CLASS 9

(NCERT Based)

FORMULA XPRESS

Mathematics

Complete Maths Revision & Concept Guide

- ✓ All Important Maths Formulas
- ✓ Basic Mathematical Terms (Clear Explanation)
- ✓ Difference Between Key Concepts
- ✓ Concept-Based & Exam-Oriented

Strong Foundation for Board Classes

By Akanksha Mathur

EduPrepIQ Series

Class 9 MATHS Formula Xpress

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Preface

Mathematics is a subject that becomes easy and enjoyable when concepts, formulas, and terms are clear.
Class 9 Maths Formula Xpress has been carefully designed to help students revise all important formulas and mathematical terms in a quick, structured, and exam-friendly format.

This book contains:

- Chapter-wise important formulas
- Key mathematical terms and definitions
- Difference between Basic Maths Terms
- Frequently used identities and rules

All content is presented in a concise and easy-to-remember manner, without lengthy theory, so that students can focus on accuracy, speed, and confidence during examinations.

Maths Formula Xpress is ideal for:

- Daily revision
- Last-minute exam preparation
- Quick recall before tests and practice
- Strengthening formula-based problem solving

The objective of this book is to reduce exam stress by providing a single-point reference for all essential formulas and terms required in Class 9 Mathematics.

We hope this book helps students develop a strong mathematical foundation and achieve excellent results through smart revision.

Happy Learning!
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Chapter 1 – Number System

◇ IMPORTANT TERMS

◇ Natural Numbers (N)

- Counting numbers starting from **1**.
- **Set:** N = {1, 2, 3, 4, …}
- **Note:** 0 is **not** a natural number.

◇ Whole Numbers (W)

- Natural numbers plus zero.
- **Set:** W = {0, 1, 2, 3, 4, …}

◇ Integers (Z)

- All positive numbers, negative numbers and zero.
- **Set:** Z = {…, −3, −2, −1, 0, 1, 2, 3, …}

◇ Rational Numbers (Q)

- Numbers that can be written in the form

$$\frac{p}{q},\ q \neq 0$$

  where **p and q are integers**.
- **Examples:**

$$\frac{1}{2},\ -3,\ 0,\ 0.75,\ 1.27\overline{27}$$

☑ Important Properties

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- All **natural, whole and integers** are rational numbers.
- Rational numbers have **terminating OR non-terminating recurring decimals**.

◇ Irrational Numbers

- Numbers **not expressible** in the form $\frac{p}{q}$.
- Decimal expansion is **non-terminating & non-recurring**.
- **Examples:**

$$\sqrt{2}, \sqrt{3}, \pi\ ,\ 0.101101110\ldots$$

◇ Real Numbers (R)

- Combination of **rational + irrational numbers**.
- Every real number corresponds to **one unique point** on the number line.

DECIMAL EXPANSION RULES

✔ For Rational Numbers

- **Terminating decimals**
  Example:

$$\frac{1}{4} = 0.25$$

- **Non-terminating recurring decimals**
  Example:

$$\frac{1}{3} = 0.33333$$

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✔ For Irrational Numbers

- **Non-terminating & non-recurring decimals**
  Example:
  $\sqrt{2} = 1.414213\ldots$

OPERATIONS ON REAL NUMBERS

◇ Rational + Irrational

- Result is **always irrational**
  $2 + \sqrt{3}$ (irrational)}

◇ Rational × Irrational (≠0)

- Result is **irrational**
  $3\sqrt{5}$

◇ Irrational ± Irrational

- May be **rational or irrational**
  $\sqrt{5} - \sqrt{5} = 0$

LAWS OF SQUARE ROOTS (VERY IMPORTANT)

For positive real numbers **a, b**:

1. $\sqrt{ab} = \sqrt{a}\sqrt{b}$
2. $\dfrac{\sqrt{a}}{\sqrt{b}} = \sqrt{\dfrac{a}{b}}$

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3. $(\sqrt{a}+\sqrt{b})(\sqrt{a}-\sqrt{b}) = a - b$
4. $(\sqrt{a}+\sqrt{b})^2 = a + b + 2\sqrt{ab}$
5. $(\sqrt{a}-\sqrt{b})^2 = a + b - 2\sqrt{ab}$

RATIONALISATION OF DENOMINATOR

◇ Meaning

Changing denominator containing surds into **rational number**.

◇ Method

If denominator is a + $\sqrt{b}$, multiply by its **conjugate**:

$$\frac{1}{a+\sqrt{b}} \times \frac{a-\sqrt{b}}{a-\sqrt{b}}$$

EXPONENTS (REAL NUMBERS)

For real number (a > 0), and rational numbers (p, q):

1. $a^p \cdot a^q = a^{p+q}$
2. $(a^p)^q = a^{pq}$
3. $\frac{a^p}{a^q} = a^{p-q}$

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4. $(ab)^p = a^p b^p$
5. $a^0 = 1$
6. $a^{-p} = \frac{1}{a^p}$
7. $a^{\frac{m}{n}} = \sqrt[n]{a^m}$

KEY EXAM POINTS (★ MUST REMEMBER)

- Every real number is **either rational or irrational**.
- Rational numbers → terminating / recurring decimals.
- Irrational numbers → non-terminating & non-recurring.
- $\sqrt{n}$ is irrational **unless n is a perfect square**.
- Rationalisation uses **conjugate pairs**.
- Laws of exponents apply to **real numbers also**.

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Chapter 2 – Polynomials

◇ IMPORTANT TERMS

1. Variable

A variable is a symbol (like x, y, z) whose value can change.

- Example: x in 2x + 3

2. Constant

A fixed numerical value whose value does not change.

- Example: 5, −3, π

3. Polynomial

An algebraic expression in one or more variables where:

- Exponents of variables are **whole numbers (0, 1, 2, 3, ...)**
- No variable appears in denominator
- No square root or fractional power of variable

General form (one variable):

$$p(x) = a_n x^n + a_{n-1} x^{n-1} + \cdots + a_1 x + a_0$$

where ($a_n \neq 0$)

Examples:

✔ $x^2 - 3x + 7$

✔ 5

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❌ $1/x$
❌ $\sqrt{x} + 1$

4. Term

Each part of a polynomial separated by + or −.

- In $3x^2 + 2x - 5$
  Terms are: $3x^2$, $2x$, -5

5. Coefficient

The numerical factor of a term.

- In $-7x^2$, coefficient = -7
- In x, coefficient = 1

6. Constant Polynomial

A polynomial with no variable.

- Example: 2, −5
- Degree = 0

7. Zero Polynomial

A polynomial whose value is always zero.

- Example: 0
- Degree is **not defined**

8. Degree of a Polynomial

The **highest power** of the variable in the polynomial.

