGLE

Definition

Here, a triangle is a **polygon having three sides/edges.** It is the only polygon which has the lowest possible number of sides/edges.

Now a polygon and a triangle have **edges/sides** and **corners/vertices.** Hence, we classify triangles into 6 types. 3 based on their sides and 3 based on angles (vertices).

Classification of Triangles with Their Properties

Based on angles

As we all know, there are mainly 3 types of angles which are possible in a triangle. They are, **Acute, Right** and **Obtuse.**

There is a **special property** for which a triangle can only have 1 obtuse angle, 3 acute angles and 1 right angle in each case.
A triangle having 1 right angle is called a **right-angled triangle.**
A triangle having 1 acute angle is called an **acute-angled triangle.**
A triangle having 1 obtuse angle is called an **obtuse-angled triangle.**

"The angle sum property says that **the sum of all angles of a triangle should be 180°"**
Based on sides

We all know that a triangle has 3 sides. The shape(appearance) of the triangle can be different.
Therefore, a triangle having all 3 sides of equal length is called an **equilateral triangle.**
A triangle having any 2 sides of equal length is called an **isosceles triangle.**
A triangle having no sides equal to each other is called a **scalene triangle.**
Now, we need to know that the **sum of 1st and 2nd sides of a triangle should measure more than the third side.**

We should also know that there are three more angles in the triangle, rather than the angles which are **inside** the triangle.
Yes, you are right. These angles are formed on the exterior of the triangle, hence these are called, **exterior angles.**
The sum of all 3 interior sides = the exterior angle + its supplementary
angle
The sum of consecutive interior and exterior angles of a triangle is supplementary.
The sum of all exterior angles is 360°

The shortest side is always opposite the smallest interior angle. Similarly, the longest side is always opposite the largest interior angle.
Area, Perimeter and the Hypotenuse of a triangle

Area: 1/2 × Base × Height.
This formula is very interesting. You will understand it more effectively when you read about **parallelograms** in this paper.
But for now, we will learn a more interesting formula.
Perimeter: As we all know, the sum of all sides is the perimeter of any polygon.
Now we will **use this data to find out the area.**
Heron's formula to find the area.
Suppose we do not know the height of the triangle. Then how are we able to find out its area? Don't worry!
We will use the perimeter to find the area of a triangle.

1. Find the **Semi-Perimeter. I.e. Perimeter/2 which we will denote as "s".**
2. **Area = √[s(s-a)(s-b)(s-c)] (Heron's Formula)**

Now we will get more into the **right-angle triangles.**
The right-angled triangle has 2 legs and the longest, i.e. **Hypotenuse.**
According to the **Pythagoras Theorem,**

Hypotenuse = √[(Side1)² + (Side2)²]

III. QUADRILATERALS

Definition

A closed figure which has 4 sides/edges is defined as a quadrilateral.
There are several types of quadrilaterals.
Let's see about them.

Basic Classification of Quadrilaterals with Their Basic Properties

1. The quadrilateral having all sides equal is a **Rhombus**

1.1 The Rhombus having 90° in its vertices is a **Square**
1.2 The diagonals of a rhombus bisect each other at right angles.
1.3 The diagonals of a rhombus may not be necessarily equal.
1.4 A rhombus can also considered a **Parallelogram**
1.5 The length of the diagonals can be calculated by various methods like using the Pythagoras theorem or by using the area of the rhombus.

2. The quadrilateral whose all opposite sides are parallel to each other is known as a **Parallelogram**

2.1 **Rectangles** and **Squares** are some popular examples of Parallelogram
2.2 The diagonals of a parallelogram always bisect each other
2.3 The opposite angles are equal.
2.4 The consecutive or adjacent angles are supplementary.
2.5 If any one of the angles is a right angle, then all the other angles will be at the right angle
2.6 Each diagonal bisects the parallelogram into two congruent Triangles
2.7 The Sum of the square of all the sides of a parallelogram is equal to the sum of the square of its diagonals. It is also called parallelogram law

3. The quadrilateral having only 1 pair of sides parallel is a **trapezium**

3.1 In trapezium, exactly one pair of opposite sides are parallel
3.2 The diagonals intersect each other
3.3 The non-parallel sides in the trapezium are unequal except in the isosceles trapezium
3.4 In trapezium, non-parallel sides are equal.

Now you have learnt about 5 different types of Quadrilaterals. Let's study in detail !!

Chapter 3.1: Rhombus

Definition

A rhombus, also referred to as a rhombi or rhombuses in plural, is a four-sided polygon characterized by the equal length of all its sides. It is alternatively known as an equilateral quadrilateral, emphasizing that all four sides share the same length.
Square is also a famous example of Rhombus.

