

Basic Geometry Postulates

1. **Postulate of Points**: Through any two distinct points, there is exactly one straight line.

Example: Given points A and B, there is one and only one line that passes through both points.

2. **Postulate of Lines**: A line segment can be extended indefinitely in both directions to form a line.

Example: The segment AB can be extended to form the line $(\overleftrightarrow{AB})$.

3. **Postulate of Intersection of Two Lines**: Two distinct lines intersect at most at one point.

Example: If lines L and M intersect, they will do so at exactly one point, say P.

4. **Postulate of Flatness**: Through any three non-collinear points, there is exactly one plane.

Example: Points A, B, and C that are not all on the same line determine a unique plane.

5. **Postulate of Plane Intersection**: If two planes intersect, their intersection is a line.

Example: If planes P and Q intersect, they do so along a line L.

6. **Postulate of Points in a Plane**: A plane contains at least three non-collinear points.

Example: Three points that do not lie on the same line determine a plane.

7. **Postulate of Parallel Lines**: If two parallel lines are cut by a transversal, the corresponding angles are equal.

Example: If lines L and M are parallel, and they are cut by transversal T, then the corresponding angles formed are equal.

8. **Postulate of Parallel Planes**: If two parallel planes are cut by a transversal, the intersections with the transversal are parallel.

Example: If planes P and Q are parallel, and they are cut by transversal R, the lines of intersection are parallel.

9. **Postulate of Distance**: The distance between two points is a positive real number.

Example: The distance between points A(1, 2) and B(4, 6) is $(\sqrt{(4-1)^2 + (6-2)^2}) = 5$.

10. **Postulate of Right Angles**: All right angles are equal.

Example: Any two right angles are congruent.

11. **Postulate of Midpoint**: The midpoint of a segment is the point that divides the segment into two equal parts.

Example: The midpoint of segment AB is the point M such that $AM = MB$.

Algebraic Postulates

12. **Commutative Property of Addition**: $(a + b = b + a)$.

Example: $(3 + 5 = 5 + 3 = 8)$.

13. **Commutative Property of Multiplication**: $(a \times b = b \times a)$.

Example: $(4 \times 6 = 6 \times 4 = 24)$.

14. **Associative Property of Addition**: $((a + b) + c = a + (b + c))$.

Example: $((2 + 3) + 4 = 2 + (3 + 4) = 9)$.

15. **Associative Property of Multiplication**: $((a \times b) \times c = a \times (b \times c))$.

Example: $((2 \times 3) \times 4 = 2 \times (3 \times 4) = 24)$.

16. **Distributive Property**: $(a(b + c) = ab + ac)$.

Example: $(2(3 + 4) = 2 \times 3 + 2 \times 4 = 14)$.

17. **Identity Property of Addition**: $(a + 0 = a)$.

Example: $(5 + 0 = 5)$.

18. **Identity Property of Multiplication**: $(a \times 1 = a)$.

Example: $(7 \times 1 = 7)$.

19. **Inverse Property of Addition**: $(a + (-a) = 0)$.

Example: $(5 + (-5) = 0)$.

20. **Inverse Property of Multiplication**: $(a \times \frac{1}{a} = 1)$, where $(a \neq 0)$.

Example: $(4 \times \frac{1}{4} = 1)$.

Set Theory Postulates

21. **Axiom of Extensionality**: Two sets are equal if and only if they have the same elements.

Example: $(\{1, 2\} = \{2, 1\})$.

22. **Axiom of Empty Set**: There exists a set with no elements, called the empty set.

Example: $(\emptyset = \{\})$.

23. **Axiom of Pairing**: For any two sets, there exists a set containing exactly those two sets.

Example: For sets A and B, there exists a set $(\{A, B\})$.

24. **Axiom of Union**: For any set, there exists a set that contains all the elements of the original set and the elements of the elements of the original set.

Example: If $(A = \{1, 2\})$, then the union of A is $(\bigcup A = \{1, 2\})$.

25. **Axiom of Infinity**: There exists a set that contains the empty set and is closed under the operation of adding one element at a time.

Example: The set $(\{\emptyset, \{\emptyset\}, \{\{\emptyset\}\}, \dots\})$ represents the set of natural numbers.