Polynomial	Degree
$3x^2 + 5x + 1$	2

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Polynomial	Degree
$7x^3 - x$	3
9	0

9. Types of Polynomials (by number of terms)

Type	Definition	Example
Monomial	One term	$5x^2$
Binomial	Two terms	$x + 3$
Trinomial	Three terms	$x^2 + x + 1$

10. Types of Polynomials (by degree)

Degree	Name	General Form
1	Linear	$ax + b$
2	Quadratic	$ax^2 + bx + c$
3	Cubic	$ax^3 + bx^2 + cx + d$

11. Value of a Polynomial

Value obtained by substituting a number for the variable.

- If $p(x) = x^2 - 2x$
- $p(2) = 4 - 4 = 0$

12. Zero / Root of a Polynomial

A number **a** is a zero of p(x) if:

$$p(a) = 0$$

- Zero of $x - 3$ is 3
- Linear polynomial has **one zero**

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- Quadratic polynomial can have **two zeroes**

◇ FACTOR THEOREM

Statement

If p(a) = 0, then **(x – a)** is a factor of p(x).

If (x – a) is a factor of p(x), then **p(a) = 0**

◇ ALGEBRAIC IDENTITIES (FORMULAS)

1. Square Identities

$$(x+y)^2 = x^2 + 2xy + y^2$$

$$(x-y)^2 = x^2 - 2xy + y^2$$

2. Difference of Squares

$$x^2 - y^2 = (x+y)(x-y)$$

3. Square of Three Terms

$$(x+y+z)^2 = x^2 + y^2 + z^2 + 2xy + 2yz + 2zx$$

4. Cube Identities

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$$(x+y)^3 = x^3 + y^3 + 3xy(x+y)$$

$$(x-y)^3 = x^3 - y^3 - 3xy(x-y)$$

---

5. Sum of Cubes Identity

$$x^3 + y^3 + z^3 - 3xyz = (x+y)(x^2 + y^2 + z^2 - xy - yz - zx)$$

◇ QUICK EXAM POINTS ★

- Polynomial never has variable in denominator
- Degree depends on **highest power**, not number of terms
- Zero of polynomial ≠ always zero
- Zero polynomial has **no defined degree**
- Linear → 1 zero, Quadratic → max 2 zeroes

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Chapter 3 – Coordinate Geometry

◇ IMPORTANT TERMS

1. Coordinate Geometry

A branch of mathematics that deals with the **position of points on a plane** using numbers.

2. Cartesian Plane (Coordinate Plane)

A plane formed by **two perpendicular number lines**:

- **x-axis (horizontal)**
- **y-axis (vertical)**

3. Coordinate Axes

- **x-axis**: Horizontal line
- **y-axis**: Vertical line

These axes divide the plane into **four regions**.

4. Origin

The point where the **x-axis and y-axis intersect**.

📌 **Coordinates of Origin :** (0, 0)

5. Coordinates of a Point

A point is written as an **ordered pair**: (x, y)

Where:

- **x** → x-coordinate (Abscissa)
- **y** → y-coordinate (Ordinate)

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⚠ Order matters:

$$(x, y) \neq (y, x)$$

6. Abscissa

The **x-coordinate** of a point.
It is the **distance from the y-axis**, measured parallel to the x-axis.

📌 Example:
For point ((4, 3)) → **Abscissa = 4**

7. Ordinate

The **y-coordinate** of a point.
It is the **distance from the x-axis**, measured parallel to the y-axis.

📌 Example:
For point ((4, 3)) → **Ordinate = 3**

8. Quadrants

The coordinate plane is divided into **four quadrants**:

Quadrant	Sign of (x, y)
I	(+ , +)
II	(− , +)
III	(− , −)
IV	(+ , −)

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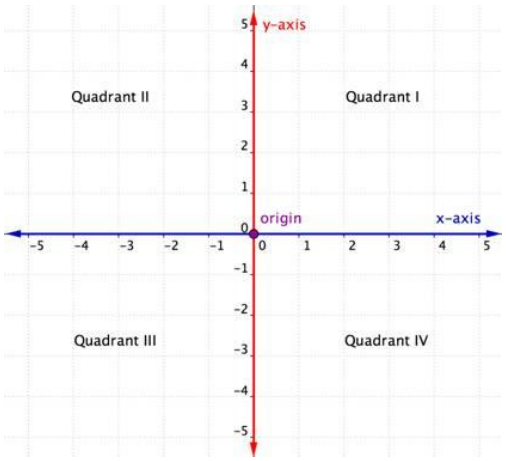

📌 Quadrants are numbered **anticlockwise** starting from Quadrant I.

9. Position of a Point in Quadrants

- If **x > 0, y > 0** → Quadrant I
- If **x < 0, y > 0** → Quadrant II
- If **x < 0, y < 0** → Quadrant III
- If **x > 0, y < 0** → Quadrant IV

10. Points on Axes

📌 On x-axis

- Distance from x-axis = 0
  Coordinates = (x, 0)

📌 On y-axis

- Distance from y-axis = 0
  Coordinates = (0, y)

11. Distance Meaning (Conceptual Formula)

- **x-coordinate** → distance from y-axis
- **y-coordinate** → distance from x-axis

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(Sign depends on direction: + or −)

12. Key Properties (Exam Points)

- Coordinates uniquely represent a point
- Origin has zero distance from both axes
- Points on axes do **not belong to any quadrant**
- Same point cannot have two different coordinates

✨ One-Line Exam Ready Points

- Cartesian plane is formed by two perpendicular axes
- Abscissa is distance from y-axis
- Ordinate is distance from x-axis
- Origin divides axes into positive and negative directions
- Quadrants determine the sign of coordinates

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Chapter 4 – Linear Equations in Two Variables

◇ IMPORTANT TERMS

1. Variable

A symbol (usually x, y) that represents an unknown quantity whose value can change.
Example: In x + y = 10, x and y are variables.

2. Linear Equation

An equation in which the highest power of each variable is 1.
Example: 2x + 3y = 12

3. Linear Equation in Two Variables

An equation involving **two variables** and both variables have power 1.
General form:

$$ax + by + c = 0$$

where **a, b, c are real numbers** and **a and b are not both zero**.

4. Coefficient

The numerical factor multiplying a variable.
Example:
In 4x + 5y = 7
• Coefficient of x = 4
• Coefficient of y = 5

5. Constant Term

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A term without any variable.
Example:
In 2x + 3y – 6 = 0, constant = –6

6. Solution of a Linear Equation

A **pair of values (x, y)** that satisfies the equation.
Example:
For 2x + 3y = 12
(3, 2) is a solution because
2(3) + 3(2) = 12 ✔

7. Ordered Pair

A pair of numbers written as **(x, y)**, where
• First number → value of x
• Second number → value of y

Example: (4, 1)

8. Infinitely Many Solutions

A linear equation in two variables has **unlimited solutions** because for every value of x, there is a corresponding value of y.

9. Graph of a Linear Equation

The graph of a linear equation in two variables is always a **straight line**.
• Every point on the line is a solution
• Every solution lies on the line

10. Intercepts

- **x-intercept**: Value of x when y = 0

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- **y-intercept**: Value of y when x = 0

Used to draw the graph.

