XAT QUANTITATIVE APTITUDE

THE CORE FORMULA COMPENDIUM & QUICK REFERENCE MANIFESTO

SYLLABUS BLOCK ARCHITECTURE		STRATEGIC FOCUS & TARGET MARKS	
High-Yield Core Blocks	Geometry, Trigonometry, Algebra, Functions, Arithmetic, Counting	**QA Question Volume**	~28 Questions (Combined with Data Interpretation)
Formula Usage Style	Conceptual application, boundary limits mapping, and multi-property equation links instead of simple plugging.		

HOW TO LEVERAGE THIS FORMULA SHEET

XAT Quant questions explicitly test the foundational boundaries of mathematical setups rather than mechanical rote substitution. While mastering these formulas is mandatory to clear high cutoffs, focus on understanding the absolute definitions, domain limits (e.g., positive reals, integers), and geometric invariants that dictate when these equations hold true.

Review this compendium comprehensively during post-mock analytical audits and in the final 48 hours leading up to the examination window.

Official Companion Suite for Premium Management Percentiles

Arithmetic Multipliers • Algebra Boundary Identities • Advanced Geometry Theorems • Modern Math Systems

Target Milestone: 99.5+ Percentile across the Quant Section

1. GEOMETRY & TRIGONOMETRY FORMULAS (HIGHEST YIELD CORE BLOCK)

1A. Triangle Geometry & Central Intersection Invariants

- **General Area Invariants:**
  - Heron's Formula: $\Delta = \sqrt{s(s-a)(s-b)(s-c)}$ where Semiperimeter $s = \frac{a+b+c}{2}$.
  - Trigonometric Area Form: $\Delta = \frac{1}{2}ab \sin C = \frac{1}{2}bc \sin A = \frac{1}{2}ac \sin B$.
- **Sine Rule Proportion:** $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C} = 2R$ (where R represents the Circumradius).
- **Cosine Rule Transformation:** $\cos A = \frac{b^2 + c^2 - a^2}{2bc} \quad;\quad \cos B = \frac{a^2 + c^2 - b^2}{2ac} \quad;\quad \cos C = \frac{a^2 + b^2 - c^2}{2ab}$
- **Apollonius Median Identity:** If line median m_a bifurcates side a into identical halves:

$$b^2 + c^2 = 2 \left(m_a^2 + \left(\frac{a}{2} \right)^2 \right)$$

- **Inradius (r) vs. Circumradius (R) Structural Boundaries:**
  - All General Triangles: $r = \frac{\Delta}{s} \quad;\quad R = \frac{abc}{4\Delta}$.
  - Right-Angled Triangles: $R = \frac{\text{Hypotenuse}\ (H)}{2} \quad;\quad r = \frac{\text{Perpendicular}\ (P) + \text{Base}\ (B) - H}{2}$.
  - Equilateral Triangles: $r = \frac{a}{2\sqrt{3}} \quad;\quad R = \frac{a}{\sqrt{3}} \implies R : r = 2 : 1$.
- **Interior Coordinates Distance (Euler's Theorem):** Distance between the circumcenter and incenter is given by $d = \sqrt{R^2 - 2Rr}$.

1B. Circles, Secants & Tangent Intercepts

- **Intersecting Chords Theorem (Internal):** If internal chords AB and CD cross at point P, then $PA \cdot PB = PC \cdot PD$.
- **Intersecting Secants Theorem (External):** If external line segments cross outside at point P cutting a circle at positions A, B and C, D respectively, then $PA \cdot PB = PC \cdot PD$.
- **Tangent-Secant Theorem:** If a tangent line hits a circle at point T from an external station P and a secant intersects at points A, B, then $PT^2 = PA \cdot PB$.
- **Common Tangents Length Form:** For circles with radii r_1, r_2 and center-to-center separation distance d:
  - Direct Common Tangent: $L_{DCT} = \sqrt{d^2 - (r_1 - r_2)^2}$.
  - Transverse Common Tangent: $L_{TCT} = \sqrt{d^2 - (r_1 + r_2)^2}$.

1C. Trigonometric Identities & Coordinate Formulations

- **Compound Trigonometric Transformations:**
  - $\sin(A \pm B) = \sin A \cos B \pm \cos A \sin B$
  - $\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$
  - $\tan(A \pm B) = \frac{\tan A \pm \tan B}{1 \mp \tan A \tan B}$
- **Coordinate Interior Division Mapping:** Point $P(x, y)$ splitting segment line $A(x_1, y_1)$ to $B(x_2, y_2)$ in ratio $m : n$ is mapped via: $x = \frac{mx_2 + nx_1}{m+n} \quad;\quad y = \frac{my_2 + ny_1}{m+n}$.
- **Perpendicular Distance Form:** The distance from point (x_1, y_1) to straight line equation $Ax + By + C = 0$ tracks exactly as: $d = \frac{|Ax_1 + By_1 + C|}{\sqrt{A^2 + B^2}}$.

2. ALGEBRA & FUNCTIONS FORMULAS

2A. Higher-Degree Polynomial Invariants & Vieta's Matrix

For any generic higher-degree polynomial expression a_n x^n + a_{n-1} x^{n-1} + \dots + a_1 x + a_0 = 0, Vieta's formulas map structural sum and product properties back to the ratio of coefficients.

