Grade 9 Math Formulas

Complete Formula Sheet

Based on Maharashtra Board Syllabus (NEP 2025-26)

Note:

This document contains a collection of key mathematical formulas and concepts typically covered in Grade 9.

Number Systems Formulas

Classification of Numbers

- Natural Numbers (N): {1, 2, 3, ...}
- Whole Numbers (W): {0, 1, 2, 3, ...}
- Integers (Z): {..., -2, -1, 0, 1, 2, ...}
- Rational Numbers (Q): Numbers that can be expressed in the form p/q, where p and q are integers and q is not equal to 0. Includes terminating and non-terminating repeating decimals.
- Irrational Numbers: Numbers that cannot be expressed in the form p/q. Non-terminating, non-repeating decimals (e.g., square root of 2, pi).
- Real Numbers (R): The collection of all rational and irrational numbers.

Operations on Real Numbers

- Addition, Subtraction, Multiplication, and Division of rational numbers follow standard arithmetic rules.
- Properties of Real Numbers (Addition and Multiplication):
    - Closure: The sum/product of two real numbers is a real number.
    - Commutativity: a + b = b + a, a multiplied by b = b multiplied by a
    - Associativity: (a + b) + c = a + (b + c), (a multiplied by b) multiplied by c = a multiplied by (b multiplied by c)
    - Distributivity: a multiplied by (b + c) = a multiplied by b + a multiplied by c
    - Identity Element: 0 for addition (a + 0 = a), 1 for multiplication (a multiplied by 1 = a)
    - Inverse Element: For every real number 'a', there is an additive inverse '-a' (a + (-a) = 0). For every non-zero real number 'a', there is a multiplicative inverse '1/a' (a multiplied by (1/a) = 1).
- Operations involving irrational numbers:
    - Sum/Difference of a rational and an irrational number is irrational.
    - Product/Quotient of a non-zero rational and an irrational number is irrational.
    - Sum, difference, product, or quotient of two irrational numbers can be either rational or irrational.

Laws of Exponents for Real Numbers

- If a > 0 is a real number and p and q are rational numbers:
    - a to the power of p multiplied by a to the power of q = a to the power of (p+q)
    - a to the power of p divided by a to the power of q = a to the power of (p-q)
    - (a to the power of p) to the power of q = a to the power of (p multiplied by q)

  - a to the power of p multiplied by b to the power of p = (a multiplied by b) to the power of p
  - a to the power of 0 = 1
  - a to the power of (-p) = 1 divided by a to the power of p
  - a to the power of (p/q) = (a to the power of p) to the power of (1/q) = (a to the power of (1/q)) to the power of p = q-th root of (a to the power of p)

Rationalizing the Denominator

- To rationalize a denominator of the form 1 divided by square root of a, multiply the numerator and denominator by square root of a. Example: 1 divided by square root of 2 = (1 multiplied by square root of 2) divided by (square root of 2 multiplied by square root of 2) = square root of 2 divided by 2.
- To rationalize a denominator of the form 1 divided by (a + square root of b), multiply the numerator and denominator by the conjugate (a - square root of b). Example: 1 divided by (3 + square root of 2) = (1 multiplied by (3 - square root of 2)) divided by ((3 + square root of 2) multiplied by (3 - square root of 2)) = (3 - square root of 2) divided by (3 squared - (square root of 2) squared) = (3 - square root of 2) divided by (9 - 2) = (3 - square root of 2) divided by 7.
- To rationalize a denominator of the form 1 divided by (square root of a + square root of b), multiply the numerator and denominator by the conjugate (square root of a - square root of b). Example: 1 divided by (square root of 3 + square root of 2) = (1 multiplied by (square root of 3 - square root of 2)) divided by ((square root of 3 + square root of 2) multiplied by (square root of 3 - square root of 2)) = (square root of 3 - square root of 2) divided by ((square root of 3) squared - (square root of 2) squared) = (square root of 3 - square root of 2) divided by (3 - 2) = square root of 3 - square root of 2.

Polynomials Formulas

Basic Concepts

- Polynomial: An algebraic expression consisting of variables and coefficients, that involves only the operations of addition, subtraction, multiplication, and non-negative integer exponents of variables.
- Term: Each part of a polynomial separated by addition or subtraction. Example: In 3x squared + 2x - 5, the terms are 3x squared, 2x, and -5.
- Coefficient: The numerical factor of a term. Example: In 3x squared, the coefficient is 3.
- Degree of a Term: The sum of the exponents of the variables in a term. Example: Degree of 3x squared y cubed is 2 + 3 = 5.
- Degree of a Polynomial: The highest degree among all the terms in the polynomial. Example: Degree of 4x cubed + 2x squared - 7x + 1 is 3.
- Constant Polynomial: A polynomial with degree 0 (a non-zero constant). Example: 5.
- Zero Polynomial: The polynomial 0. Its degree is undefined.