◇ IMPORTANT FORMULAS & STANDARD RESULTS

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1. Standard Form

$$ax + by + c = 0$$

where
$a \neq 0$ or $b \neq 0$

2. Equation with One Variable as Zero

- If equation has only x:
  $$ax + b = 0 \quad = \quad ax + 0y + b = 0$$
- If equation has only y:
  $$by + c = 0 \quad = 0x + by + c = 0$$

3. Finding Solutions

- Put **x = 0**, find y
- Put **y = 0**, find x

This gives easy solutions.

4. Checking a Solution

To check whether (x, y) is a solution:
👉 Substitute values of x and y in the equation
👉 If LHS = RHS → ✔ solution
👉 Otherwise → ✗ not a solution

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5. Number of Solution

Types of Number of Solutions

◇ 1. No Solution

A system of two linear equations has **no solution** when the lines are **parallel**.

Condition:

$$\frac{a_1}{a_2} = \frac{b_1}{b_2} \neq \frac{c_1}{c_2}$$

Meaning:

- Coefficients of x and y are proportional
- Constants are **not** proportional
- Lines never intersect

Example:

$$x + y = 5$$
$$2x + 2y = 8$$

◇ 2. Unique Solution

A system has **exactly one solution** when the two lines **intersect at one point**.

Condition:

$$\frac{a_1}{a_2} \neq \frac{b_1}{b_2}$$

Meaning:

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- Slopes are different
- Lines cut each other at one point

Example:

$x + y = 5$
$x - y = 1$

◇ 3. Infinitely Many Solutions

A system has **infinitely many solutions** when both equations represent the **same line**.

Condition:

$$\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$$

Meaning:

- One equation is a multiple of the other
- Lines overlap completely

Example:

$x + y = 4$
$2x + 2y = 8$

◇ QUICK COMPARISON TABLE

Type of Solution	Graph Nature	Number of Solutions
No Solution	Parallel lines	0
Unique Solution	Intersecting lines	1

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Type of Solution	Graph Nature	Number of Solutions
Infinitely Many Solutions	Coincident lines	∞

◇ IMPORTANT EXAM LINE

A linear equation in two variables always has infinitely many solutions, but a system of two linear equations may have 0, 1, or infinitely many solutions.

◇ ONE-LINE EXAM POINTS

- Degree of a linear equation in two variables is **1**
- Solution is always written as **(x, y)**
- Graph is always a **straight line**
- a and b cannot both be zero
- Every solution represents a **point on the graph**

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Chapter 5: Introduction to Euclid's Geometry

◇ IMPORTANT TERMS

Geometry

Geometry is the branch of mathematics that deals with the study of **shapes, sizes, positions, and properties of figures**.

Origin of word:

- *Geo* → Earth
- *Metrin* → Measure

So, geometry means **measurement of the earth**.

Point

- A **point** represents a **position only**.
- It has **no length, no breadth, no thickness**.
- Represented by a **dot (•)**.
- Example: Location of a star in the sky.

👉 In modern geometry, **point is an undefined term**.

Line

- A **line** has **length only**, no breadth.
- It extends **infinitely in both directions**.
- Represented by a straight path with arrowheads on both ends.

👉 A line is also an **undefined term**.

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Line Segment

- A **part of a line** bounded by **two end points**.
- Has a **fixed length**.
- Example: AB

Plane (Plane Surface)

- A **plane** has **length and breadth only**.
- It has **no thickness**.
- Example: Table top, blackboard.

👉 Plane is also an **undefined term**.

Dimension

Dimension means the **measure of extension**.

Object	Dimension
Solid	3D
Surface	2D
Line	1D
Point	0D

Solid

- A solid has **length, breadth, and height**.
- Example: Cube, pyramid, cylinder.

Axiom

- An **axiom** is a statement which is **universally true**.
- It is **accepted without proof**.
- Applies to **all branches of mathematics**.

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Postulate

- A **postulate** is a statement assumed to be true **only for geometry**.
- It is **not proved**.
- Based on **geometrical observation**.

Theorem / Proposition

- A **statement that is proved** using:
  - Definitions
  - Axioms
  - Postulates
  - Previously proved results

◇ EUCLID'S DEFINITIONS (IMPORTANT ONES)

No.	Definition
1	A point is that which has no part
2	A line is breadthless length
3	The ends of a line are points
4	A straight line lies evenly with points on itself
5	A surface has length and breadth only
6	The edges of a surface are lines
7	A plane surface lies evenly with straight lines on itself

📌 These definitions are **not fully accepted today**, hence point, line, plane are treated as **undefined terms**.

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◇ EUCLID'S AXIOMS (COMMON NOTIONS)

✨ Important Axioms:

1. Things equal to the same thing are equal to one another
2. If equals are added to equals, the wholes are equal
3. If equals are subtracted from equals, the remainders are equal
4. Things which coincide with one another are equal
5. The whole is greater than the part
6. Things which are double of the same things are equal
7. Things which are halves of the same things are equal

📌 These axioms apply to **magnitudes of the same kind only**.

◇ EUCLID'S FIVE POSTULATES (VERY IMPORTANT)

📐 Postulate 1

A straight line can be drawn from **any one point to any other point**.

📐 Postulate 2

A **terminated line (line segment)** can be produced **indefinitely** in both directions.

📐 Postulate 3

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A **circle** can be drawn with **any centre and any radius**.

📐 Postulate 4

All **right angles** are equal to one another.

📐 Postulate 5 (Parallel Postulate)

If a straight line falling on two straight lines makes the interior angles on the same side **less than two right angles**, then the two lines, if extended, will meet on that side.

📌 This is the **most complex postulate**.

◇ IMPORTANT RESULTS / THEOREMS

☑ Axiom 5.1

Through two distinct points, there is one and only one straight line.

☑ Theorem 5.1

Two distinct lines cannot have more than one point in common.

◇ KEY EXAM NOTES (ONE-LINERS)

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- ✔ Point, line, and plane are **undefined terms**
- ✔ Axioms are **universal truths**
- ✔ Postulates are **geometry-specific assumptions**
- ✔ Theorems are **proved statements**
- ✔ Euclid's geometry is based on **deductive reasoning**

📌 Difference Between Axiom and Postulate

Basis	Axiom	Postulate
Definition	An axiom is a statement accepted as **universally true** without proof	A postulate is a statement assumed to be true **specifically in geometry**
Scope	Applies to **all branches of mathematics**	Applies **only to geometry**
Nature	General statements	Geometry-specific statements
Usage	Used in **algebra, arithmetic, geometry**, etc.	Used **only in geometrical constructions and proofs**
Example	"Things equal to the same thing are equal to one another."	"A straight line can be drawn joining any two points."

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Chapter 6: Lines and Angles

◇ IMPORTANT TERMS

1. Line

A line is a straight path that extends infinitely in both directions.
👉 It has **no endpoints**.

2. Line Segment

A part of a line with **two fixed endpoints**.
Example: Segment AB has endpoints A and B.