26. **Axiom of Power Set**: For any set, there exists a set that contains all the subsets of that set.

Example: The power set of $(\{1, 2\})$ is $(\{\emptyset, \{1\}, \{2\}, \{1, 2\}\})$.

27. **Axiom of Choice**: For any collection of non-empty sets, there exists a set containing exactly one element from each set.

Example: Given $(\{\{a, b\}, \{c, d\}\})$, we can choose a set $(\{a, c\})$.

28. **Axiom of Regularity**: Every non-empty set (A) contains an element that is disjoint from (A).

Example: If $(A = \{\{1\}\})$, then $(\{1\})$ is disjoint from (A).

Euclidean Geometry Postulates

29. **Euclid's First Postulate**: A straight line can be drawn from any point to any other point.

Example: From point A to point B, you can draw a straight line.

30. **Euclid's Second Postulate**: A finite straight line can be extended continuously in a straight line.

Example: The segment AB can be extended indefinitely in both directions.

31. **Euclid's Third Postulate**: A circle can be drawn with any center and any radius.

Example: A circle with center O and radius OB can be drawn.

32. **Euclid's Fourth Postulate**: All right angles are equal to one another.

Example: Any two right angles are congruent.

33. **Euclid's Fifth Postulate (Parallel Postulate)**: If a line segment intersects two lines, and the sum of the interior angles on one side is less than two right angles, the two lines will meet on that side.

Example: This is the basis for the concept of parallel lines.

Part 1: Definitions (Short Answer)*

1. **Q:** What is a line segment?

A: A part of a line that has two endpoints.

2. **Q:** Define a ray.

A: A line that starts from one point and extends infinitely in one direction.

3. **Q:** What do we call lines that never meet?

A: Parallel lines.

4. **Q:** What is a right angle?

A: An angle that measures exactly 90° .

5. **Q:** What is a reflex angle?

A: An angle greater than 180° but less than 360° .

6. **Q:** Define a polygon.

A: A closed shape formed by straight lines.

7. **Q:** What is a diagonal?

A: A line connecting two non-adjacent vertices of a polygon.

8. **Q:** What do we call a line touching a circle at only one point?

A: A tangent.

9. **Q:** What is the longest chord in a circle?

A: The diameter.

10. **Q:** What is the sum of the angles in a triangle?

A: 180° .

Part 2: Multiple Choice

11. **Which shape has all sides equal and all angles 90° ?

- A) Rectangle
- B) Rhombus
- C) Square
- D) Parallelogram

****Answer:** C) Square**

12. **The line that cuts two or more lines at different points is called:

- A) Transversal
- B) Diagonal
- C) Tangent
- D) Radius

****Answer:** A) Transversal**

13. **Which of the following triangles has all sides equal?

- A) Scalene
- B) Isosceles
- C) Equilateral

D) Right

****Answer:** C) Equilateral**

14. ****A shape that can be divided into two identical halves has:****

- A) Similarity
- B) Symmetry
- C) Congruence
- D) Rotation

****Answer:** B) Symmetry**

15. ****The formula of Pythagoras' Theorem is:****

- A) $a^2 + b^2 = c^2$
- B) $a + b = c$
- C) $a^2 = b^2 + c^2$
- D) $a^2 - b^2 = c^2$

****Answer:** A) $a^2 + b^2 = c^2$**

16. ****The line passing through the center of a circle is called:****

- A) Radius
- B) Diameter
- C) Chord
- D) Arc

****Answer:** B) Diameter**

17. ****Which figure has one pair of parallel sides?***

- A) Square
- B) Rhombus
- C) Trapezium
- D) Kite

****Answer:** C) Trapezium**

18. ****In a right triangle, the side opposite the right angle is called:****

- A) Base
- B) Height
- C) Hypotenuse
- D) Median

****Answer:** C) Hypotenuse**

19. ****Two angles whose sum is 180° are called:****

- A) Complementary
- B) Supplementary
- C) Adjacent
- D) Alternate

****Answer:** B) Supplementary**

Which transformation produces a mirror image?