Properties of Rhombus
See page 13.

Formulas for Area, Perimeter and Diagonals

Area: We can calculate the rhombus's area with 3 methods
By Using Diagonals: $\frac{1}{2} \times d1 \times d2$
By Using Base and Height: $B \times H$
By Using Trigonometry: $b^2 \times \sin(a)$

Perimeter: 4a

Diagonals: In order to obtain the diagonal1 using the given data, i.e. diagonal2, the formula is **2 a/d2** or $\sqrt{[4a^2 - d2^2]}$
In order to obtain **both the diagonals without having any data except for the side, it would be:**
Diagonal1 = $a\sqrt{(2+2\cos\theta)}$
Diagonal2 = $a\sqrt{(2-2\cos\theta)}$

Chapter 3.2: Square

(The rhombus having 90° in its vertices)

Definition

A square is a geometric shape and a type of quadrilateral (rhombus) that possesses certain defining characteristics. Specifically, a square is a rhombus with four equal-length sides and four right angles. In other words, all sides of a square have the same length, and each internal angle measures 90 degrees.

Properties

1. Each of the interior angles in the square is identical, measuring 90°.
2. All four sides of the square are congruent, ensuring equality in length.
3. The square exhibits parallelism between its opposite sides.
4. The diagonals of the square intersect at a 90° angle, bisecting each other.
5. Both diagonals of the square share equal length.
6. The square is characterized by four vertices and four sides.
7. The diagonals of the square divide it into two similar isosceles triangles.
8. The length of the diagonals surpasses that of the sides of the square.

Formulas

Area: For area, it is $Side^2$
Perimeter: For perimeter, it is $4 \times side$
Diagonal:

The diagonal of a square has a length of $s\sqrt{2}$, where s represents the side length of the square. Since the diagonals are equal, applying the Pythagorean theorem confirms that the diagonal serves as the hypotenuse. The two sides of the triangle formed by the square's diagonal are perpendicular to the base.

Since hypotenuse 2 = base 2 + perpendicular 2

Therefore, diagonal 2 = side 2 + side 2
Diagonal = $\sqrt{(2side^2)}$
Therefore, $d = s\sqrt{2}$
Hence, $d=\sqrt{[2(s)^2]}$
Where d is the length of the diagonal of the square and s is the side of the square.

Chapter 3.3: Parallelogram
(Including Rectangle)

Definition (Parallelogram)

A parallelogram is a four-sided polygon characterised by its unique set of features. It is defined as a quadrilateral with opposite sides that are both equal in length and parallel. Additionally, the opposite angles in a parallelogram are also equal. These defining properties distinguish a parallelogram, making it a geometric figure where pairs of sides and angles exhibit a symmetrical relationship.

Definition (Rectangle)

A rectangle is a four-sided polygon distinguished by its specific geometric attributes. It is defined as a quadrilateral with four right angles, meaning each internal angle measures

90 degrees. Additionally, a rectangle possesses opposite sides of equal length, contributing to its characteristic shape. These defining features make a rectangle a type of parallelogram, and it is often recognized for its regular and symmetrical appearance, emphasising the right angles and equal side relationships.

Properties of Parallelogram

See page 13

Properties of Rectangle

1. It is a closed shape.
2. It consists of four vertices, four sides, and four angles.
3. Its two measurements are its length and width.
4. A rectangle has 90° angles at each corner.
5. The opposing sides are parallel and equal.
6. It has two equal-length diagonals.
7. Rectangles are quadrilaterals.
8. The opposing sides are parallel to one another and equal in size.
9. Every internal angle is 90 degrees.
10. 360 degrees is the total of all the interior angles.
11. The diagonals are bisecting one another, and their lengths are equal.
12. The perimeter of a rectangle with side lengths of a and b is equal to 2a plus 2b units.
13. The area of a rectangle of lengths a and b is equal to ab sin 90 = ab square units.
14. The diagonal of a rectangle serves as the diameter of its circumcircle.
15. The length of each diagonal in a rectangle with sides a and b is: $\sqrt{(a^2 + b^2)} = d$
16. At different angles, the diagonals bisect one another. There are two types of angles: acute and obtuse.
17. The rectangle is referred to as a square if the two diagonals bisect at a right angle.

Formulas for Parallelograms and Rectangles

Area: In rectangles and squares, we can find them by using **Length × Breadth**

Because a square does not have any difference in its sides, we conclude it as **side × side,** i.e. **Side^2**

Breadth = Width

In parallelograms, we will find the area in a very unique way.