3. Ray

A part of a line that starts at one point and extends infinitely in one direction.
Example: Ray AB starts from A and goes through B.

4. Collinear Points

Three or more points lying on the **same straight line**.

5. Non-collinear Points

Points that **do not lie on the same line**.

6. Angle

An angle is formed when **two rays originate from the same point**.

- Common point → **Vertex**
- Rays → **Arms**

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◇ TYPES OF ANGLES

Type of Angle	Measure
Acute Angle	$0° < \theta < 90°$
Right Angle	$\theta = 90°$
Obtuse Angle	$90° < \theta < 180°$
Straight Angle	$\theta = 180°$
Reflex Angle	$180° < \theta < 360°$

◇ PAIRS OF ANGLES (IMPORTANT TERMS)

1. Complementary Angles

Two angles whose **sum = 90°**

📌 Formula:

$$\angle A + \angle B = 90^\circ$$

2. Supplementary Angles

Two angles whose **sum = 180°**

📌 Formula:

$$\angle A + \angle B = 180^\circ$$

3. Adjacent Angles

Two angles are adjacent if:

- They have a **common vertex**
- A **common arm**

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- Their non-common arms lie on **different sides**

📌 Property:
Sum of adjacent angles = angle formed by non-common arms

4. Linear Pair of Angles

A pair of **adjacent angles whose non-common arms form a straight line**

📌 Formula:

$$\angle 1 + \angle 2 = 180^\circ$$

◇ AXIOMS (VERY IMPORTANT)

◇ Linear Pair Axiom

If a ray stands on a line, then the sum of the two adjacent angles so formed is **180°**.

📌 Converse also true.

◇ INTERSECTING LINES

Vertically Opposite Angles

When two lines intersect, the angles opposite to each other are equal.

📌 Formula:

$$\angle A = \angle B$$

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📌 **Theorem**:
If two lines intersect, their vertically opposite angles are equal.

◇ PARALLEL LINES

1. Parallel Lines

Lines that **never intersect**, no matter how far extended.

2. Distance Between Parallel Lines

The **perpendicular distance** between two parallel lines is **same everywhere**.

◇ ANGLES FORMED BY A TRANSVERSAL

When a transversal cuts two parallel lines:

1. Corresponding Angles

📌 If lines are parallel → Corresponding angles are **equal**

$$\angle 1 = \angle 2$$

2. Alternate Interior Angles

📌 If lines are parallel → Alternate angles are **equal**

$$\angle A = \angle B$$

3. Interior Angles on Same Side of Transversal

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📌 If lines are parallel → Sum = **180°**

$$\angle A + \angle B = 180^\circ$$

4.Vertically Opposite Angles :

$$\angle A = \angle B$$

- **IMPORTANT THEOREMS**
- **Theorem 1**

If two lines intersect → **Vertically opposite angles are equal**

- **Theorem 2**

Lines parallel to the **same line** are **parallel to each other**

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Chapter 7: TRIANGLES

◇ IMPORTANT TERMS

1. Triangle

A closed figure formed by **three line segments**.
It has:

- **3 sides**
- **3 angles**
- **3 vertices**

2. Congruent Figures

Two figures are **congruent** if:

- Shape is same
- Size is same

👉 They **completely overlap** when placed on each other.

3. Congruent Triangles

Two triangles are congruent if their:

- Corresponding sides are equal
- Corresponding angles are equal

Symbol:

$$\triangle ABC \cong \triangle PQR$$

4. Corresponding Parts

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When two triangles are congruent:

- Matching sides → Corresponding sides
- Matching angles → Corresponding angles

📌 **CPCT** = *Corresponding Parts of Congruent Triangles are equal*

◇ CONGRUENCE RULES (VERY IMPORTANT)

5. SAS (Side–Angle–Side) Congruence Rule

If:

- Two sides of one triangle = two sides of another triangle
- The **included angle** is equal

Then triangles are congruent.

📌 SAS is an **axiom** (accepted without proof)

6. ASA (Angle–Side–Angle) Congruence Rule

If:

- Two angles are equal
- The **included side** is equal

Then triangles are congruent.

7. AAS (Angle–Angle–Side) Congruence Rule

If:

- Two angles are equal
- Any one corresponding side is equal

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Then triangles are congruent
(Third angle becomes automatically equal)

8. SSS (Side–Side–Side) Congruence Rule

If:

- All three sides of one triangle are equal to all three sides of another triangle

Then triangles are congruent.

9. RHS (Right angle–Hypotenuse–Side) Congruence Rule

Applies **only to right-angled triangles**.

If:

- Right angle is equal
- Hypotenuse is equal
- One side is equal

Then triangles are congruent.

◇ TYPES OF TRIANGLES (Based on Sides)

10. Isosceles Triangle

A triangle with **two equal sides**.

11. Equilateral Triangle

A triangle with:

- All sides equal

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- All angles equal

Each angle = **60°**

◇ TYPES OF TRIANGLES (Based on Angles)

12.Acute-Angled Triangle

Definition:
A triangle in which **all three angles are less than 90°**.

Example:
Angles: 50°, 60°, 70°

13.Right-Angled Triangle

Definition:
A triangle in which **one angle is exactly 90°**.

Example:
Angles: 30°, 60°, 90°

14.Obtuse-Angled Triangle

Definition:
A triangle in which **one angle is greater than 90° but less than 180°**.

Example:
Angles: 110°, 40°, 30°

◇ IMPORTANT THEOREMS & PROPERTIES

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15. Angles Opposite to Equal Sides

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In an isosceles triangle:

- Angles opposite to equal sides are **equal**

16. Sides Opposite to Equal Angles

If:

- Two angles of a triangle are equal

Then:

- Sides opposite to them are equal

(Converse of Theorem 12)

17. Perpendicular Bisector Property

Any point on the perpendicular bisector of a line segment is:

- Equidistant from its endpoints

18. Angle Bisector Property

A point equidistant from two intersecting lines lies on:

- The bisector of the angle between them

◇ IMPORTANT ANGLE FACTS

19. Sum of Angles of a Triangle

$$\angle A + \angle B + \angle C = 180^\circ$$

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20. Right-Angled Triangle

A triangle having:

- One angle = **90°**

◇ ONE-LINE EXAM POINTS

✔ SSA is **NOT** a valid congruence rule
✔ AAA gives **similar**, not congruent triangles
✔ Congruence means **same shape + same size**
✔ Included angle = angle between two given sides

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Chapter 8 - Quadrilaterals

◇ IMPORTANT TERMS

1. Quadrilateral

A polygon having **four sides, four angles, and four vertices**.

2. Parallelogram

A quadrilateral in which **both pairs of opposite sides are parallel**.

3. Diagonal

A line segment joining **two non-adjacent vertices** of a polygon.

4. Congruent Triangles

Two triangles are congruent if they are **exactly the same in shape and size**.

5. Rectangle

A parallelogram in which **each angle is a right angle (90°)**.

6. Rhombus

A parallelogram in which **all four sides are equal**.