- A) Translation
- B) Rotation
- C) Reflection
- D) Enlargement

Answer: C) Reflection

Part 3: True or False

- 21. A radius is longer than a diameter. False
- 22. All squares are rectangles, but not all rectangles are squares. True
- 23. Parallel lines meet at infinity. False
- 24. A rhombus always has right angles. False
- 25. The diagonals of a rectangle are equal. True
- 26. A tangent to a circle touches it at two points. False
- 27. Every circle has an infinite number of radii. True
- 28. Similar shapes have the same size. False
- 29. A triangle cannot have two right angles. True
- 30. Perpendicular lines form a 90° angle. True

Part 4: Problem Solving and Theorems

31. Q: In a right triangle, if one side is 3 cm and the other is 4 cm, find the hypotenuse.

A: $\sqrt{3^2 + 4^2} = \sqrt{25} = 5$ cm.

32. Q: If the sum of two angles is 180° , and one is 110° , find the other.

A: $180^\circ - 110^\circ = 70^\circ$.

33. Q: The diagonals of a rhombus intersect at right angles. True or false?

A: True.

34. Q: Find the sum of the interior angles of a hexagon.

A: $(6 - 2) \times 180^\circ = 720^\circ$.

35. Q: If one tangent from a point to a circle is 8 cm, what is the length of the second tangent from the same point?

A: 8 cm (tangents from the same point are equal).

36. Q: In a circle, what is the angle in a semicircle?

A: 90° .

37. Q: What is the relationship between the opposite sides of a parallelogram?

A: They are parallel and equal.

38. Q: What is the perimeter of a square with side 5 cm?

A: $4 \times 5 = 20$ cm.

39. Q: What type of triangle has sides 7, 7, and 10 cm?

A: Isosceles triangle.

40. Q: A quadrilateral with all sides equal and all right angles is called what?

A: Square.

The primary types of numbers form a nested hierarchy, meaning each set is contained within the next larger set. This is often visualized starting with the simplest numbers and expanding outward.

Here are the main types of numbers:

1. Real Numbers (\mathbb{R})

Real Numbers include all the numbers that can be plotted on a number line. They are subdivided into two main groups: Rational and Irrational.

A. Rational Numbers (\mathbb{Q})

A rational number is any number that can be expressed as a fraction $\frac{p}{q}$, where p and q are integers and q is not zero. Their decimal representation either terminates or repeats.

- **Integers (\mathbb{Z}):** The set of all positive whole numbers, negative whole numbers, and zero.
 - Examples: $\dots, -3, -2, -1, 0, 1, 2, 3, \dots$
- **Whole Numbers (\mathbb{W}):** All positive integers, starting from zero.
 - Examples: $0, 1, 2, 3, \dots$
- **Natural Numbers (\mathbb{N}):** Also called Counting Numbers. These are the positive integers, starting from one.
 - Examples: $1, 2, 3, 4, \dots$
- **Other Rational Examples:** $\frac{1}{2} = 0.5$ (terminating), $\frac{1}{3} = 0.333\dots$ (repeating).

B. Irrational Numbers (\mathbb{I})

An irrational number cannot be expressed as a simple fraction. Their decimal representation is non-terminating and non-repeating.

- Examples: $\pi \approx 3.14159\dots$, $\sqrt{2} \approx 1.41421\dots$, and the base of the natural logarithm, $e \approx 2.71828\dots$

2. Imaginary and Complex Numbers

These sets expand the number system beyond the standard number line to solve equations that have no real solutions.

A. Imaginary Numbers

These numbers are a multiple of the imaginary unit, i , where i is defined as the square root of negative one: $i = \sqrt{-1}$.

- Examples: $i, 2i, -5i, i\sqrt{3}$.

B. Complex Numbers (\mathbb{C})

A complex number is any number that can be expressed in the form $a + bi$, where a and b are real numbers, and i is the imaginary unit. This is the largest standard set of numbers.

- a is called the real part.
- bi is called the imaginary part.
- Note: All Real Numbers are also Complex Numbers (where the imaginary part $b=0$).

Example	Real Part (a)	Imaginary Part (bi)
$3 + 4i$	3	$4i$
-7	-7	0 (making it a Real Number)
$2i$	0	$2i$ (making it a Purely Imaginary Number)