GENERAL

list of all mathematical formulas

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Introduction

Mathematics is a language that describes the world around us, from the simple patterns in a sunflower's petals to the complex equations that govern the behavior of galaxies. Whether you're a student tackling a homework assignment, a professional solving engineering problems, or simply a curious mind, having a **list of all mathematical formulas**at your fingertips can be a game changer. In this guide, we'll walk through the most essential equations across a wide range of topics, organized in a way that makes them easy to find and remember.

Why a Comprehensive List Matters

Having a single, well structured reference for mathematical formulas saves time and reduces the risk of errors. It also helps you see connections between different areas of math, fostering deeper understanding. Instead of flipping through multiple textbooks or searching the internet for each formula, you can consult one organized resource that covers:

- Fundamental algebraic identities
- Geometric shapes and their properties
- Trigonometric ratios and identities
- Calculus concepts like differentiation and integration
- Statistical measures and probability formulas
- Linear algebra, matrices, and vector operations
- Special functions and series expansions

Below, we'll explore each of these categories in detail, providing the key formulas and brief explanations of where and why they're used.

Algebraic Foundations

Basic Operations and Identities

Before diving into more advanced topics, it's useful to recall the core algebraic identities that underpin all higher mathematics.

- Distributive Property: a(b + c) = ab + ac
- Associative Property: (a + b) + c = a + (b + c)
- Commutative Property: a + b = b + a; ab = ba
- Quadratic Formula: x = \\dfrac{-b \\pm \\sqrt{b^2-4ac}}{2a}
- Difference of Squares: a^2 - b^2 = (a + b)(a - b)
- Perfect Square Trinomial: a^2 \\pm 2ab + b^2 = (a \\pm b)^2
- Sum/Difference of Cubes: a^3 \\pm b^3 = (a \\pm b)(a^2 \\mp ab + b^2)

Systems of Equations

Solving simultaneous equations is a staple in algebra. The most common methods are substitution, elimination, and matrix inversion. Below are the key formulas.

- Substitution: Solve one equation for a variable and substitute into the other.
- Elimination: Add or subtract equations to eliminate a variable: k •x + k ,y = m •, k •x + k ,y = m , !’ (k •x + k ,y) - (k •x + k ,y) = m • - m ,
- Matrix Inverse Method: If AX = B, then X = A {¹B (provided A is invertible).
- Cramer’s Rule: For a 2×2 system, x = \\dfrac{det\\begin{pmatrix}m_1 & b\\\\ m_2 & d\\end{pmatrix}}{det\ \begin{pmatrix}a & b\\\\ c & d\\end{pmatrix}}, y = \\dfrac{det\\begin{pmatrix}a & m_1\\\\ c & m_2\\end{pmatrix}}{det\ \begin{pmatrix}a & b\\\\ c & d\\end{pmatrix}}

Geometry and Trigonometry

Basic Geometric Formulas

Understanding shapes and their properties is fundamental for both pure and applied mathematics. Here’s a quick reference to the most common geometric formulas.

- Area of a Circle: A = < +
- Circumference of a Circle: C = 2<
- Area of a Triangle: A = \\dfrac{1}{2}bh or A = \\dfrac{1}{2}ab \\sin C
- Area of a Parallelogram: A = bh
- Area of a Rectangle: A = lw
- Area of a Trapezoid: A = \\dfrac{1}{2}(a + b)h
- Pythagorean Theorem: a² + b² = c²
- Volume of a Sphere: V = \\dfrac{4}{3}< +0
- Surface Area of a Sphere: SA = 4< +
- Volume of a Cylinder: V = < +&€
- Surface Area of a Cylinder: SA = 2< "†, ² "•
- Volume of a Cone: V = \\dfrac{1}{3}< +&€
- Surface Area of a Cone: SA = < "‡" ² 2’ v†W&R 2 —2 F†R 6Æ çB †V–v‡@

Trigonometric Identities

Trigonometry is essential for solving problems involving angles and lengths. Below are the core identities.