7. Square

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A special quadrilateral which is **both a rectangle and a rhombus**
→ all sides equal and all angles 90°.

8. Mid-point

The point which **divides a line segment into two equal parts**.

9. Mid-point Theorem

The line joining the mid-points of two sides of a triangle is **parallel to the third side** and **half of it**.

◇ IMPORTANT THEOREMS & PROPERTIES (EXAM-ORIENTED)

Theorem 1: Diagonal of a Parallelogram

👉 A diagonal of a parallelogram divides it into **two congruent triangles**.

Theorem 2: Opposite Sides of a Parallelogram

👉 In a parallelogram:

- Opposite sides are **equal**
- Opposite sides are **parallel**

Theorem 3 (Converse)

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👉 If both pairs of opposite sides of a quadrilateral are equal,
then the quadrilateral is a **parallelogram**.

Theorem 4: Opposite Angles

👉 In a parallelogram, **opposite angles are equal**.

Theorem 5 (Converse)

👉 If both pairs of opposite angles of a quadrilateral are equal,
then it is a **parallelogram**.

Theorem 6: Diagonals of a Parallelogram

👉 Diagonals of a parallelogram **bisect each other**.

Theorem 7 (Converse)

👉 If diagonals of a quadrilateral bisect each other,
then the quadrilateral is a **parallelogram**.

◇ **RECTANGLE –**

- All angles = **90°**
- Diagonals:
  - **Equal**
  - **Bisect each other**

👉 If diagonals of a parallelogram are equal → it is a **rectangle**.

◇ **RHOMBUS –**

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- All sides equal
- Diagonals:
  - **Bisect each other**
  - **Perpendicular to each other**

👉 If diagonals bisect at right angles → it is a **rhombus**.

◇ SQUARE –

- All sides equal
- All angles = 90°
- Diagonals:
  - Equal
  - Bisect each other
  - Perpendicular

◇ MID-POINT THEOREM (IMPORTANT FORMULAS)

Theorem

If E and F are mid-points of two sides of a triangle, then:

- **EF ∥ third side**
- **EF = ½ (third side)**

Converse of Mid-point Theorem

A line drawn through the mid-point of one side of a triangle parallel to another side **bisects the third side**.

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◇ QUICK REVISION – ONE LINE POINTS

- ✔ Diagonal of parallelogram → 2 congruent triangles
- ✔ Opposite sides equal → Parallelogram
- ✔ Opposite angles equal → Parallelogram
- ✔ Diagonals bisect → Parallelogram
- ✔ Equal diagonals → Rectangle
- ✔ Perpendicular diagonals → Rhombus
- ✔ Equal + perpendicular diagonals → Square
- ✔ Mid-point join → Parallel & half

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Chapter 9 - Circles

◇ IMPORTANT TERMS

1. Circle

A circle is the **set of all points in a plane** that are at the **same distance** from a fixed point.

- Fixed point → **Centre**
- Fixed distance → **Radius**

2. Centre (O)

The fixed point inside the circle from which all points on the circle are equally distant.

3. Radius (r)

A line segment joining the **centre to any point on the circle**.

👉 All radii of a circle are **equal**.

4. Diameter (d)

A chord that **passes through the centre** of the circle.

- Longest chord of the circle
- **Formula:**

$$d = 2r$$

5. Chord

A line segment joining **any two points on the circle**.

- Diameter is a **special chord**

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- Longer chord is **closer to the centre**

6. Arc

A part of the circumference of a circle.

- **Minor Arc** – smaller part
- **Major Arc** – larger part

7. Semicircle

An arc formed by a diameter that divides the circle into two equal halves.

8. Congruent Circles

Two circles having the **same radius**.

9. Distance of a Chord from Centre

The **perpendicular distance** from the centre of the circle to the chord.

🔺 ANGLES RELATED TO CIRCLE

10. Angle Subtended by a Chord

The angle formed by a chord at:

- **Centre** → Central angle
- **Point on circle** → Inscribed angle

📐 IMPORTANT THEOREMS & FORMULAS

☑ Theorem 1

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Equal chords of a circle subtend equal angles at the centre.

☑ Theorem 2 (Converse)

If angles subtended by chords at the centre are equal, then the chords are equal.

☑ Theorem 3

The perpendicular drawn from the centre of a circle to a chord bisects the chord.

☑ Theorem 4 (Converse)

A line through the centre that bisects a chord is perpendicular to the chord.

☑ Theorem 5

Equal chords of a circle are equidistant from the centre.

☑ Theorem 6 (Converse)

Chords equidistant from the centre are equal in length.

☑ Theorem 7 (MOST IMPORTANT)

Angle subtended by an arc at the centre is double the angle subtended at any point on the remaining circle.

$$\angle\text{Centre} = 2 \times \angle\text{Point on Circle}$$

☑ Theorem 8

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Angles in the same segment of a circle are equal.

★ Special Result

Angle in a semicircle is always 90° (Right Angle).

☑ Theorem 9 (Concyclic Points)

If a line segment subtends **equal angles at two points**, then **all four points lie on a circle**.

◇ CYCLIC QUADRILATERAL

11. Cyclic Quadrilateral

A quadrilateral whose **all vertices lie on a circle**.

☑ Theorem 10

Sum of opposite angles of a cyclic quadrilateral is 180°.

$$\angle A + \angle C = 180^\circ \angle B + \angle D = 180^\circ$$

☑ Theorem 11 (Converse)

If sum of opposite angles of a quadrilateral is 180°, then the quadrilateral is **cyclic**.

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📌 QUICK FORMULA & RESULT SUMMARY

Concept	Formula / Result
Diameter	d = 2r
Equal chords	Equal distance from centre
Angle at centre	2 × angle at circle
Angle in semicircle	90°
Cyclic quad	Opposite angles sum = 180°

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Chapter 10 – Heron's Formula

IMPORTANT TERMS

◇ 1. Triangle

A **triangle** is a closed plane figure formed by joining three non-collinear points.
It has:

- **3 sides**
- **3 angles**
- **3 vertices**

◇ 2. Sides of a Triangle (a, b, c)

The three line segments forming the boundary of a triangle are called its **sides**.

- Usually denoted by **a, b, c**
- Measured in **cm, m, etc.**

◇ 3. Perimeter of a Triangle

The **perimeter** is the total length of all sides of a triangle.

📌 Formula:

$$\text{Perimeter} = a + b + c$$

◇ 4. Semi-Perimeter (s)

Semi-perimeter is **half of the perimeter** of a triangle.

📌 Formula:

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$$s = \frac{a+b+c}{2}$$

This is the most important term in Heron's Formula.

◇ 5. Heron's Formula

Heron's Formula is used to find the **area of a triangle when only the lengths of its three sides are known**, and height is not given.

Formula:

$$\text{Area of triangle} = \sqrt{s(s-a)(s-b)(s-c)}$$

Where:

- (a, b, c) = sides of the triangle
- (s) = semi-perimeter

◇ 6. Area of a Triangle

Area is the region enclosed by a triangle, measured in **square units** (cm^2, m^2).