Types of Polynomials

- Based on number of terms:
  - Monomial: 1 term (e.g., 5x)
  - Binomial: 2 terms (e.g., 2x + 3)
  - Trinomial: 3 terms (e.g., x squared - 5x + 6)
- Based on degree:
  - Linear Polynomial: Degree 1 (e.g., 3x + 5)
  - Quadratic Polynomial: Degree 2 (e.g., 2x squared - x + 1)
  - Cubic Polynomial: Degree 3 (e.g., x cubed - 4x squared + 2x - 9)

Operations on Polynomials

- Addition and Subtraction: Combine like terms (terms with the same variable and same exponent) by adding or subtracting their coefficients.
- Multiplication: Multiply each term of one polynomial by each term of the other polynomial and then combine like terms. Use the distributive property.

Algebraic Identities

- (a + b) squared = a squared + 2ab + b squared
- (a - b) squared = a squared - 2ab + b squared
- (a + b)(a - b) = a squared - b squared
- (x + a)(x + b) = x squared + (a + b)x + ab
- (a + b + c) squared = a squared + b squared + c squared + 2ab + 2bc + 2ca
- (a + b) cubed = a cubed + b cubed + 3ab(a + b) = a cubed + 3a squared b + 3ab squared + b cubed
- (a - b) cubed = a cubed - b cubed - 3ab(a - b) = a cubed - 3a squared b + 3ab squared - b cubed
- a cubed + b cubed = (a + b)(a squared - ab + b squared)
- a cubed - b cubed = (a - b)(a squared + ab + b squared)
- a cubed + b cubed + c cubed - 3abc = (a + b + c)(a squared + b squared + c squared - ab - bc - ca)
- If a + b + c = 0, then a cubed + b cubed + c cubed = 3abc

Factor Theorem and Remainder Theorem

- Remainder Theorem: If a polynomial P(x) is divided by (x - a), then the remainder is P(a).
- Factor Theorem: (x - a) is a factor of the polynomial P(x) if and only if P(a) = 0.

Factorisation of Polynomials

- Taking out common factors.
- Grouping terms.
- Using algebraic identities.
- Splitting the middle term (for quadratic trinomials).
- Using the Factor Theorem.

Coordinate Geometry Formulas

The Coordinate Plane

- The Cartesian plane is formed by two perpendicular number lines, the x-axis (horizontal) and the y-axis (vertical), intersecting at the origin (0, 0).
- The axes divide the plane into four quadrants:
    - Quadrant I: $x > 0$, $y > 0$ (+, +)
    - Quadrant II: $x < 0$, $y > 0$ (-, +)
    - Quadrant III: $x < 0$, $y < 0$ (-, -)
    - Quadrant IV: $x > 0$, $y < 0$ (+, -)

- The coordinates of a point are written as an ordered pair (x, y), where x is the x-coordinate (abscissa) and y is the y-coordinate (ordinate).
- Points on the x-axis have coordinates (x, 0).
- Points on the y-axis have coordinates (0, y).
- The origin has coordinates (0, 0).

Distance Formula

- The distance between two points P(x1, y1) and Q(x2, y2) is given by:
  Distance PQ = square root of [(x2 - x1) squared + (y2 - y1) squared]
- The distance of a point P(x, y) from the origin O(0, 0) is:
  Distance OP = square root of (x squared + y squared)

Section Formula (Internal Division)

- The coordinates of the point P(x, y) that divides the line segment joining points A(x1, y1) and B(x2, y2) internally in the ratio m : n are given by:
  x = (m multiplied by x2 + n multiplied by x1) divided by (m + n)
  y = (m multiplied by y2 + n multiplied by y1) divided by (m + n)

Midpoint Formula

- The coordinates of the midpoint of the line segment joining points A(x1, y1) and B(x2, y2) are given by:
  Midpoint coordinates = ((x1 + x2) divided by 2, (y1 + y2) divided by 2)
- This is a special case of the Section Formula where the ratio m : n is 1 : 1.

End of Complete Formula Sheet - Grade 9