- Basic Ratios: sin;, Ò ÅÆFg ac{opposite}{hypotenuse}, cos;, Ò ÅÆFg ac{adjacent}{hypotenuse}, tan;, Ò ÅÆFg ac{opposite}{adjacent}
- Pythagorean Identity: sin²;, ² 6÷;#¸ = 1
- Double Angle: sin2;, Ò '6–ã¸cos;,Â 6÷3#¸ = cos²;, Ò 6–ë#¸
- Sum and Difference: sin(; ²) = sin; 6÷3² ± cos; 6–ã², cos(; ²) = cos; 6÷3² " sin; 6–ã²
- Product-to-Sum: sin; 6–ã² = \\dfrac{1}{2}[cos(; Ò ²) - cos(; ² ²)]
- Co-Function Identities: sin(90° - ;,’ Ò 6÷3¸, cos(90° - ;,’ Ò 6–ã¸

Calculus Essentials

Differentiation

Differentiation measures how a function changes as its input changes. The following formulas are the backbone of calculus.

- Power Rule: \\dfrac{d}{dx}x • = nx^{n-1}
- Product Rule: \\dfrac{d}{dx}[u(x)v(x)] = u"v + uv"
- Quotient Rule: \\dfrac{d}{dx}\\left(\\dfrac{u}{v}\\right) = \\dfrac{u"v - uv"}{v²}
- Chain Rule: \\dfrac{d}{dx}f(g(x)) = f"(g(x))g"(x)

- Derivative of e.3 \\dfrac{d}{dx}e^{x} = e^{x}
- Derivative of sinx and cosx: \\dfrac{d}{dx}\\sin x = \\cos x, \\dfrac{d}{dx}\\cos x = -\\sin x
- Implicit Differentiation: Differentiate both sides of an equation that defines y implicitly.

Integration

Integration is the reverse process of differentiation, used to find areas, volumes, and accumulated quantities.

- Indefinite Integral: \\int f(x)dx = F(x) + C where F''(x) = f(x)
- Definite Integral: \\int_{a}^{b} f(x)dx = F(b) - F(a)
- Fundamental Theorem of Calculus: If F is an antiderivative of f, then \\int_{a}^{b} f(x)dx = F(b) - F(a)
- Integration by Parts: \\int u\\,dv = uv - \\int v\\,du
- Substitution: \\int f(g(x))g''(x)dx = \\int f(u)du where u = g(x)
- Trigonometric Integrals: \\int \\sin^{n}x dx, \\int \\cos^{n}x dx, \\int \\sec^{2}x dx = \\tan x + C
- Partial Fractions: Decompose rational functions into simpler fractions for easier integration.

Series and Sequences

Series help approximate functions and solve differential equations.

- Geometric Series: \\sum_{k=0}^{\\infty} ar^{k} = \\dfrac{a}{1-r} for |r|
- Arithmetic Series: \\sum_{k=1}^{n} (a + (k-1)d) = \\dfrac{n}{2}[2a + (n-1)d]
- Harmonic Series: \\sum_{k=1}^{n} \\dfrac{1}{k}
- Maclaurin/Taylor Series: f(x) = \\sum_{n=0}^{\\infty} \\dfrac{f^{(n)}(0)}{n!}x^{n}
- Euler’s Formula: e^{i;‡Ò ÒÅÆ6÷3¸ + i\\sin;€

Probability and Statistics

Probability Basics

Probability quantifies the likelihood of events. Here are the foundational formulas.

- Probability of an Event: P(A) = \\dfrac{\\text{Number of favorable outcomes}}{\\text{Total number of outcomes}}
- Complementary Probability: P(A'') = 1 - P(A)
- Conditional Probability: P(A|B) = \\dfrac{P(A'')B)}{P(B)}
- Multiplication Rule: P(A'')B) = P(A)P(B|A) = P(B)P(A|B)
- Addition Rule: P(A''*B) = P(A) + P(B) - P(A'')B)
- Bayes’ Theorem: P(B|A) = \\dfrac{P(A|B)P(B)}{P(A)}

Descriptive Statistics

Descriptive statistics summarize data sets.

- Mean (;Â“ ;Â Ò ÅÆFg ac{1}{n}\\sum_{i=1}^{n}x_i
- Median: Middle value when data are ordered.
- Mode: Most frequently occurring value.

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