✔ **When height is known:**

$$\text{Area} = \frac{1}{2} \times \text{base} \times \text{height}$$

✔ **When height is NOT known:**

👉 **Use Heron's Formula**

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◇ 7. Applicability of Heron's Formula

Heron's Formula is used when:

- Triangle is **scalene, isosceles, equilateral, or right-angled**
- Only **three sides are given**
- Height is **difficult or impossible** to find directly

◇ 8. Special Cases using Heron's Formula

(a) Equilateral Triangle

All sides are equal.

If side = (a)

- Semi-perimeter:

$$s = \frac{3a}{2}$$

- Area:

$$\sqrt{s(s-a)^3}$$

(b) Isosceles Triangle

Two sides are equal, one is unequal.
Heron's Formula works normally using all three sides.

(c) Right-Angled Triangle

If sides satisfy:

$$a^2 + b^2 = c^2$$

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Area can be checked by:

$$\frac{1}{2} \times \text{base} \times \text{height}$$

Heron's Formula gives the **same result**, verifying correctness.

◇ 9. Units of Area

- If sides are in **cm** → area in **cm^2**
- If sides are in **m** → area in **m^2**

◇ 10. Important Points for Exams ⭐

✔ Always calculate **semi-perimeter first**
✔ Substitute values **step-by-step**
✔ Write units correctly
✔ Use **square root carefully**
✔ Heron's Formula works for **all types of triangles**

Chapter Summary Formula

$$\text{Area of triangle} = \sqrt{s(s-a)(s-b)(s-c)}, \quad s = \frac{a+b+c}{2}$$

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Chapter 11-Surface Areas and Volumes

◇ IMPORTANT TERMS

1. RIGHT CIRCULAR CONE

1. **Cone**
   A solid formed by joining all points of a circular base to a fixed point called the vertex.
2. **Right Circular Cone**
   A cone in which the line joining the vertex to the centre of the base is **perpendicular** to the base.
3. **Radius (r)**
   Radius of the circular base of the cone.
4. **Height (h)**
   The perpendicular distance from the vertex to the centre of the base.
5. **Slant Height (l)**
   Distance from the vertex to any point on the circumference of the base.

$$l = \sqrt{r^2 + h^2}$$

6. **Curved Surface Area (CSA)**
   Area of the curved surface only (excluding base).
7. **Total Surface Area (TSA)**
   Area of curved surface + area of base.

◇ Formulas (Cone)

Quantity	Formula
Curved Surface Area	π r l
Total Surface Area	π r (l + r)

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Quantity	Formula
Volume	$\frac{1}{3}\pi\ r^2\ h$

◇ 2. SPHERE

◇ Important Terms

1. **Sphere**
   A 3-D solid in which all points on the surface are at the same distance from the centre.
2. **Radius (r)**
   Distance from the centre to any point on the surface.
3. **Surface of a Sphere**
   A sphere has **only one curved surface** and no flat surface.

◇ Formulas (Sphere)

Quantity	Formula
Surface Area	$4\ \pi\ r^2$
Volume	$\frac{4}{3}\pi\ r^3$

◇ 3. HEMISPHERE

◇ Important Terms

1. **Hemisphere**
   Half of a sphere formed by cutting it through its centre.

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2. **Curved Surface**
   The rounded part of the hemisphere.
3. **Flat Surface (Base)**
   The circular face of the hemisphere.

◇ Formulas (Hemisphere)

Quantity	Formula
Curved Surface Area	$2\pi r^2$
Total Surface Area	$3\pi r^2$
Volume	$\frac{2}{3}\pi r^3$

◇ 4. IMPORTANT RELATIONS

- Slant height of cone:

$$l^2 = r^2 + h^2$$

- Units:
  - Surface Area → square units (cm^2, m^2)
  - Volume → cubic units (cm^3, m^3)
  - 1 m^3 = 1000 litres

◇ 5. COMMON MISTAKES TO AVOID ✖

- Using **TSA instead of CSA** in tent or dome problems
- Forgetting to **convert diameter to radius**
- Using wrong unit (cm instead of m)

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Chapter 12 - STATISTICS

◇ IMPORTANT TERMS

◇ 1. Statistics

Statistics is the branch of mathematics that deals with:

- Collection of data
- Organisation of data
- Presentation of data
- Analysis and interpretation of data

◇ 2. Data

Data means information collected in numerical form for a specific purpose.

◇ 3. Graphical representation of data

It is the method of representing data using graphs so that:

- Data becomes easy to understand
- Comparison becomes simple
- Large data can be analysed quickly

Types studied in this chapter:

1. **Bar Graph**
2. **Histogram**
3. **Frequency Polygon**

◇ 4. Bar graph

Definition:

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A **bar graph** is a graphical representation in which:

- Bars of **equal width**
- Bars have **equal spacing**
- Height of bars represents the value of data

Key Points:

- Used for **discrete data**
- Width of bars does **not matter**
- Bars do **not touch each other**

Axes:

- **X-axis** → Categories / variables
- **Y-axis** → Values / frequencies

◇ 5. Histogram

Definition:

A **histogram** is a graphical representation of a **grouped frequency distribution** with **continuous class intervals**.

Important Features:

- Bars are **touching**
- Width of bars **matters**
- Area of rectangle ∝ frequency

Axes:

- **X-axis** → Class intervals
- **Y-axis** → Frequencies

◇ 6. Continuous class interval

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A class interval in which:

- Upper limit of one class = Lower limit of next class
  Example:
  30.5 – 35.5, 35.5 – 40.5

◇ 7. Frequency

Frequency is the number of times a particular observation occurs.

◇ 8. Histogram with equal class width

When all class intervals have:

- Same width
- Height of bar ∝ frequency

◇ 9. Histogram with unequal class width

When class intervals are of **different widths**, then:

- Height of bars is adjusted using **frequency density**

Formula:

$$\textbf{Adjusted Frequency} = \frac{\text{Frequency}}{\text{Class Width}} \times \text{Minimum Class Width}$$

◇ 10. Frequency polygon

Definition:

A **frequency polygon** is obtained by:

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- Joining the **mid-points** of the tops of rectangles of a histogram

OR

- Joining points plotted using **class marks** and frequencies

◇ 11. Class interval

The range within which observations fall.
Example: 40 – 50

◇ 12. Class limits

- **Lower limit**: Smallest value of class
- **Upper limit**: Largest value of class

◇ 13. Class mark

Definition:

The mid-point of a class interval.