It is **Height × Breadth.**
As we all know, if we cut the parallelogram diagonally, it will form a triangle.
Because the triangle is the half of a parallelogram, we will use **½ ×b × h**
We can consider the breadth of the rectangle as its height, because it is perpendicular to the lenght. Hence, we have Length × Breadth in rectangles.
Perimeter: We all know that the perimeter is the sum of all sides. Hence, in rectangle it is :
Length + Breadth + Length + Breadth = Perimeter
If we simplify it, we will get
(2×Length) + (2×Breadth) = Perimeter.
If we simplify it more, we will get
2(Length+Breadth)=Perimeter
And in a parallelogram, it is also
2 (Side1+Side2)
Diagonals: In rectangles, it is very easy to calculate. The formula for the diagonals is :
$\sqrt{(\text{Length}^2+\text{Breadth}^2)}$
But in parallelograms, it is quite difficult.

One easy way to calculate is to understand the connection between the diagonals and sides, i.e. $p^2 + q^2 = 2(x^2 + y^2)$

Where,

- p and q are the diagonals respectively.
- x and y are the sides of the parallelogram.

But the difficult method is to use trigonometry by :
$P = \sqrt{(x^2+y^2-2xy \cos A)} = \sqrt{(x^2+y^2+2xy \cos B)}$
$Q = \sqrt{(x^2+y^2+2xy \cos A)} = \sqrt{(x^2+y^2-2xy \cos B)}$

Here, P and Q are the diagonals.

Chapter 3.4: Trapezium

Definition

A trapezium is a geometric shape that falls under the category of quadrilaterals. It is defined as a four-sided polygon that contains at least one pair of parallel sides known as bases, with the remaining two sides being called legs. The legs may or may not be of equal length. The angles formed by the bases and the legs can vary, but the key characteristic is the presence of parallel sides. In some regions, particularly in the United States, a trapezium is referred to as a trapezoid. However, in many other parts of the world, a trapezoid is defined as a quadrilateral with no parallel sides, so it's important to be aware of regional variations in terminology.

Properties of Trapezium

1. A trapezium is a flat, geometric figure with two dimensions.
2. A trapezium features one set of opposite sides that run parallel to each other.
3. These parallel lines are identified as the bases.
4. One set of opposing sides in a trapezium lacks parallelism to each other.
5. The sides that are not parallel are referred to as the legs of a trapezium.
6. The diagonals in a trapezium have equal lengths.
7. In a trapezium, both diagonals intersect each other.
8. The sum of adjacent interior angles in a trapezium is 180°.
9. The total sum of interior angles in a trapezium always equals 360°.

Formulas for Trapezium

(As an example, we are taking ABCD a quadrilateral)

Area: As we all know, the trapezium possesses only a single set of sides parallel. Sometimes, the parallel sides are also unequal. Therefore, as a quadrilateral, **the average of the parallel sides is multiplied by the height of the trapezium**
Hence, the formula is

1. To obtain the average of the parallel sides, i.e. **(AB+CD)/2**
2. Now we will multiply it by the height of the trapezium. I.e.

[(AB+CD)/2]×Height

Perimeter: The trapezium is a very topsy-turvy shape. Hence we will use the basic formula. The sum of all sides. I.e. **AB+BC+CD+DA**

Diagonal: Here, we are going to use the Pythagorean theorem.
Let's take **ABCD** a trapezium.
Now, let's take **AC as** the diagonal and **CE as** the height**.**
Therefore**, AE is the base**
Hence we obtain a right-angled triangle inside a trapezium.
Therefore, the triangle is **Triangle ACE.**
Hence the diagonal is the **Hypotenuse** and AE is the **Base** and Ce is the **Perpendicular.**
According to Pythagorean theorem,
$AC^2=AE^2+EC^2$
Now we get the value of AC, which was the **Diagonal.**

Bonus Chapter: Number of Diagonals

In order to get the number of diagonals present in any polygon. Whether it is a quadrilateral, a pentagon or a polygon with 99 sides. Use this Formula !!!

[No. of Side(Side-3)] / 2

E.g. In a quadrilateral, there are 4 sides. Hence it will go like

[4(4-3)] / 2
4/2
2.

Therefore, here are 2 diagonals in a quadrilateral.
E.g. In a pentagon, there are 5 sides. Hence it will go like

[5(5-3)] / 2
[5×2]/2
10/2
5.

Hence there are 5 diagonals in a pentagon.