- **Quadratic Equations (ax^2 + bx + c = 0):**
  - Roots Solution: x = rac{-b \pm \sqrt{b^2 - 4ac}}{2a} where discriminant is defined as \Delta = b^2 - 4ac.
  - Sum of Roots: lpha + eta = -b/a \quad;\quad Product of Roots: lpha eta = c/a.
- **Cubic Equations (ax^3 + bx^2 + cx + d = 0):**
  - Singular Roots Sum: lpha + eta + \gamma = -b/a.
  - Pairwise Product Sum: lpha eta + eta\gamma + \gamma lpha = c/a.
  - Cumulative Product: lpha eta\gamma = -d/a.
- **Symmetric Algebraic Collapses:** a^3 + b^3 + c^3 - 3abc = (a+b+c)(a^2+b^2+c^2 - ab - bc - ca).
  Boundary Condition: If a + b + c = 0, then a^3 + b^3 + c^3 = 3abc.

2B. Logarithms, Domain Restrictions & Inequalities

- **Foundational Multi-Base Transformations:**
  - Base-Change Law: \log_a b = rac{\log_c b}{\log_c a} = rac{1}{\log_b a}
  - Combined Factor Scaling: \log_{a^m} b^n = rac{n}{m}\log_a b
  - Power Swap Identity: x^{\log_y z} = z^{\log_y x}
- **Inequality Decaying Base Flip:** For expression \log_a x > \log_a y:
  - If base a > 1, the function scales continuously up: x > y.
  - If base is a fraction 0 < a < 1, the function decays, flipping direction: x < y.
- **Modulus Geometric Bounds:** Expression |x - a| \le b maps to the continuous interval range: a - b \le x \le a + b.

3. ADVANCED MODERN MATH, SEQUENCES & COUNTING SUITE

3A. Progressions & Optimization Limits

- **Arithmetic Progression (AP) Series:** T_n = a + (n-1)d \quad;\quad S_n = rac{n}{2}[2a + (n-1)d] = rac{n}{2}[a + T_n].
- **Geometric Progression (GP) Series:** T_n = ar^{n-1} \quad;\quad S_n = rac{a(r^n - 1)}{r-1}.
  - Infinite Sum Convergence: If common ratio tracks strictly within |r| < 1, the series limit converges to: S_\infty = rac{a}{1-r}.
- **AM-GM-HM Inequality Chain:** For any set of strictly positive real terms, their calculated means satisfy:

  rac{a_1 + a_2 + \dots + a_n}{n} \ge (a_1 \cdot a_2 \dots a_n)^{1/n} \ge rac{n}{ rac{1}{a_1} + rac{1}{a_2} + \dots + rac{1}{a_n}}

  Symmetric balance equality (AM = GM = HM) holds true if and only if all variables are identical (a_1 = a_2 = \dots = a_n).

3B. Combinatorics, Permutations & Probability

- **Circular Permutations Counting Invariants:** Arrangement count of n unique objects along a closed loop tracks at (n-1)!. If the physical structure ignores orientation (e.g., beads on a necklace), the unique count halves to rac{(n-1)!}{2}.
- **Total De-arrangements Formula:** Number of ways to rearrange n distinct items into n distinct slots such that no single item lands in its natively intended correct slot is given by:

  D_n = n! \left(1 - rac{1}{1!} + rac{1}{2!} - rac{1}{3!} + \dots + rac{(-1)^n}{n!} ight)

  Shortcut recursive execution format: D_n = (n-1)(D_{n-1} + D_{n-2}) where base cases are D_1 = 0, D_2 = 1.

- **Probability Conditional Updates (Bayes' Theorem):** P(A|B) = rac{P(B|A) \cdot P(A)}{P(B)}.

4. ARITHMETIC ENGINE & NUMBER SYSTEMS

4A. Kinematics, Rates & Work Parameters

- **Proportionality Constancy Rules:**
  - Given constant Distance (D): Speed maps inversely to Time (S_1/S_2 = T_2/T_1).
  - Given constant Time (T): Distance tracks directly with Speed (D_1/D_2 = S_1/S_2).
- **Average Kinematic Velocity:** If distance components match, the net speed is the harmonic mean of velocities:

S_{avg} = rac{2S_1S_2}{S_1 + S_2}

- **Dilution Component Concentrates:** If a container initially holds V units of pure liquid concentrate, and x units are drawn out and replaced with water repeatedly for n independent operation cycles:

ext{Pure Liquid Concentrate Remaining Volume} = V \left(1 - rac{x}{V} ight)^n

4B. Modular Arithmetic, Factoring & Legandre Rules

- **Euler's Totient Rule:** If numbers a and n are co-prime integers, the remainder of expression rac{a^{\phi(n)}}{n} yields exactly 1, where the totient count matches: \phi(n) = n \prod_{p|n} (1 - rac{1}{p}).
- **Highest Exponent Factorials (Legendre's Identity):** The maximum power of a prime factor p that divides factorial value N! completely is given by summing integer quotients across successive powers:

E_p(N!) = \lfloor rac{N}{p} floor + \lfloor rac{N}{p^2} floor + \lfloor rac{N}{p^3} floor + \dots

- **LCM & HCF Fraction Inversions:**

ext{LCM of Fractions} = rac{ ext{LCM of Numerators}}{ ext{HCF of Denominators}} \quad;\quad ext{HCF of Fractions} = rac{ ext{HCF of Numerators}}{ ext{LCM of Denominators}}