Formula:

$$\textbf{Class Mark} = \frac{\text{Upper Limit} + \text{Lower Limit}}{2}$$

Example:

For class 20 – 30

$$\text{Class Mark} = \frac{20 + 30}{2} = 25$$

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◇ 14. Zero frequency class

An imaginary class added:

- Before first class
- After last class
  To complete a frequency polygon

◇ 15. Uses of frequency polygon

- Useful for **large data**
- Helpful in **comparison of two data sets**
- Shows trend clearly

◇ 16. COMPARISON: BAR GRAPH vs HISTOGRAM

Bar Graph	Histogram
Discrete data	Continuous data
Bars have gaps	Bars touch
Width not important	Width important
Height shows value	Area shows frequency

◇ 17. SUMMARY FORMULAS (Quick View)

Term	Formula
Class Mark	(Upper + Lower) ÷ 2
Adjusted Frequency	(Frequency ÷ Class Width) × Minimum Width

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📊 Class 9 – Difference Between Maths Xpress

1. Natural Numbers vs Whole Numbers

Basis	Natural Numbers	Whole Numbers
Definition	Counting numbers starting from 1	Natural numbers including zero
Zero	Not included	Included
Set	{1, 2, 3, …}	{0, 1, 2, 3, …}

2. Whole Numbers vs Integers

Basis	Whole Numbers	Integers
Negative numbers	Not included	Included
Set	{0,1,2,…}	{…,−2,−1,0,1,2,…}
Use	Simple counting	Gains, losses, temperature

3. Rational Numbers vs Irrational Numbers

Basis	Rational Numbers	Irrational Numbers
Form	p/q, $q \neq 0$	Cannot be written as p/q
Decimal	Terminating or recurring	Non-terminating, non-recurring
Example	$3/4$, -2	$\sqrt{2}$, π

4. Terminating vs Non-terminating Decimals

Basis	Terminating	Non-terminating
Decimal digits	Finite	Infinite
End	Ends	Never ends
Nature	Rational	Rational / Irrational

5. Recurring vs Non-recurring Decimals

Basis	Recurring	Non-recurring
Repetition	Repeats	Does not repeat
Nature	Rational	Irrational
Example	0.666…	$\sqrt{5}$

6. Real Numbers vs Rational Numbers

Basis	Real Numbers	Rational Numbers
Includes	Rational + Irrational	Only rational
Representation	On number line	On number line
Example	$\sqrt{3}$, 2	3/5

7. Polynomial vs Algebraic Expression

Basis	Polynomial	Algebraic Expression
Powers	Non-negative integers	Any power
Structure	Well-defined	General form
Example	$x^2 + 2x + 1$	$x^{-1} + 3$

8. Monomial vs Binomial

Basis	Monomial	Binomial
Number of terms	One	Two
Example	$5x^2$	$x + 4$
Operation	Simple	Slightly complex

9. Binomial vs Trinomial

Basis	Binomial	Trinomial
Number of terms	Two	Three
Example	$a + b$	$a + b + c$
Degree	Usually smaller	Can be higher

10. Linear Polynomial vs Quadratic Polynomial

Basis	Linear	Quadratic
Degree	1	2
Graph	Straight line	Parabola
Example	$2x + 1$	$x^2 + 3x + 2$

11. Zero of Polynomial vs Factor of Polynomial

Basis	Zero	Factor
Meaning	Value making polynomial zero	Divides polynomial completely
Relation	Gives x-value	Gives expression
Example	$x=2$	$(x-2)$

12. Linear Equation vs Quadratic Equation

Basis	Linear	Quadratic
Degree	1	2

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Basis	Linear	Quadratic
Solutions	One	Two
Graph	Straight line	Curve

13. Equation vs Identity

Basis	Equation	Identity
Validity	Some values	All values
Solution	Required	Not required
Example	$x+3=5$	$(a+b)^2=a^2+2ab+b^2$

14. Coordinate Plane vs Cartesian Plane

Basis	Coordinate Plane	Cartesian Plane
Meaning	Plane with axes	Coordinate plane by Descartes
Axes	X and Y	X and Y
Origin	(0,0)	(0,0)

15. Abscissa vs Ordinate

Basis	Abscissa	Ordinate
Axis	X-axis	Y-axis
Position	Horizontal	Vertical
Example	$(3,4) \rightarrow 3$	$(3,4) \rightarrow 4$

16. Quadrilateral vs Parallelogram

Basis	Quadrilateral	Parallelogram
Sides	4	4

Basis	Quadrilateral	Parallelogram
Parallel sides	Not necessary	Two pairs
Angles	Any	Opposite equal

17. Rectangle vs Square

Basis	Rectangle	Square
Sides	Opposite equal	All equal
Angles	90°	90°
Diagonal	Equal	Equal

18. Rhombus vs Parallelogram

Basis	Rhombus	Parallelogram
Sides	All equal	Opposite equal
Angles	Not 90°	Not necessary 90°
Diagonal	Perpendicular	Not perpendicular

19. Triangle vs Polygon

Basis	Triangle	Polygon
Sides	3	3 or more
Angle sum	180°	Depends on sides
Type	Closed figure	Closed figure

20. Congruent vs Similar Figures

Basis	Congruent	Similar
Shape	Same	Same

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Basis	Congruent	Similar
Size	Same	Proportional
Symbol	$\cong$	$\sim$

21. Area vs Perimeter

Basis	Area	Perimeter
Meaning	Surface covered	Boundary length
Unit	Square unit	Unit
Formula	$l \times b$	$2(l+b)$

22. Surface Area vs Volume

Basis	Surface Area	Volume
Meaning	Outer area	Space occupied
Unit	cm^2	cm^3
Use	Covering	Capacity

23. Circle vs Sphere

Basis	Circle	Sphere
Dimension	2D	3D
Area	πr^2	$4\pi r^2$
Volume	Not defined	$(4/3)\pi r^3$

24. Chord vs Diameter

Basis	Chord	Diameter
Definition	Line joining two points	Longest chord
Passes centre	Not necessary	Always
Length	Variable	Maximum

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25. Radius vs Diameter

Basis	Radius	Diameter
Length	Centre to circle	End to end
Relation	r	2r
Use	Measure size	Measure width

26. Mean vs Median

Basis	Mean	Median
Meaning	Average	Middle value
Effect of extremes	Affected	Not affected
Use	General data	Skewed data

27. Median vs Mode

Basis	Median	Mode
Meaning	Middle value	Most frequent
Data type	Ordered	Frequency-based
Use	Central tendency	Popular value

28. Mean vs Mode

Basis	Mean	Mode
Based on	All values	Frequency
Calculation	Formula	Observation
Use	Precise	Approximate

29. Bar Graph vs Histogram

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Basis	Bar Graph	Histogram
Data	Discrete	Continuous
Gap	Present	No gap
Shape	Bars	Rectangles

30. Frequency vs Cumulative Frequency

Basis	Frequency	Cumulative
Meaning	Occurrence	Running total
Table	Simple	Progressive
Use	Raw data	Distribution

31. Experimental vs Theoretical Probability

Basis	Experimental	Theoretical
Based on	Experiment	Formula
Accuracy	Varies	Fixed
Example	Toss result	1/2

32. Certain vs Impossible Event

Basis	Certain	Impossible
Probability	1	0
Occurrence	Always	Never
Example	Sun rises	7 on dice

33. Direct vs Inverse Proportion

Basis	Direct	Inverse
Relation	Same direction	Opposite
Formula	$y \propto x$	$y \propto 1/x$

Basis	Direct	Inverse
Example	Cost-quantity	Speed-time

34. Simple Interest vs Compound Interest

Basis	Simple	Compound
Interest	On principal	On principal + interest
Growth	Linear	Faster
Formula	PRT/100	$P(1+r/100)^n$

35. Cost Price vs Selling Price

Basis	CP	SP
Meaning	Buying price	Selling price
Relation	Base	Compared
Use	Calculation	Profit/loss

36. Profit vs Loss

Basis	Profit	Loss
Condition	SP > CP	SP < CP
Formula	SP−CP	CP−SP
Result	Gain	Loss

37. Discount vs Rebate

Basis	Discount	Rebate
Time	Before sale	After sale
Purpose	Attract buyers	Encourage bulk
Example	Marked price cut	Cashback

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38. Marked Price vs Selling Price

Basis	MP	SP
Meaning	Printed price	Actual price
Discount	Applied on MP	After discount
Use	Reference	Transaction

39. Factor vs Multiple

Basis	Factor	Multiple
Meaning	Divides exactly	Product
Count	Finite	Infinite
Example	3 of 12	12 of 3

40. Prime vs Composite Number

Basis	Prime	Composite
Factors	Exactly two	More than two
Smallest	2	4
Example	11	12

41. Co-prime vs Twin Prime

Basis	Co-prime	Twin Prime
Relation	No common factor	Difference 2
Type	Any numbers	Only primes
Example	8 & 15	17 & 19

42. Square vs Square Root

Basis	Square	Square Root
Meaning	Number × itself	Reverse process

Basis	Square	Square Root
Symbol	n^2	$\sqrt{n}$
Example	25	5

43. Cube vs Cube Root

Basis	Cube	Cube Root
Meaning	n^3	$\sqrt[3]{n}$
Operation	Multiply thrice	Reverse
Example	27	3

44. Face Value vs Place Value

Basis	Face	Place
Depends on	Digit	Position
Value	Fixed	Variable
Example	5	50

45. Exponent vs Power

Basis	Exponent	Power
Meaning	Number of times	Complete expression
Example	3 in 2^3	2^3

46. Base vs Exponent

Basis	Base	Exponent
Meaning	Repeated number	Times repeated
Example	2 in 2^3	3 in 2^3
Role	Main number	Count

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47. Angle vs Linear Pair

Basis	Angle	Linear Pair
Definition	Between two rays	Adjacent angles
Sum	Any	180°
Shape	Single	Pair

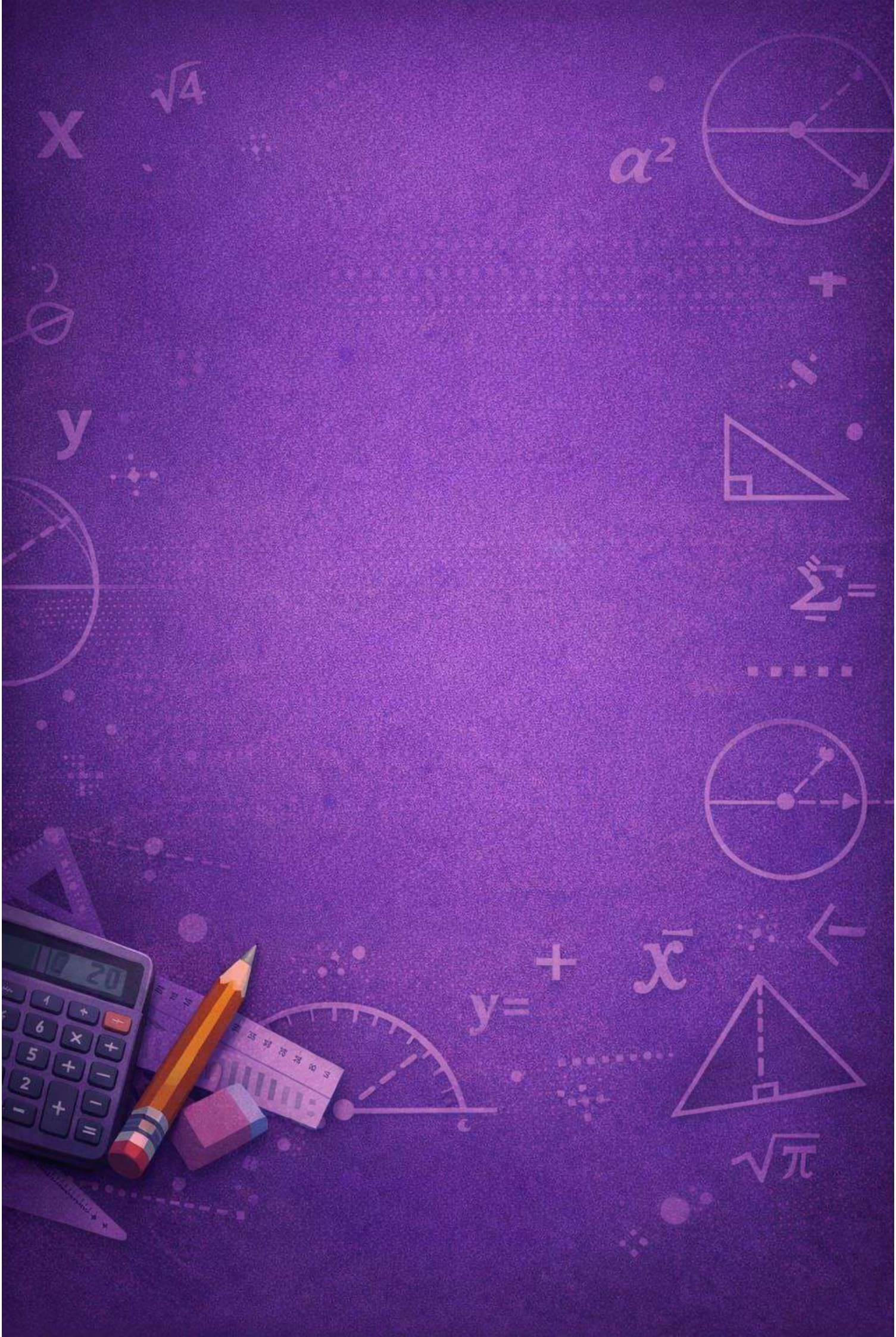
48. Adjacent vs Vertically Opposite Angles

Basis	Adjacent	Vertically Opposite
Position	Side by side	Opposite
Common arm	Yes	No
Equality	Not equal	Equal

49. Plane Figure vs Solid Figure

Basis	Plane	Solid
Dimension	2D	3D
Area	Yes	Yes
Volume	No	Yes

50. Statistics vs Probability

Basis	Statistics	Probability
Study	Data analysis	Chance
Use	Interpretation	Prediction
Example	Mean, graph	Toss, dice

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